

# The Effectiveness of RME Approach to Elementary School Students' Mathematical Abilities: A Meta-Analysis Study

Samritin<sup>1\*</sup> 

<sup>1</sup>Elementary School Teacher Education Study Program, Universitas Muhammadiyah Buton, Baubau, Indonesia

\*Corresponding author: [samritin75@gmail.com](mailto:samritin75@gmail.com)

## Abstrak

Banyak penelitian yang menguji keefektifan pendekatan RME terhadap kemampuan matematika siswa sekolah dasar memberikan hasil yang tidak konsisten. Oleh karena itu, penelitian ini bertujuan untuk menganalisis keefektifan pendekatan RME terhadap kemampuan matematika siswa sekolah dasar dengan menggunakan jenis pendekatan penelitian metaanalisis. Studi meta-analitik ini menganalisis 10 studi primer yang diterbitkan dalam sepuluh tahun terakhir. Pengumpulan data menggunakan database Google Scholar, ERIC, DOAJ, Springer, AIP Proceedings, IOP Sciences, dan Elsevier. Hasil analisis menunjukkan bahwa penerapan pendekatan RME berpengaruh terhadap kemampuan matematika siswa SD jika dibandingkan dengan pembelajaran tradisional ( $g = 0,63$ ;  $p < 0,01$ ). Hasil analisis variabel moderator menunjukkan bahwa pengaruh penerapan pendekatan RME terhadap kemampuan matematika siswa SD berbeda secara signifikan berdasarkan tingkatan kelas ( $Qb = 6,01$ ;  $p = 0,01$ ) dan ukuran sampel ( $Qb = 7,63$ ;  $p = 0,01$ ). Namun, tidak ada perbedaan yang signifikan berdasarkan tahun kelompok studi ( $Qb = 3,16$ ;  $p = 0,08$ ) dan jenis publikasi ( $Qb = 2,58$ ;  $p = 0,11$ ). Temuan ini diharapkan dapat menjadi dasar pemilihan strategi pembelajaran matematika di sekolah dasar agar kualitas pembelajaran dapat ditingkatkan.

**Kata kunci:** Kemampuan Matematika, Sekolah Dasar, RME, Meta-Analysis, Effect Size.

## Abstract

Various studies examining the effectiveness of the RME approach to the mathematics abilities of elementary school students have yielded inconsistent results. Therefore, this study aims to analyze the effectiveness of the RME approach to the mathematics abilities of elementary school students by using a type of meta-analysis research approach. This meta-analytic study analyzed 10 primary studies published in the last ten years. Data collection uses Google Scholar, ERIC, DOAJ, Springer, AIP Proceedings, IOP Sciences, and Elsevier databases. The results of the analysis show that the application of the RME approach has an effect on the mathematics abilities of elementary school students when compared to traditional learning ( $g = 0.63$ ;  $p < 0.01$ ). The results of the moderator variable analysis showed that the effect of applying the RME approach to the mathematics abilities of elementary school students differed significantly based on class level ( $Qb = 6.01$ ;  $p = 0.01$ ) and sample size ( $Qb = 7.63$ ;  $p = 0.01$ ). However, there was no significant difference by year of study group ( $Qb = 3.16$ ;  $p = 0.08$ ) and type of publication ( $Qb = 2.58$ ;  $p = 0.11$ ). These findings are expected to be the basis for selecting strategies for learning mathematics in elementary schools so that the quality of learning can be improved.

**Keywords:** Mathematical Ability, Elementary School, RME, Meta-Analysis, The Effect Size.

### History:

Received : January 28, 2023

Revised : January 30, 2023

Accepted : April 06, 2023

Published : April 25, 2023

**Publisher:** Undiksha Press

**Licensed:** This work is licensed under a Creative Commons Attribution 4.0 License



## 1. INTRODUCTION

Mathematics is a general science that underlies the latest technological advances, has an important function in various fields of science and develops the power of the human mind. Apart from being an autonomous knowledge study that can stand alone, and the only science that has the most real human creativity capabilities, mathematics also has a meaning as a tool, servant, and as a means of communication for other knowledge (Budi et al., 2020; Keller, B.A., Hart, E.W., & Martin, 2001). Mathematics is able to formulate problem phenomena with mathematical models. Furthermore, the mathematical model is solved using mathematical analysis and the solution results are obtained through computation or mathematical calculations. Even if mathematical modeling cannot be solved through ordinary mathematical analysis, it can be done using computational science through numerical simulations.

Mathematical ability is a person's ability to acquire, process, and store mathematical information or as the capacity to learn and master new mathematical ideas and skills (Koshy et al., 2009; Vilkomir & O'Donoghue, 2009). Mathematical ability can also be defined as a student's ability to effectively solve a given mathematical problem. Mathematical abilities have an important role in the development of science and technology (Nizham et al., 2017; Rosa & Orey, 2011; Siagian, 2016). Mathematical ability has an important role in the formation of habits, positive attitudes, and the ability to create plausible hypotheses and challenges. A strong foundation in mathematics can provide abilities that will be useful in future mathematics lessons, other academic courses, and life in general. Good mathematical abilities from an early age are more likely for them to succeed in school (Chesloff, 2013; Maulana, 2019; Rosa & Gavarrete, 2017). Therefore, math skills are very important for students to strengthen since they are in elementary school.

Based on Piaget's cognitive development theory, elementary school students are at the concrete operational stage. At this stage, the construction of new knowledge will be easier if the teacher displays material in real terms according to what they see (Desstya et al., 2017; Fredricks et al., 2016). But in fact, learning mathematics in the abstract is one of the causes of students' dislike of mathematics. Many students think that learning mathematics is scary, boring, and unimportant (Kurniasih et al., 2020; Van den Heuvel-Panhuizen & Drijvers, 2020). Mathematics learning presented by teachers tends to be theoretical without giving meaning to learning mathematics itself. This problem causes students to have difficulty understanding mathematical concepts and fail to find meaning in learning mathematics. Therefore, in order to make mathematics learning more meaningful and easy for students to understand, teachers must apply a learning approach that is able to make it easier for students to understand material abstractly and give the impression of learning mathematics that is more meaningful. one of the appropriate approaches is a realistic approach to mathematics education (RME).

The RME approach teaches students to relate learning in a real way so that it will make it easier for students to improve their problem-solving skills independently (Zakaria & Syamaun, 2017). The RME implementation emphasizes that mathematics education is a human activity and emphasizes the use of the real world (Lestari & Surya, 2017; Zakaria & Syamaun, 2017). Furthermore, previous study state that applying real-life use can assist in explaining topics that exist in mathematics learning objectives by making mathematics learning more meaningful (Rasmussen & King, 2000). Previous study stated that the RME learning model provides the widest possible opportunity for learners to build their knowledge through a given problem-solving process (Warsito & Herman, 2018). RME helps teachers to improve students' mathematics skills. This is because RME facilitates students with the tools necessary to discuss, think critically, and solve real-world problems around students (Hasibuan et al., 2019; Tanujaya et al., 2017).

Many studies have shown that the RME method is better than the traditional method for improving primary school students' mathematics skills (Hidayat et al., 2020; Noviani et al., 2017; Warsito & Herman, 2018) But distinct outcomes were discovered by previous study who found that there was no significant difference between mathematics learning and the RME approach and the traditional approach (Uskun et al., 2021). These results indicate inconsistencies regarding the effectiveness of the RME approach to elementary school students' mathematics skills. Based on this problem, To confirm and support earlier findings on the impact of the RME approach on primary school students' mathematical competence, further study is required (Altaylar & Kazak, 2021; Cahyaningsih & Nahdi, 2021; Gistituati & Atikah, 2022). A meta-analysis study must be conducted for this reason. Meta-analysis is one of the efforts to summarize various research results quantitatively (Borenstein et al., 2021; Retnawati et al., 2018). Meta-analysis can improve the validity of certain fields of study

because it combines study findings with similar findings (Karbono & Retnawati, 2021; Turgut, 2022). This study looks at the consistency or inconsistency of research findings brought on by the rising number of research replications and verifications, which frequently increase the likelihood of differences in research findings. Studies that use meta-analysis assess the findings of earlier research to draw detailed and precise conclusions (Young, J. R., Ortiz, N., & Young, 2016; Young, 2017).

Based on the results of a literature review, the effectiveness of employing the RME approach has been investigated in a meta-analysis study (Ariati et al., 2022; Juandi & Tamur, 2021; Tamur et al., 2021). However, the meta-analysis study did not focus on testing the effectiveness of using the RME approach on mathematical ability at the elementary school level. The purpose of this study is to assess the effectiveness of the RME approach and traditional teaching methods in improving the mathematical skills of students in primary schools. The effectiveness of using the RME approach to improve primary school students' mathematical skills along with other factors that might have an impact. This study is anticipated to yield more precise findings that can be used as a foundation for policy-making to achieve the standard of mathematics instruction in elementary schools.

## **2. METHODS**

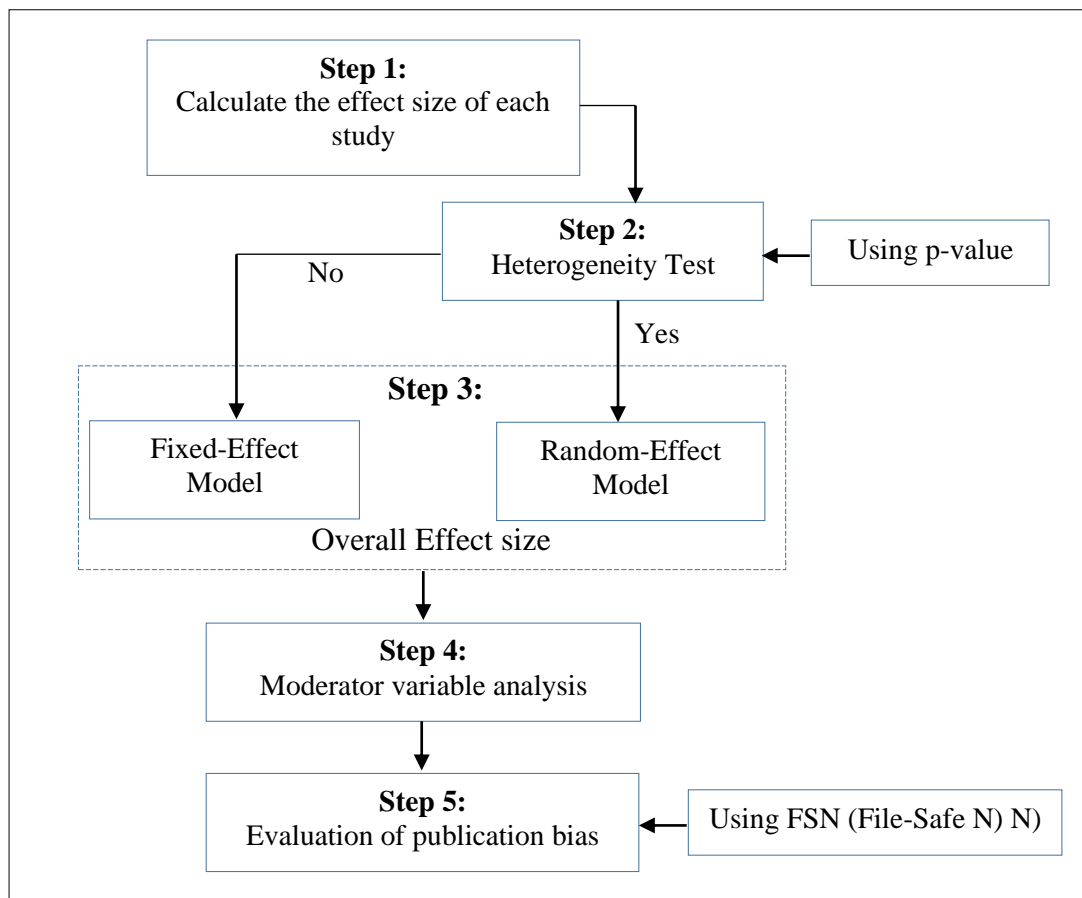
Various studies on the effectiveness of the RME approach to mathematical abilities that have been carried out previously have yielded inconsistent results. Therefore, this study uses a meta-analysis research design (Borenstein et al., 2021). The meta-analysis research procedures included determining inclusion criteria, data collection, data coding/extraction, and data analysis. The population in this study were all studies on the effectiveness of the RME approach to students' mathematical abilities which were published in national and international journals. The sample taken is a study that meets the inclusion criteria set by the researcher. The purpose of the inclusion criteria is to identify the studies that can be included in a systematic review with meta-analysis. The following criteria were used in this meta-analysis: 1.) Known publications ranging from 2017 to 2022. 2.) Research using the experimental research methods. 3.) There is a minimum of 1 experimental group that applies the RME approach and a control group with traditional teaching. 4.) Research should report enough statistical data. 5.) Research is published in national and international journals. The stage of collecting relevant literature with inclusion criteria was established using online databases such as Google Scholar, ERIC, DOAJ, Springer publishing, AIP Proceedings, IOP Sciences, and Elsevier. The keywords used in literature searches are "RME", "PMRI", and "primary school". The search results found 112 studies that were successfully collected on the effectiveness of the application of RME in elementary schools. Furthermore, the collected research is filtered based on established inclusion criteria. The process resulted in 10 primary studies that met the eligibility criteria.

The instrument in this meta-analysis used a coding sheet which contained data extraction from the primary studies used in the research. Coding needs to be done to record research results that will be aggregated in a meta-analysis. The coding sheet in this meta-analysis study contains information about the statistical data to calculate the effect size, namely the sample size, mean, standard deviation, p-value, t-value of each primary study. Categorical information includes grade level, sample size, year of publication, and type of publication. Statistical analysis in this study includes: Calculating the effect size of each study, conducting heterogeneity tests, calculating summary of effects/combined effect sizes, analysis of moderator variables, and evaluating publication bias. Statistical analysis in this study using the OpenMEE application. This application has quite complete features for conducting meta-analysis studies. OpenMEE is also efficient in conducting activities to

analyze subgroups (moderator variables). The classification of the effect size of each study and the combined effect size in this study refers to the classification shown in Table 2. Then Figure 1 presents the flow of statistical analysis in this study. The meta-analysis focuses on effect size.

**Table 2.** Categories of Effect Size (g) Groups Using the Cohen Interpretation

No	Classification	Interval
1	Weak	$g \leq 0.20$
2	Moderate	$0.20 < g \leq 0.50$
3	Strong	$0.50 < g \leq 1.00$
4	Very Strong	$g > 1.00$



**Figure 1.** Statistical Analysis in this Meta-Analysis

### 3. RESULTS AND DISCUSSION

#### Results

##### *The Effect Size of Each Study*

Effect sizes range from 0.142 to 4.865 according to the analysis of 10 primary studies. Three effect sizes (n = 3) are considered to be very strong effects, three effect sizes (n = 3) are considered to be strong effects, three effect sizes (n = 3) are considered to be moderate effects, and one effect size (n = 1) is considered to be a weak effect. Table 3 provides more information.

**Table 3.** The Effect Size of Each Study

No	Author	Characteristics of study			Effect Size (g)	Variant
		Grade Level	Sample Size	Publication Type		
1	(Hidayat et al., 2020)	Tall	Small	Journal	0.90	0.08
2	(Praja et al., 2022)	Tall	Small	Proceeding	1.31	0.18
3	(Herman et al., 2019)	Tall	Small	Proceeding	1.08	0.08
4	(Ulandari et al., 2019)	Tall	Small	Journal	0.83	0.22
5	(Noviani et al., 2017)	Low	Big	Journal	0.56	0.05
6	(Cahyaningsih & Nahdi, 2021)	Tall	Small	Proceeding	0.48	0.13
7	(Altaylor & Kazak, 2021)	Tall	Small	Journal	0.35	0.08
8	(Uskun et al., 2021)	Tall	Big	Journal	0.14	0.06
9	(Gistituati & Atikah, 2022)	Tall	Small	Journal	0.39	0.08
10	(Kurniasih et al., 2020)	Low	Small	Journal	4.86	0.32

**Heterogeneity and Overall Effect Size Tests**

The results of the heterogeneity test yielded a Q value of 67.99 > chi-square (df = 9). It may be said that the effect size variations of the 10 studies that were examined were heterogeneous. Because of this, a random-effect estimating model is employed. The overall effect size is (g = 0.63; p 0.01) according to the random-effect estimation model. The group of powerful effects includes this effect. Therefore, it can be said that the RME approach has a significant impact on primary school students' mathematical abilities. Summary of heterogeneity and combined effect size test results is show in Table 4.

**Table 4.** Summary of Heterogeneity and Combined Effect Size Test Results

Estimation Model	k	Effect Size (g)	95% Confidence Interval	p	Df	Heterogeneity		
						Q	P	I <sup>2</sup>
Random	10	0.63	[0.46, 1.53]	< 0.01	9	67.99	< 0.01	86.76
Fixed	10	0.72	[0.53, 0.91]	< 0.01	9			

**Moderator Variable Analysis**

Prior research revealed that the variation in impact size across all assessed studies was heterogeneous, suggesting that it may be used as a variable in future analysis. Table 5 provides a summary of the analysis of the moderator variables.

**Table 5.** Moderator Variable Analysis

Moderator Variables	K	d	p	Heterogeneity				
				Q	Df	Qw	Qb	P
Overalls	10	0.63	< 0.01	67.99	9			
<b>Grade Level</b>								
High Grade (Grade 4-6)	8	0.63	< 0.01	12.01	1	61.98	6.01	0.01
Low Grade (Grade 1-3)	2	1.14	< 0.01	49.97				
<b>Sample Size</b>								
≥ 31	2	0.36	0.08	1.60	1	60.36	7.63	0.00
≤ 30	8	1.19	< 0.01	58.76				
<b>Year of Publication</b>								
2017-2019	2	0.99	< 0.01	0.20	1	64.83	3.16	0.08
2020-2022	8	1.01	< 0.01	64.63				

Moderator Variables	K	d	p	Heterogeneity				
				Q	Df	Qw	Qb	P
<b>Publication Type</b>								
Journal	7	1.03	< 0.01	62.78	1	65.41	2.58	0.11
Proceeding	3	0.95	< 0.01	2.63				

Note. k = number of studies; Qw = Q within; Qb = Q intermediate

Based on Table 5, the grade level, it was found that the average effect size of the high-class group was ( $g = 0.63$ ;  $p < 0.01$ ), and the low-grade group was ( $g = 1.14$ ;  $p < 0.01$ ). The results of the average difference test between the two groups showed that there was a significant difference ( $Qb = 6.01$ ;  $p = 0.01$ ). This suggests that the grade level affects the effectiveness of using the RME approach to the mathematical abilities of primary school students compared to traditional learning approaches. Based on the sample size, it was discovered that the sample group of less than 30 had an effect size of  $g = 1.19$  with  $p = 0.01$  while the sample group of more than 30 had an effect size of  $g = 0.36$  with  $p = 0.08$ . This suggests that the sample size affects the effectiveness of using the RME approach to the mathematical abilities of primary school students compared to traditional learning approaches.

According to the year of publication, it was discovered that the effect size for the 2017–2019 group was ( $g = 0.99$ ;  $p = 0.01$ ) and the effect size for the 2020–2022 group was ( $g = 1.01$ ;  $p = 0.01$ ). The average difference test findings between the two groups revealed that there was no discernible difference ( $Qb = 3.16$ ;  $p = 0.08$ ). This suggests that the variables of the year of the study did not affect the effectiveness of using the RME approach to the mathematical abilities of primary school students compared to traditional learning approaches. According to the form of publishing, the journal group's average effect size was ( $g = 1.03$ ;  $p = 0.01$ ) and the proceedings group's average effect size was ( $g = 0.95$ ;  $p = 0.01$ ). The average difference test findings between the two groups revealed no discernible difference ( $Qb = 2.58$ ;  $p = 0.11$ ). It is not significant difference was found. This implies that using the RME strategy to improve primary school students' mathematical abilities is just as effective as using more conventional teaching methods, regardless of the publishing type variable..

### Publication Bias

One thing to note in meta-analysis research is the possibility of publication bias, namely the possibility that the studies available for analysis will usually be a biased sample of all existing studies. This is probably because all the studies used tend to be published with only significant results. Therefore an analysis of publication bias is needed so that a publication bias test is needed so that the data obtained is valid and free of publication bias. The publication bias test in this study used the N Rosenthal fail-safe test with the help of OpenMEE software. A overview of the findings from the publication bias test is shown in Table 6.

**Table 6.** File-Safe N (FSN)

	K	FSN	Target Significance	Observed Significance
Rosenthal	10	269	0.05	< 0.01

Base on Table 6, the analysis of publication bias produced the value  $FSN = 1973 > 5k+10 = 5(10) + 10 = 60$ . According to this score, there is no discernible publication bias in the papers that have been looked at to determine how the RME technique has affected primary school students' mathematical skills.

## **Discussion**

The analysis findings revealed that the joint effect size was ( $g = 0.63$ ;  $p 0.01$ ). The effect size is in the strong effect category. These findings indicate that compared to conventional teaching methods, the RME approach has a significant effect on the mathematics abilities of elementary school students. This is because at the stage of understanding contextual problems in the RME approach it makes it easier for students to understand problems by seeing what is known and what is asked, developing problem-solving plans, carrying out problem-solving plans, and correcting the solutions that have been obtained. Contextual problems that are presented in real life and are familiar to students make it easier for students to solve problems. This is in accordance with the opinion of previous study that state learning that uses problems that are close to life and the environment so that they are accessible to students' imagination, makes it easier for students to find solutions to problems systematically (Ulandari et al., 2019). Other study stated that the RME approach is one of the most effective approaches in developing mathematical representations, beliefs and problem-solving skills that can improve student achievement (Yuanita et al., 2018). According to study the RME approach has the characteristics of using contextual problems where students are given math problems related to everyday life that are close to students (Noviani et al., 2017). The findings of this investigation support the meta-analysis studies carried out (Juandi et al., 2022; Tamur et al., 2021; Turgut, 2022). Additionally, their findings categorically state that the RME approach is superior than the conventional approach. As a result, the RME technique is strongly advised for elementary school mathematics instruction. Furthermore, based on the analysis of moderator variables at the class level, the effect size of the low class group was greater than that of the high class group. The results of the two groups' difference test showed that class-level variables affected the impact of the application of the RME approach on the mathematics abilities of elementary school students. This means that the RME approach will be more effectively applied at the lower grade level (grades 1-3) compared to the upper grade level (grades 4-6). To get more consistent and accurate results, further research can analyze it further by utilizing more primary data.

The sample size analysis shows that the effect size is bigger for the sample size  $\leq 30$  than for the sample size more  $> 30$ . This demonstrates that using the RME technique on a sample group with fewer than 30 participants is more successful than using it on a sample group with more participants. These results are in line with a meta-analysis study which revealed that the effect of RME use on students' mathematical ability was influenced by smaller sample sizes (Juandi et al., 2022; Tamur et al., 2021). However, in contrast to the findings of previous study who found that small sample sizes have less effect size than large samples (Bayir & Bozkurt, 2018). This inconsistency of results can be investigated further by involving the synthesis of more primary studies. Although the results of the analysis showed that the average effect size of the two groups differed significantly, it was proven that the RME approach was effective when applied to both groups. Based on the variables of the study year, it was found that the effect size of the 2020-2022 research year group was higher than the 2017-2019 group. Although no discernible variations were detected between the two groups' average effect sizes, It has been demonstrated that applying the RME approach to the mathematical aptitude of primary school kids did not suffer from the effects of the research year's variables. These findings are also in line with the findings of which showed that the variables of the research years (2010-2015 and 2016-2019) had no impact on how well RME was used to improve students' mathematical skills (Juandi et al., 2022). As opposed to finding which indicated that the effect size of the year of publication tends to be bigger (Purnomo et al., 2022). Further research can be conducted by utilizing more primary sources to achieve more reliable results. Based on the publishing type variable, it was discovered that the journal publication group had a larger effect size than the proceedings publication group. The

average effect size between the two groups, however, did not show any discernible variations. It is demonstrated that applying the RME technique to the mathematical aptitude of primary school kids is successful regardless of the publishing type variable. These results support which discovered that the publication type variable had no bearing on how well RME improved students' mathematical skills (Tamur et al., 2021).

This meta-analysis study only examined journal-sourced research, so the number of studies involved only 10 primary studies. In the future, we can expand the number of studies by involving other sources such as master's theses and doctoral dissertations. It is expected to be consistent and strengthen the findings of this meta-analysis study, thus allowing generalizations to be broader. In addition, the moderator variables analyzed were limited to four variables, namely class level, sample size, known research, and publication type. Further research can be further examined by involving other moderator variables, such as sampling techniques, sample size, duration of experiments, and types of subject matter so that the results of the analysis are broader.

#### 4. CONCLUSION

Based on a meta-analysis of 10 main studies that examined the effectiveness of the RME approach on elementary school students' mathematical abilities, it can be concluded that overall (without looking at moderator variables) the use of the RME approach has a significant effect on elementary school students' mathematical abilities. In addition, based on the analysis of moderator variables, it was found that class level and sample size variables influenced the impact of using the RME approach on the mathematics abilities of elementary school students, but the variables of research year and source of publication did not affect the impact of using the RME approach on mathematics abilities. elementary school students. Skills integrating Canva in the learning process may be necessary for future studies.

#### 5. REFERENCES

- Altaylar, B., & Kazak, S. (2021). The Effect of Realistic Mathematics Education on Sixth Grade Students' Statistical Thinking. *Acta Didactica Napocensia*, 14(1), 76–90. <https://doi.org/10.24193/adn.14.1.6>.
- Ariati, C., Anzani, V., Juandi, D., & Hasanah, A. (2022). Meta-Analysis Study: Effect of Realistic Mathematics Education Approach On Student's Mathematical Literacy Ability. *Axioma: Journal of Mathematics Education Study Program*, 11(4), 2953–2963. <https://doi.org/10.24127/ajpm.v11i4.6182>.
- Bayir, O. G., & Bozkurt, M. (2018). Effectiveness of Cooperative Learning Approaches Used in the Course of Social Studies in Turkey: A Meta-Analysis Study. *Online Submission*, 4(10), 171–192. <https://doi.org/10.5281/zenodo.1313863>.
- Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2021). *Introduction to meta-analysis*. John Wiley & Sons.
- Budi, S., Darmawan, H., & Saputro, M. (2020). Analysis of Mathematic Communication Ability to be Reviewed From Student Learning Creativity In Statistical Materials. *Daya Matematis: Jurnal Inovasi Pendidikan Matematika*, 8(1), 105. <https://doi.org/10.26858/jds.v8i1.13325>.
- Cahyaningsih, U., & Nahdi, D. S. (2021). The effect of realistic mathematics education on elementary students' critical thinking skills. *In Journal of Physics: Conference Series*, 1764(1), 012127.
- Chesloff, J. D. (2013). STEM education must start in early childhood. *Education Week*, 32(23), 27–32.



- [https://www.academia.edu/download/72533316/1303\\_EdWeek\\_STEMEarlyChildhood.pdf](https://www.academia.edu/download/72533316/1303_EdWeek_STEMEarlyChildhood.pdf).
- Desstya, A., Novitasari, I. I., Razak, A. F., & Sudrajat, K. S. (2017). Refleksi pendidikan IPA sekolah dasar di Indonesia (relevansi model pendidikan Paulo Freire dengan pendidikan IPA di sekolah dasar). *Profesi Pendidikan Dasar*, 4(1), 1–11. <https://journals.ums.ac.id/index.php/ppd/article/view/2745>.
- Fredricks, J. A., Wang, M. Te, Schall Linn, J., Hofkens, T. L., Sung, H., Parr, A., & Allerton, J. (2016). Using qualitative methods to develop a survey measure of math and science engagement. *Learning and Instruction*, 43, 5–15. <https://doi.org/10.1016/j.learninstruc.2016.01.009>.
- Gistituati, N., & Atikah, N. (2022). E-Module Based on RME Approach in Improving the Mathematical Communication Skills of Elementary Students. *Elementary School Scientific Journal*, 6(1), 106–115. <https://doi.org/10.23887/jisd.v6i1.42314>.
- Hasibuan, A. M., Saragih, S., & Amry, Z. (2019). Development of Learning Materials Based on Realistic Mathematics Education to Improve Problem-Solving Ability and Student Learning Independence. *International Electronic Journal of Mathematics Education*, 14(1), 243–252. <https://doi.org/10.29333/iejme/4000>.
- Herman, M., Arnawa, I. M., & Ardipal, A. (2019). The Effect of Realistic Mathematic Education (RME) toward Motivation and Learning Achievement of the Fourth Grade Elementary Students. In *1st International Conference on Innovation in Education (ICoIE 2018)*, 508–511. <https://doi.org/10.2991/icoie-18.2019.109>.
- Hidayat, E. I. F., Yandhari, I. A. V., & Alamsyah, T. P. (2020). The Effectiveness of Realistic Mathematics Education (RME) Approaches to Improve the Comprehension Ability of Mathematical Concepts of Grade V Students. *Elementary School Scientific Journals*, 4(1), 106–113. <https://doi.org/10.55951/nurture.v17i2.253>.
- Juandi, D., Kusumah, Y. S., & Tamur, M. (2022). A meta-analysis of the last two decades of realistic mathematics education approaches. *International Journal of Instruction*, 15(1), 381–400. <https://doi.org/10.29333/iji.2022.15122a>.
- Juandi, D., & Tamur, M. (2021). Review of problem-based learning trends in 2010-2020: A meta-analysis study of the effect of problem-based learning in enhancing mathematical problem-solving skills of Indonesian students. *Journal of Physics: Conference Series*, 1722(1), 12103. <https://doi.org/10.1088/1742-6596/1722/1/012103>
- Karbono, K., & Retnawati, H. (2021). The Correlation between Religiosity and Multiple Intelligences: A Meta-Analysis. *International Journal of Instruction*, 14(1), 365–378. <https://doi.org/10.29333/iji.2021.14121a>.
- Keller, B.A., Hart, E.W., & Martin, W. G. (2001). Illuminating NCTM's principles and standards for school mathematics. *School Science and Mathematics*, 101(6), 292–304. <https://doi.org/10.1111/j.1949-8594.2001.tb17960.x>.
- Koshy, V., Ernest, P., & Casey, R. (2009). Mathematically gifted and talented learners: theory and practice. *International Journal of Mathematical Education in Science and Technology*, 40(2), 213–228. <https://doi.org/10.1080/00207390802566907>.
- Kurniasih, A. W., Hidayah, I., & Asikin, M. (2020). Developing mathematics learning materials of fifth grade of elementary school integrating mathematics game, problem posing, and manipulative. In *Journal of Physics: Conference Series*, 1567(2), 022089. <https://iopscience.iop.org/article/10.1088/1742-6596/1567/2/022089/meta>.
- Lestari, L., & Surya, E. (2017). The effectiveness of realistic mathematics education approach on ability of students' mathematical concept understanding. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 34(1), 91–100. <https://core.ac.uk/download/pdf/249335868.pdf>.

- Maulana, D. F. (2019). The ability of mathematical literacy on learning treffinger realistic assistance schoology. *Journal of Physics: Conference Series*, 1321(3). <https://doi.org/10.1088/1742-6596/1321/3/032132>.
- Nizham, H., Suhendra, S., & P., B. A. (2017). Improving ability mathematic literacy, self-efficacy and reducing mathematical anxiety with learning Treffinger model at senior high school students. *International Journal of Science and Applied Science: Conference Series*, 2(1), 130. <https://doi.org/10.20961/ijsascs.v2i1.16696>.
- Noviani, J., Syahputra, E., & Murad, A. (2017). The effect of realistic mathematics education (RME) in improving primary school students' spatial ability in subtopic two-dimension shape. *JEP*, 8(34), 112–126. [https://www.researchgate.net/profile/Edi-Syahputra/publication/322326573\\_The\\_Effect\\_of\\_Realistic\\_Mathematic\\_Education\\_RME\\_in\\_Improving\\_Primary\\_School\\_Students'\\_Spatial\\_Ability\\_in\\_Subtopic\\_Two-Dimension\\_Shape/links/5a540efbaca2725638cb5861/The-Effect-of-Realistic-Mathematic-Education-RME-in-Improving-Primary-School-Students-Spatial-Ability-in-Subtopic-Two-Dimension-Shape.pdf](https://www.researchgate.net/profile/Edi-Syahputra/publication/322326573_The_Effect_of_Realistic_Mathematic_Education_RME_in_Improving_Primary_School_Students'_Spatial_Ability_in_Subtopic_Two-Dimension_Shape/links/5a540efbaca2725638cb5861/The-Effect-of-Realistic-Mathematic-Education-RME-in-Improving-Primary-School-Students-Spatial-Ability-in-Subtopic-Two-Dimension-Shape.pdf).
- Praja, A. F. N., Budiarti, S., & Samsiyah, N. (2022). The effectiveness of the realistic mathematics education (rme) approach to improve the ability to understand mathematics in grade IV SDN Sempu, Ponorogo Regency. *Proceedings of the Basic Scientific Conference*, 3, 548–553. <http://journal.um-surabaya.ac.id/index.php/pgsd/article/view/7336>.
- Purnomo, B., Muhtadi, A., Ramadhani, R., Manaf, A., & Hukom, J. (2022). The effect of flipped classroom model on mathematical ability: A meta-analysis study. *Jurnal Pendidikan Progresif*, 12(3), 1201–1217. <https://doi.org/10.23960/jpp.v12.i3.202216>.
- Rasmussen, C. L., & King, K. D. (2000). Locating starting points in differential equations: A realistic mathematics education approach. *International Journal of Mathematical Education in Science and Technology*, 31(2), 161–172. <https://doi.org/10.1080/002073900287219>.
- Retnawati, H., Djidu, H., Kartianom, K., Apino, E., & Anazifa, R. D. (2018). Teachers' Knowledge About Higher-Order Thinking Skills And Its Learning Strategy. *Problems of Education in the 21st Century*, 76(2), 215–230. <https://doi.org/10.33225/pec/18.76.215>.
- Rosa, M., & Gavarrete, M. E. (2017). An Ethnomathematics Overview: An Introduction. *ICME-13 Monographs*, 3–19. [https://doi.org/10.1007/978-3-319-59220-6\\_1](https://doi.org/10.1007/978-3-319-59220-6_1).
- Rosa, M., & Orey, D. (2011). Ethnomathematics: the cultural aspects of mathematics. *Revista Latinoamericana de Etnomatemática*, 4(2), 32–54. <http://funes.uniandes.edu.co/3079/>
- Siagian, M. D. (2016). Kemampuan koneksi matematik dalam pembelajaran matematika. *MES: Journal of Mathematics Education and Science*, 2(1), 58–67. <https://doi.org/10.30743/mes.v2i1.117>.
- Tamur, M., Jehadus, E., Nurjaman, A., Mandur, K., & Ndiung, S. (2021). The effect of the realistic mathematics education approach: Meta-analysis of the measured mathematical ability angle. In *1st International Conference on Mathematics and Mathematics Education (ICMMEd 2020)*, 40–46. <https://doi.org/10.2991/assehr.k.210508.040>.
- Tanujaya, B., Prahmana, R. C. I., & Mumu, J. (2017). Mathematics instruction, problems, challenges and opportunities: A case study in Manokwari Regency, Indonesia. . *World Transactions on Engineering and Technology Education*, 15(3), 287–291. <http://repository.unipa.ac.id:8080/xmlui/handle/123456789/267>.
- Turgut, İ. G. (2022). The Effects of Realistic Mathematics Education on Mathematics Attitudes of Turkish Students: A Meta-Analysis. *Bartın University Journal of Faculty of Education*, 11(2), 446–460. <https://doi.org/10.14686/buefad.987649>.

- Ulandari, L., Amry, Z., & Saragih, S. (2019). Development of Learning Materials Based on Realistic Mathematics Education Approach to Improve Students' Mathematical Problem Solving Ability and Self-Efficacy. *International Electronic Journal of Mathematics Education*, 14(2), 375–383. <https://doi.org/10.29333/iejme/5721>.
- Uskun, K. A., Osman, Ç. İ. L., & Okan, K. U. Z. U. (2021). The effect of realistic mathematics education on fourth graders' problem posing/problem-solving skills and academic achievement. *Eğitimde Nitel Araştırmalar Dergisi*, 28, 22–50. <https://doi.org/10.14689/enad.28.2>.
- Van den Heuvel-Panhuizen, M., & Drijvers, P. (2020). Realistic mathematics education. *Encyclopedia of Mathematics Education*, 713–717. [https://link.springer.com/content/pdf/10.1007/978-3-030-15789-0\\_170.pdf](https://link.springer.com/content/pdf/10.1007/978-3-030-15789-0_170.pdf).
- Vilkomir, T., & O'Donoghue, J. (2009). Using components of mathematical ability for initial development and identification of mathematically promising students. *International Journal of Mathematical Education in Science and Technology*, 40(2), 183–199. <https://doi.org/10.1080/0020739080>.
- Warsito, D., & Herman, T. (2018). Improving students' mathematical representational ability through RME-based progressive mathematization. *Journal of Physics: Conference Series*, 948(1), 012038. <https://doi.org/10.1088/1742-6596/948/1/012038>.
- Young, J. R., Ortiz, N., & Young, J. L. (2016). STEMulating interest: A meta-analysis of the effects of out-of-school time on student STEM interest. *International Journal of Education in Mathematics, Science and Technology*, 5(1), 62–74. <https://doi.org/10.18404/ijemst.61149>.
- Young, J. R. (2017). Technology integration in mathematics education: examining the quality of metaanalytic research. *International Journal on Emerging Mathematics Education*, 1(1), 71–86. <https://doi.org/10.12928/ijeme.v1i1.5713>.
- Yuanita, P., Zulnaldi, H., & Zakaria, E. (2018). The effectiveness of Realistic Mathematics Education approach: The role of mathematical representation as mediator between mathematical belief and problem solving. *PloS One*, 13(9), e0204847. <https://doi.org/10.1371/journal.pone.0204847>.
- Zakaria, E., & Syamaun, M. (2017). The effect of realistic mathematics education approach on students' achievement and attitudes towards mathematics. *Mathematics Education Trends and Research*, 1(1), 32–40. <https://doi.org/10.5899/2017/metr-00093>.