Mandalika Mathematics and Education Journal
Volume 7 Nomor 4 Desember 2025
e-ISSN 2715-1190| |p-ISSN 2715-8292
DOI: http://dx.doi.org/10.29303/jm.v7i4.10165

Meta-analysis of the effect of RME on students' critical thinking skills

Irfantoni Eksa Indrastoto [1], Ali Mahmudi [2*]

[1] *Mahasiswa Pendidikan Matematika, FMIPA, Universitas Negeri Yogyakarta, Yogyakarta*
[2] *Pendidikan Matematika, FMIPA, Universitas Negeri Yogyakarta, Yogyakarta*

irfantonieksa.2023@student.uny.ac.id

Diterima: 07-11-2025; Direvisi: 23-11-2025; Dipublikasi: 02-12-2025

Abstract
This study aims to conduct a meta-analysis of studies evaluating the impact of the Realistic Mathematics Education (RME) approach on enhancing students' critical thinking skills. Using a meta-analytic method, this research combines data from 16 studies to calculate effect sizes, test data heterogeneity, and analyze moderator variables. The effect size is calculated using the Hedges' g formula and classified according to Cohen's criteria: small (less than 0.2), medium (0.2–0.5), and large (above 0.8). The findings show that RME has a significant positive impact, with effect sizes ranging from 0.193 to 2.737. The largest impact was found in urban areas (effect size 1.2014) compared to rural areas (effect size 0.5581). At the elementary school level, the effect size was 0.7908, and at the junior high school level, it was 0.8287. The highest effect size was recorded in the 2023–2025 period (1.1487). Based on these results, it is recommended that educators and policymakers adopt the RME approach, considering local context and student characteristics. Further research with a larger dataset will strengthen statistical validity and deepen understanding of RME implementation in various learning contexts.

Keywords: Meta-analysis 1; Realistic Mathematics Education 2; Critical Thinking 3

Abstrak
Penelitian ini bertujuan untuk melakukan meta-analisis terhadap studi-studi yang mengevaluasi dampak pendekatan Realistic Mathematics Education (RME) dalam meningkatkan keterampilan berpikir kritis siswa. Menggunakan metode meta-analisis, penelitian ini menggabungkan data dari 16 studi untuk menghitung ukuran efek, menguji heterogenitas data, dan menganalisis variabel moderator. Ukuran efek dihitung dengan rumus Hedges' g dan diklasifikasikan menurut kriteria Cohen: kecil (kurang dari 0,2), sedang (0,2–0,5), dan besar (di atas 0,8). Temuan menunjukkan bahwa RME memberikan dampak positif signifikan dengan ukuran efek antara 0,193 hingga 2,737. Dampak terbesar tercatat di daerah perkotaan (1,2014) dibandingkan perdesaan (0,5581). Pada jenjang SD, ukuran efek 0,7908 dan SMP 0,8287. Periode 2023–2025 mencatat ukuran efek tertinggi (1,1487). Berdasarkan hasil ini, disarankan agar pendidik dan pemangku kebijakan mengadopsi pendekatan RME, dengan mempertimbangkan konteks lokal dan karakteristik siswa. Penelitian selanjutnya dengan data yang lebih luas akan memperkuat validitas statistik dan memperdalam pemahaman tentang penerapan RME di berbagai konteks pembelajaran.

Kata Kunci: Meta-Analisis 1; Realistic Mathematics Education 2; Berpikir Kritis 3

1. INTRODUCTION

In the modern era, marked by rapid advancements in technology and information, the learning system must continuously adapt to meet the demands of the times. Modern education has shifted from merely transferring knowledge to actively fostering students' critical thinking abilities, aiming to equip them for the growing complexities of future challenges (Hidayah et al., 2017; Miterianifa et al., 2021).

Factually, critical thinking skills are highly important because today's learners live amid an overwhelming flow of information that is rapid, complex, and often unverified. The World Economic Forum (2018)World Economic reports that critical thinking is one of the three most essential skills required in the twenty-first-century workforce. Moreover, recent findings from PISA and TIMMS also indicate that many students still demonstrate weaknesses in higher-order reasoning abilities, further emphasizing the urgency of strengthening critical thinking skills in schools. Theoretically, the urgency of critical thinking is supported by Facione (2015), who asserts that critical thinking is a disciplined intellectual process involving interpretation, analysis, evaluation, and inference as the foundation for rational decision-making. This view is reinforced by Ennis (2011), who states that critical thinking is an essential skill that enables students to assess information logically and systematically. This skill has become a central focus of modern education due to its significant impact on academic success and its role in preparing students for the workforce (Aisyah et al., 2021; Rivas et al., 2023; TRIPON, 2019). Therefore, critical thinking ability has become a fundamental competence that must be cultivated through modern instructional practices.

In the face of the shifting educational paradigm that increasingly emphasizes innovative and contextual approaches, the Realistic Mathematics Education (RME) approach has the potential to enhance student learning outcomes while simultaneously developing critical thinking skills, which are crucial in the 21st century (Nur & Angriani, 2021). Hans Freudenthal originally introduced this concept, highlighting that mathematics should not be viewed as a set of abstract rules, but as a human activity that becomes more meaningful when taught through exploration and real-world experiences. (Freudenthal, 1991; Gravemeijer, 1994). Students get a deeper comprehension of mathematical ideas as well as analytical and evaluative skills, both of which are essential for critical thinking through a context-based approach grounded on real-world situations. RME also enables students to independently explore mathematical concepts and cultivate flexible problem-solving strategies, fostering a habit of thinking systematically and logically in addressing various problems. RME plays a crucial role in developing students' thinking flexibility and analytical skills in tackling various mathematical challenges (Hickendorff et al., 2022; Telaumbanua et al., 2023). By encouraging the exploration of various problem-solving strategies, in-depth discussions, and critical evaluations of the results obtained, students are trained to think rationally and independently. This approach greatly strengthens students' critical thinking, problem-solving, and mathematical

communication skills in addition to improving their understanding of mathematical ideas (Delfita et al., 2019; Elwijaya et al., 2020; Hidayah, 2021). Through active social interaction, students can exchange ideas, test arguments, and provide justifications for the solutions they develop. The process of discussion and reflection in learning strengthens logical, analytical, and reflective thinking, which forms the foundation of critical thinking.

Although many studies have been conducted on the effects of the Realistic Mathematics Education (RME) approach in developing critical thinking skills, the results obtained are still varied. Some studies indicate that the application of RME significantly enhances students' critical thinking abilities, while other studies reveal that the difference compared to conventional teaching methods is not as pronounced, as shown in the research conducted by (Fauzan et al,. 2018) and (Ardiniawan, 2022). This inconsistency in results may be attributed to various factors, including differences in research design, sample size, duration of the intervention, and the education level of the student subjects. Moreover, the effectiveness of the RME approach is also heavily influenced by the preparedness of educators in implementing it. The teacher's understanding of the fundamental principles of RME and their ability to guide students in learning through exploration are crucial elements for the success of this approach. Therefore, despite the positive effects of this approach on critical thinking, its success is highly dependent on several factors that require further investigation. A deeper investigation is necessary to uncover the elements that enhance or impede the success of RME in mathematics instruction, allowing for the development of more suitable strategies to achieve consistent and optimal results across diverse educational settings.

To obtain a deeper insight into the impact of RME on critical thinking abilities, it is essential to carry out a meta-analysis. In this process, researchers gather and examine data from earlier studies by evaluating the effect size. Through meta-analysis, researchers can offer well-founded recommendations based on substantial evidence from multiple studies, including detailed analysis of the collected data (Fahrezi et al., 2020). This study highlights the importance of performing a meta-analysis to assess RME's impact and explore how different measurement variables can influence the effect size across various studies (Tamur et al., 2020). Therefore, this approach not only consolidates previous research findings but also provides stronger empirical evidence about the contribution of RME to improving critical thinking skills. The outcomes of this meta-analysis can serve as a valuable reference for educators and policymakers to enhance the implementation of RME in ways that are more effective in fostering students' critical thinking abilities.

The purpose of this study is to perform a meta-analysis of several studies that have assessed how the RME approach affects students' development of critical thinking abilities. This study uses a meta-analytic technique to examine data heterogeneity,

compute effect sizes from various studies, and look at moderator variables that could affect how effective the RME approach is in teaching mathematics. It is anticipated that the study's findings will produce more solid empirical support, pinpoint important elements that contribute to RME's effectiveness, and offer suggestions for teachers looking to better integrate this strategy into math classes. Therefore, this study can serve as a reference for designing innovative instructional strategies that strengthen students' critical thinking skills in mathematics and equip them to face the demands of the 21st century more effectively.

2. METHOD

This study uses a meta-analytic approach, which aims to combine the results of various primary studies using a quantitative method. The advantage of the meta-analytic method lies in its ability to provide an integrated quantitative summary, reduce bias, enhance statistical power, and provide a solid evidence base for evidence-based decision-making across various disciplines (Higgins, 2023; Jati Ananto et al., 2022; Örtqvist & Wincent, 2006; Paxton et al., 2018). Borenstein et al. (2022) stated that there are several stages that must be followed in meta-analysis research, which can be seen in the flow diagram in Figure 1.

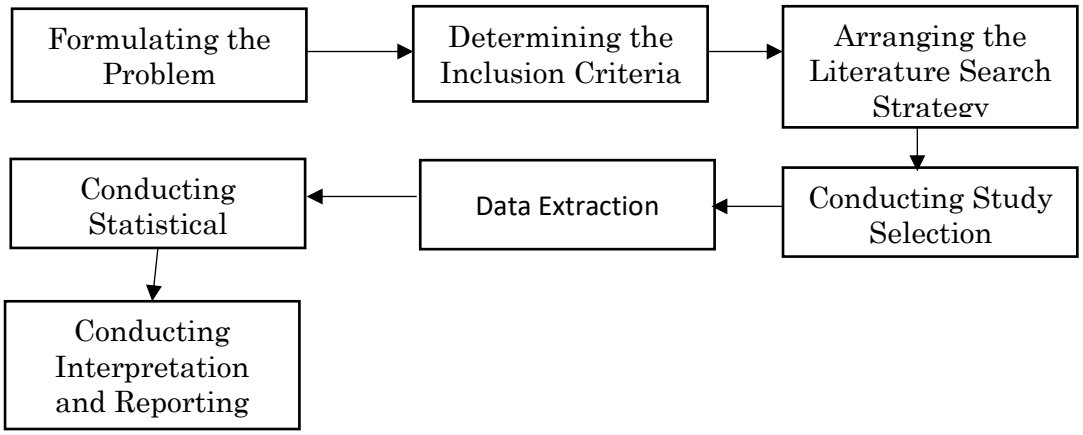

Figure 1. Meta-Analysis Stages

This study adheres to a series of stages. Among the steps that will be discussed are the criteria for inclusion, the strategy for searching literature, data collection, selection of studies, and statistical analysis.

2.1 Inclusion Criteria

There are currently few comprehensive studies on how the Realistic Mathematics Education (RME) approach enhances students' critical thinking abilities. The study uses Liberati et al. (2009) 's PICOS framework (Population, Intervention, Comparator, Outcomes, and Study Design) to focus this meta-analysis. The following are the studies' inclusion criteria:

1. The participants in the primary studies are students from Indonesia.
2. The intervention in these studies involves the use of the RME approach.
3. The studies report outcomes related to students' critical thinking skills.
4. The studies must report statistical data such as the mean, standard deviation, sample size, t-value, and p-value.
5. The studies selected were published between 2016 and 2021 and indexed in Sinta 1, Sinta 2, Scopus, and WoS.

The PICOS approach significantly contributes to improving the reliability and validity of literature synthesis, especially in meta-analysis and systematic review-based research (Alfayad & Dwiyanti, 2022).

2.2 Literature Search Strategy

To carry out a meta-analysis on the impact of the Realistic Mathematics Education (RME) approach on students' critical thinking skills, a comprehensive literature search was undertaken across several reputable electronic databases, including Google Scholar, Semantic Scholar, GARUDA, ERIC, and SpringerLink. Key search terms included "Realistic Mathematics Education", "Critical Thinking Skills," and "RME." The search primarily focused on articles indexed in Sinta 1, Sinta 2, Scopus, and WoS to ensure the credibility and authority of the sources. A combination of various keywords was used to achieve comprehensive and diverse results. Relevant studies were selected based on their publication dates, ranging from 2016 to 2025.

The inclusion criteria encompass studies that evaluate the effects of implementing the RME approach on students' critical thinking skills, using experimental or quasi-experimental research designs, and providing statistical data such as means, standard deviations, sample sizes, t-values, and p-values. Each article identified through the literature search will be further assessed to ensure its relevance and quality in line with the objectives of this meta-analysis. Selected articles may originate from international journals or conference proceedings indexed in reputable databases.

2.3 Study Selection

Particular inclusion criteria were used in the selection of the primary studies. Liberati et al. (2009) state that the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) protocol has four essential steps in the study selection process: Identification, screening, eligibility, and inclusion are the first four steps.

2.4 Data Extraction

After completing the inclusion criteria and selection stages, the researcher collects essential information such as author names, statistical values (means, standard

deviations, sample sizes, t-values, p-values), and publication years. This step is crucial for ensuring the accuracy and trustworthiness of the data, which in turn guarantees the quality and reliability of the meta-analysis results.

2.5 Statistical Analysis

The effect size in this meta-analysis is calculated using the Hedges' g formula. In meta-analysis, Hedges' g is a standardized effect size measure commonly used to assess the mean difference between groups with a bias correction for small sample sizes (Bok et al., 2023; Compernolle et al., 2019). The Hedges' g formula can be calculated as follows.

$$g = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{(n_1 - 1){S_1}^2 + (n_2 - 1){S_2}^2}{n_1 + n_2 - 2}}}$$

However, in some cases, especially when the sample size is small, using g' may be more accurate as it corrects for potential bias that may occur with small samples.

$$g' = g\left(1 - \frac{3}{4(n_1 + n_2) - 9}\right)$$

The classification of effects according to Cohen et al. (2018) is presented in Table 1.

Table 1. The classification of effects

Effect Size (ES)	Interpretasi
$0.00 \leq ES < 0.20$	Ignored
$0.20 \leq ES < 0.50$	Small
$0.50 \leq ES < 0.80$	Moderate
$0.80 \leq ES < 1.30$	Large
$1.30 \leq ES$	Very Large

Data analysis in this study was conducted using the RStudio application.

3. RESULT AND DISCUSSION

This study uses a total of seven articles selected according to the inclusion criteria set. Details of each article can be found in Table 2.

Table 1. RME Articles Data, Critical Thinking Skills

Code	Citation	Statistic Data						T-Value
		RME			Conventional Learning			
		Mean	Standard Deviation	Sample Size	Mean	Standard Deviation	Sample Size	
J01	(Amir *et al*., 2024)	85.23	7.764	22	83.55	9.580	22	
J02	(Cahyaningsih & Nahdi, 2021)	10.818	2.508	16	9.794	1.553	16	2.624
J03	(Herlawan *et al*., 2023)	86.83	7.598	30	62.83	9.798	30	14.806
J04	(Palinussa, 2013)	59.36	10.65	52	50.13	9.80	54	
J05	(Triwidayati & Budiastra, 2023)	87.91	5.475	28	75,80	5,475	28	
J06	(Setyaningsih et al., 2021)	80.29	11.74	38	71.53	11.01	38	
J07	(Sofie *et al*., 2023)	2.68	1.085	25	2.36	1.30	25	
J08	(Arofah *et al*., 2016)	18.780	10.575	41	11.667	6.133	42	
J09	(Muslimahayati *et al*., 2020)	58.33	11.54	32	44.40	11.81	32	
J10	(Susandi & Widyawati, 2022)			21			21	2.30
J11	(Farida *et al*., 2022)	80.02		31	68.82		31	3.129
J12	(Lestari *et al*., 2023)			26			26	8.28
J13	(Juprijal *et al*., 2017)			24			24	4.13
J14	(Widiana *et al*., 2023)			20			20	-7.414
J15	(Dhayanti *et al*., 2018)			25			25	4.42

J16	(Sutarni & Gatiniggsih, 2022)	32	32	2.84

According to Table 2, the sixteen studies demonstrate that the RME approach was utilized in the research. The primary objective of this study is to assess the overall effectiveness of the RME approach in improving students' critical thinking skills. The effect size is used to determine the extent of influence the intervention has on the results. In this analysis, the relationships between variables are examined through a meta-analysis, which explores how the RME technique affects the development of students' critical thinking skills. The findings of this study are presented in Table 3.

Table 2. Effect Size Data of Articles

Citation	Effect Size	Confidence Interval		Standard Error
		Lower Limit	Upper Limit	
(Amir et al., 2024)	0.193	-0.4	0.785	0.302
(Cahyaningsih & Nahdi, 2021)	0.491	-0.212	1.194	0.359
(Herlawan *et al*., 2023)	2.737	2.033	3.442	0.359
(Palinussa, 2013)	0.903	0.503	1.302	0.204
(Triwidayati & Budiastra, 2023)	2.212	1.547	2.877	0.339
(Setyaningsih *et al*., 2021)	0.77	0.304	1.236	0.238
(Sofie *et al*., 2023)	0.267	-0.29	0.824	0.284
(Arofah *et al*., 2016)	0.825	0.377	1.274	0.229
(Muslimahayati *et al*., 2020)	1.193	0.661	1.725	0.271
(Susandi & Widyawati, 2022)	0.342	0.086	1.333	0.318
(Farida *et al*., 2022)	0.375	0.278	1.312	0.264

(Lestari *et al*., 2023)	0.76	1.596	2.99	0.357
(Juprijal *et al*., 2017)	0.52	0.578	1.806	0.313
(Widiana *et al*., 2023)	0.769	-3.15	-1.539	0.411
(Dhayanti *et al*., 2018)	0.538	0.644	1.856	0.309
(Sutarni & Gatiniggsih, 2022)	0.339	0.205	1.215	0.258

Based on Table 3, the effect sizes range from 0.193 to 2.737 within a 95% confidence interval. These findings indicate that the RME approach positively contributes to the development of students' critical thinking skills, consistent with prior studies. Furthermore, the meta-analysis results from the selected studies are presented using both fixed-effect and random-effect models, as in Table 4.

Table 3. Effect size transformation each study

Estimation Model	n	Z	p	Effect size	95% CL		Qb	P-Value	I-Squared
					Lower Limit	Upper Limit			
Fixed	16	10.888	$1.31e-27$	0.778	0.638	0.919	66.454	$1.9e-08$	77.43
Random	16	4.871	$1.11e-06$	0.814	0.487	1.142			

The results of the meta-analysis utilizing the fixed-effects and random-effects models of estimate are shown in Table 4. According to Cohen et al. (2018) , the fixed-effects model's effect size of 0.778, with a 95% confidence interval ranging from 0.638 to 0.919, is classified as medium. The random-effects model, on the other hand, classifies the effect as large, estimating an effect size of 0.814 with a 95% confidence interval between 0.487 and 1.142. A significant degree of variability among the studies is indicated by the Qb value of 66.454, p-value of 1.9e-08 (less than 0.05), and I-squared value of 77.43%. In order to better account for this variability, the random-effects model was used.

Overall, these results suggest that the Realistic Mathematics Education (RME) approach makes a significant contribution to enhancing students' critical thinking abilities, despite

the contextual variations across studies. The subsequent phase of this meta-analysis involves detecting potential publication bias, which is illustrated using the funnel plot diagram presented in Figure 2.

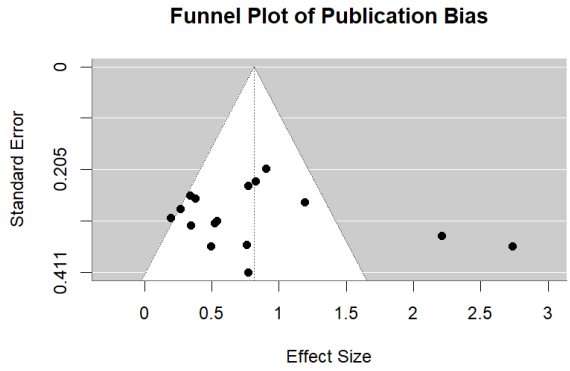

Figure 2. Funnel Plot Check for Publication Bias

Using Egger's regression and the funnel plot to investigate potential publication bias, no significant evidence of such bias was discovered in the examined studies. The funnel plot's apparent asymmetry is not statistically significant, according to the Egger test's p-value of 0.3191 ($p > 0.05$). Thus, it can be said that publication bias is unlikely to have an impact on the findings of this meta-analysis.

Apart from examining the main effect size, this study also looks into other aspects of each study that could influence the variations in results. The characteristics examined include the educational level of participants (such as elementary, junior high), the geographic location of the study (rural or urban), the range of mathematics topics covered by the RME approach, and the publication year. The goal of this analysis is to assess whether these factors contribute to the variations in effect sizes observed. Details of the study characteristics are provided in Table 5.

Table 4. Moderator Analysis Results Based on Study Characteristics

Karakteristik Studi	**Group**	**Number of Studies**	**Effect Size**	**Null hypothesis test**		**Heterogeneity**		
				Z-Value	**P-Value**	**Between Effect Class (Qb)**	**Df(Q)**	**P**
Educational Level	Elementary School	6	0.7908	2.6642	0.0077	0.0116	1	0.9144
	Junior High School	10	0.8287	3.8822	0.0001			
Geographic Location	Village	9	0.5581	5.3939	$p < 0.0001$	4.6267	1	0.0315

Publication Year	City	7	1.2014	3.5616	0.0004	2.0511	2	0.3586
	2016-2019	3	0.6711	4.2309	$P < 0.0001$			
	2020-2022	6	0.5996	4.1549	$P < 0.0001$			
	2023-2025	6	1.1487	2.6395	0.0083			
Mathematics Topics	Arithmetic and Number Operations	4	0.6073	1.5214	0.1282	4.4262	5	0.4898
	Algebra and Equations	3	0.8253	1.5548	0.1200			
	Geometry	3	0.1291	0.2273	0.8202			
	Probability	1	0.1527	0.1851	0.8531			
	Set Theory	1	-0.2323	-0.2945	0.7684			
	Not Specified	4	-0.0549	-0.1040	0.9172			

According to Table 5, the studies conducted at the elementary level resulted in an effect size of 0.7908, falling under the medium category based on Cohen's classification. Studies at the junior high school level, in contrast, demonstrated a larger effect size of 0.8287, which is classified as a substantial effect. A Qb value of 0.0116 and a p-value of 0.9144 ($p > 0.05$) from the variability analysis between the two groups indicate that the average impact sizes between the two educational levels do not differ statistically significantly. As a result, it is possible to consider the impact size distribution to be uniform among the groups. These results show that whether students are in elementary or junior high school, the Realistic Mathematics Education (RME) approach has no effect on how well it develops their critical thinking abilities.

Regarding geographic location, the Realistic Mathematics Education (RME) approach has demonstrated a notable effect on students' critical thinking abilities, both in rural and urban settings. In rural areas, the effect size is 0.5581, with a z-value of 5.3939 and a p-value of less than 0.0001, indicating a statistically significant but medium-sized impact according to Cohen's criteria. In contrast, urban areas show a stronger impact, with an effect size of 1.2014, a z-value of 3.5616, and a p-value of 0.0004, classified as a large effect. The moderator test reveals a Qb value of 4.6267 with a p-value of 0.0315, signifying a significant difference in the effect sizes between the two regions. As a result, it can be concluded that geographic location plays a role in the effectiveness of the RME approach, with its influence being more pronounced in urban environments than in rural ones.

When analyzing the publication year, the effectiveness of the Realistic Mathematics Education (RME) approach on enhancing students' critical thinking skills varies across different periods. In the 2016–2019 range, the effect size of 0.6711 with a significance level of $p < 0.0001$ was found, while the 2020–2022 period showed a slightly smaller effect size of 0.5996, with a p-value of less than 0.0001. Both values fall under the medium category according to Cohen's interpretation scale. Despite being classified as medium, the very low p-values suggest that the RME approach still has a statistically significant effect in both periods, with the impact being real and relevant, though not yet at a very high level. Conversely, studies published between 2023 and 2025 demonstrate a stronger effect with an effect size of 1.1487 ($p = 0.0083$), categorized as large. The moderator test shows a Qb value of 2.0511 ($p = 0.3586$), indicating that the difference in average effects across publication years is not statistically significant. Therefore, although there appears to be a trend towards increasing effectiveness over time, the RME approach consistently demonstrates a positive influence on students' critical thinking abilities throughout the analyzed periods.

Next, when considering the classification of mathematics subjects, the effect of the Realistic Mathematics Education (RME) approach in enhancing critical thinking abilities shows variation across different topics. Algebra and Equations have the highest effect size of 0.8253, followed by Arithmetic and Number Operations with an effect size of 0.6073. Both fall within the medium to high effect range; however, since their p-values exceed 0.05 ($p = 0.1200$ and $p = 0.1282$), their impact does not reach statistical significance. In contrast, Geometry and Probability topics show smaller effect sizes of 0.1291 and 0.1527, respectively, with high p-values, indicating no significant impact. Set Theory and studies that did not explicitly specify the subject type also show low and non-significant effect sizes ($p = 0.7684$ and $p = 0.9172$). According to the moderator test results, the difference in RME effects by subject type is not statistically significant ($p > 0.05$), with a Qb value of 4.4262 and a p-value of 0.4898. As a result, even though the effect sizes for different topics vary numerically, these distinctions are meaningless. All things considered, the findings indicate that the RME approach has a comparatively constant effect on students' growth in critical thinking skills, independent of the particular mathematical subject taught.

Regardless of the educational level, the year of publication, or the kind of material used, the Realistic Mathematics Education (RME) approach has been shown to continuously have a positive and significant impact on students' critical thinking skills, with a noticeable propensity for greater efficacy in urban settings as opposed to rural ones. It is advised that educators, curriculum designers, and legislators include the RME approach into mathematics instruction in light of the meta-analysis's conclusions. According to the studies analyzed, RME consistently improves students' critical thinking skills across a wide range of mathematical topics, including algebra, arithmetic, and geometry, as well as across different publication periods, educational levels, and geographic locations (rural and urban). This consistent impact highlights RME's flexibility and its potential for

diverse learning environments. Thus, RME can be regarded as an effective alternative teaching method to foster analytical, reflective, and contextual thinking—skills that are crucial for addressing the challenges of the 21st century.

4. CONCLUSION

The findings of this meta-analysis lead to the conclusion that the Realistic Mathematics Education (RME) approach plays a significant role in enhancing students' critical thinking skills. Overall, the magnitude of the impact falls within the medium to high range, reflecting the effectiveness of this approach in mathematics instruction. Analysis based on study characteristics indicates that the impact of RME tends to be greater in urban areas, although it remains significant in rural areas as well. From the publication year perspective, there is a noticeable trend of increasing RME effectiveness over time, although statistically, no significant differences were found. Meanwhile, categorization by educational level and subject type did not show significant differences, suggesting that the RME approach is consistent across various learning contexts.

Based on the findings of this study, educators and policymakers in the field of education are encouraged to begin adopting the RME approach in mathematics instruction, particularly by adapting its implementation to the local context, such as the school environment and the characteristics of students, especially in rural areas. For future studies, it is advisable to expand the volume of primary data to enhance the statistical power of the analysis and to include additional moderator variables such as gender, socioeconomic background, or students' learning styles. Research that combines quantitative and qualitative approaches, or utilizes a longitudinal design, will also deepen the understanding of how the RME approach shapes and influences students' critical thinking abilities in the long term.

5. REFERENSI

Aisyah, F. R., Arfandi, A., & Syamsidah. (2021). Analisis Keterampilan Kerja Mahasiswa Jurusan Pendidikan Kesejahteraan Keluarga Terhadap Kesiapan Kerja Pada Industri Fesyen. *UNM Journal of Technology and Vocational*, *5*(3), 1–23.

Alfayad, A., & Dwiyanti, E. (2022). Systematic Review: Analisis Pengadaan Musik Kerja terhadap Produktivitas Kerja Tenaga Kerja. *Preventia : The Indonesian Journal of Public Health*, *7*(2), 8. https://doi.org/10.17977/um044v7i22022p8-17

Amir, F., Firdaus, F. M., & Pada, A. (2024). How does Realistic Mathematics Learning Shape Learners ' Problem Solving and Critical Thinking Skills ? *Al-Ishlah: Jurnal Pendidikan*, *16*, 3588–3602. https://doi.org/10.35445/alishlah.v16i3.5101

Ardiniawan, D. Y. (2022). Effectiveness of Realistic Mathematical Education (RME) Approach Compared to Conventional Learning Models Elementary School Students. *International Journal of Social Science and Human Research*, *05*(04), 1305–1308. https://doi.org/10.47191/ijsshr/v5-i4-14

Arofah, D., Purwanto, S. E., & Tsurayya, A. (2016). Influence of learning on Mathematics Realistic ICT-assisted critical thinking skills students. *ICCE 2016 - 24th International Conference on*

Computers in Education: Think Global Act Local - Main Conference Proceedings, 648–650.

Bok, S. K., Song, Y., Lim, A., Jin, S., Kim, N., & Ko, G. (2023). High-Tech Home-Based Rehabilitation after Stroke: A Systematic Review and Meta-Analysis. *Journal of Clinical Medicine*, *12*(7). https://doi.org/10.3390/jcm12072668

Borenstein, M., Hedges, L. V, Higgins, J. P., & Rothstein, H. R. (2022). Introduction to Meta-Analysis. In *Principles and Practice of Clinical Trials*. https://doi.org/10.1007/978-3-319-52636-2_287

Cahyaningsih, U., & Nahdi, D. S. (2021). The Effect of Realistic Mathematics Education on Elementary Students' Critical Thinking Skills. *Journal of Physics: Conference Series*, *1764*(1). https://doi.org/10.1088/1742-6596/1764/1/012127

Cohen, L., Manion, L., & Morrison, K. (2018). Research Methods in Education (8th ed.). In *Routledge* (8th ed.). http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

Compernolle, S., Desmet, A., Poppe, L., Crombez, G., De Bourdeaudhuij, I., Cardon, G., Van Der Ploeg, H. P., & Van Dyck, D. (2019). Effectiveness of interventions using self-monitoring to reduce sedentary behavior in adults: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity*, *16*(1). https://doi.org/10.1186/s12966-019-0824-3

Delfita, O., Roza, Y., & Maimunah, M. (2019). Analisis Kesalahan Siswa Dalam Menyelesaikan Masalah Kontekstual Berdasarkan Newman'S Error Analysis (Nea). *Media Pendidikan Matematika*, *7*(1), 1. https://doi.org/10.33394/mpm.v7i1.1427

Dhayanti, D., Johar, R., & Zubainur, C. M. (2018). Improving Students' Critical and Creative Thinking through Realistic Mathematics Education using Geometer's Sketchpad. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *3*(1), 25. https://doi.org/10.23917/jramathedu.v3i1.5618

Elwijaya, F., Yerizon, Y., Syarifuddin, H., & Desyandri, D. (2020). Efektivitas Pengembangan Local Instructional Theory Berbasis RME pada Topik Pecahan Terhadap Kemampuan Pemecahan Masalah Matematis Siswa di Sekolah Dasar. *Jurnal Basicedu*, *6*(1), 102–108. https://doi.org/https://doi.org/10.31004/basicedu.v6i1.1904

Ennis, R. H. (2011). *The Nature of Critical Thinking: An Outline of Critical Thinking Dispositions and Abilities*. http://faculty.education.illinois.edu/rhennis/documents/TheNatureofCriticalThinking_51711_000.pdf

Facione, P. (2015). Critical Thinking: What It Is and Why It Counts. *Insight Assessment*.

Fahrezi, I., Taufiq, M., Akhwani, A., & Nafia'ah, N. (2020). Meta-Analisis Pengaruh Model Pembelajaran Project Based Learning Terhadap Hasil Belajar Siswa Pada Mata Pelajaran IPA Sekolah Dasar. *Jurnal Ilmiah Pendidikan Profesi Guru*, *3*(3), 408. https://doi.org/10.23887/jippg.v3i3.28081

Farida, U., Caswita, C., & Sutiarso, S. (2022). Pengembangan Bahan Ajar Berbasis Realistic Mathematics Education Berorientasi Kemampuan Berpikir Kritis. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(2), 1563. https://doi.org/10.24127/ajpm.v11i2.4942

Fauzan, A., Musdi, E., & Yani, R. (2018). The Influence of Realistic Mathematics Education (RME) Approach on Students‟ Mathematical Representation Ability. *1st International Conference*

on Education Innovation (ICEI 2017, 28–33. https://doi.org/10.2991/icei-17.2018.3

Forum, W. E. (2018). *The Future of Jobs Report 2018*. https://www.weforum.org/reports/the-future-of-jobs-report-2018/

Freudenthal, H. (1991). *Revisiting mathematics education: China lectures*. Kluwer Academic Publishers.

Gravemeijer, K. P. E. (1994). *Developing Realistic Mathematics Education*. Utrecht University.

Herlawan, Armin, R., & Poa, I. R. (2023). Efektivitas Pembelajaran Matematika Melalui Pendekatan PMRI Berbantu Video Pembelajaran Terhadap Kemampuan Berpikir Kritis Siswa. *Edumatica: Journal of Mathematics Education*, *13*(3).

Hickendorff, M., McMullen, J., & Verschaffel, L. (2022). Mathematical Flexibility: Theoretical, Methodological, and Educational Considerations. *Journal of Numerical Cognition*, *8*(3), 326–334. https://doi.org/10.5964/jnc.10085

Hidayah, R., Salimi, M., & Susiani, T. (2017). CRITICAL THINKING SKILL: KONSEP DAN INIDIKATOR PENILAIAN. *Taman Cendekia: Jurnal Pendidikan Ke-SD-An*, *1(2)*, 127–133. https://doi.org/https://doi.org/10.30738/tc.v1i2.1945

Hidayah, A. R. (2021). Proses Berpikir Siswa Dalam Memecahkan Masalah Matematika Kontekstual Ditinjau Dari Kemampuan Matematika Dan Jenis Kelamin. *MATHEdunesa*, *10*(1), 121–136. https://doi.org/10.26740/matheduneSa.v10n1.p121-136

Higgins, S. (2023). Self-regulation and learning: evidence from meta-analysis and from classrooms. *BJEP Monograph Series II: Part 10 Self-Regulation and Dialogue in Primary Classrooms*. https://doi.org/10.53841/bpsmono.2013.cat1370.7

IEA. (2016). *Trends in International Mathematics and Science Study (TIMSS) 2015: International Results in Mathematics and Science*. https://timssandpirls.bc.edu/timss2015/international-results/

Jati Ananto, F., Abdillah, A., Pratama Putra, P. Y., & Herwanto, E. S. (2022). Perbandingan Efektivitas dan Keamanan Early dengan Delayed Kolesistektomi Laparoskopik untuk Kolesistitis Akut: Systematic Review dan Meta-Analisis dari 18 RCT. *Cermin Dunia Kedokteran*, *49*(8), 458–464. https://doi.org/10.55175/cdk.v49i8.289

Juprijal, Hasratuddin, & Simamora, E. (2017). Development of Learning Devices Based on Realistic Mathematics Education to Improve Students Critical Thinking Ability at SMP Harapan 2 Medan. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, *7*(7), 11–18.

Lestari, R., Prahmana, R. C. I., Chong, M. S. F., & Shahrill, M. (2023). Developing Realistic Mathematics Education-Based Worksheets for Improving Students' Critical Thinking Skills. *Infinity Journal*, *12*(1), 69–84. https://doi.org/10.22460/infinity.v12i1.p69-84

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ (Clinical Research Ed.)*, *339*. https://doi.org/10.1136/bmj.b2700

Miterianifa, M., Ashadi, A., Saputro, S., & Suciati, S. (2021). Higher Order Thinking Skills in the 21st Century: Critical Thinking. *Proceedings of the 1st International Conference on Social Science, Humanities, Education and Society Development (ICONS 2020)*, *30 Novembe*. https://doi.org/10.4108/eai.30-11-2020.2303766

Muslimahayati, Dasari, D., & Agustiani, R. (2020). Mathematical critical thinking ability of

students with realistic mathematics learning innovations with ethnomathematics (PMRE). *Journal of Physics: Conference Series*, *1480*(1). https://doi.org/10.1088/1742-6596/1480/1/012004

Nur, F., & Angriani, A. D. (2021). Meta Analisis: Pengaruh Penerapan Pendekatan Realistic Mathematics Education Terhadap Hasil Belajar Siswa Di Sekolah Dasar. *AULADUNA: Jurnal Pendidikan Dasar Islam*, *8*(1), 109. https://doi.org/10.24252/auladuna.v8i1a9.2021

OECD (Organisation for Economic Co-operation and Development). (2023). *PISA 2022 Results (Volume II): Learning During – and From – Disruption*. https://doi.org/https://doi.org/10.1787/a97db61c-en

Örtqvist, D., & Wincent, J. (2006). Prominent consequences of role stress: A meta-analytic review. *International Journal of Stress Management*, *13*(4), 399–422. https://doi.org/10.1037/1072-5245.13.4.399

Palinussa, A. L. (2013). Students' Critical Mathematical Thinking Skills and Character: Experiments for Junior High School Students through Realistic Mathematics Education Education Culture-Based. *IndoMS.J.M.E*, *4*(1), 75–94.

Paxton, E. W., Mohaddes, M., Laaksonen, I., Lorimer, M., Graves, S. E., Malchau, H., Namba, R. S., Kärrholm, J., Rolfson, O., & Cafri, G. (2018). Meta-analysis of individual registry results enhances international registry collaboration. *Acta Orthopaedica*, *89*(4), 369–373. https://doi.org/10.1080/17453674.2018.1454383

Rivas, S. F., Saiz, C., & Almeida, L. S. (2023). The Role of Critical Thinking in Predicting and Improving Academic Performance. *Sustainability (Switzerland)* , *15*(2), 1–10. https://doi.org/10.3390/su15021527

Setyaningsih, R., Haryanto, H., & Rhosyida, N. (2021). Pengaruh Pendekatan Realistic Mathematics Education Terhadap Keterampilan Berpikir Kritis Mahasiswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(3), 1658. https://doi.org/10.24127/ajpm.v10i3.3859

Sofie, D. A., Pambudi, D. S., Fatekurohman, M., Lestari, N. D. S., & Kurniati, D. (2023). Peningkatan Kemampuan Berpikir Kritis Siswa Dengan Pendekatan Rme Berbasis Lslc. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(3), 2773. https://doi.org/10.24127/ajpm.v12i2.6432

Susandi, A. D., & Widyawati, S. (2022). Implementation of realistic mathematic education (RME) learning model in improving critical thinking skills. *Al-Jabar : Jurnal Pendidikan Matematika*, *13*(2), 251–260. https://doi.org/10.24042/ajpm.v13i2.14996

Sutarni, S., & Gatiniggsih, R. (2022). Improving Mathematical Critical Thinking Ability Through Realistic Mathematics Learning In JHS Students. *Jurnal Riset Pendidikan Matematika*, *9*(1), 46–56. https://doi.org/10.21831/jrpm.v9i1.48750

Tamur, M., Ndiung, S., Nurjaman, A., & Jerito, P. (2020). Do differences in measured mathematical abilities moderate the effectiveness of the realistic mathematics education approach? Meta-analysis studies. *Jurnal Math Educator Nusantara*, *7*(1), 13–26. http://repository.polnep.ac.id/xmlui/bitstream/handle/123456789/354/03-YANI R.pdf?sequence=1

Telaumbanua, Y. N., Dewi, I., & Simamora, E. (2023). Philosophy Perspective of Mathematics Education As a Field of Knowledge. *EDUTEC : Journal of Education And Technology*, *6*(3), 703–710. https://doi.org/10.29062/edu.v6i3.479

TRIPON, C. (2019). Learning to Learn: Critical Thinking Skills to Help Students for Life. *Logos Universality Mentality Education Novelty: Philosophy & Humanistic Science*, *6*(2), 1–10.

https://doi.org/10.18662/lumenphs/06

Triwidayati, N., & Budiastra, A. K. (2023). PENGARUH PENDEKATAN MATEMATIKA REALISTIK DAN SAINTIFIK TERHADAP KEMAMPUAN BERPIKIR KRITIS DITINJAU DARI MOTIVASI BELAJAR SISWA SEKOLAH DASAR. *ELSE (Elementary School Education Journal)*, *8*(3), 1–8. https://doi.org/http://dx.doi.org/10.30 651/else.v8i3.24469 Abstract

Widiana, A. N., Sintawati, M., & Abdurrahman, G. (2023). The Effectiveness of Realistic Mathematics Education on Learning Outcomes and Critical Thinking for Elementary School Students. *International Journal of Learning Reformation in Elementary Education*, *2*(03), 114–126. https://doi.org/10.56741/ijlree.v2i03.337