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Effectiveness of Realistic Mathematics Education: A Meta-Analysis

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ABSTRACT

This study uses a meta-analysis of 15 studies (2014–2023) to assess the effectiveness of the Realistic Mathematics Education (RME) approach in improving students' mathematics achievement. RME, which emphasizes real-life contexts and student-centered learning, showed a significant overall effect size (Hedges' g = 0.65). Despite variability across studies, no major publication bias was detected, and consistent positive impacts were observed. The findings support the integration of RME into curricula, particularly in regions with persistent underperformance in mathematics. The study recommends improved teacher training, development of RME-based materials, and wider adoption of RME, along with further research into its long-term and cross-cultural impact.

Keywords: Realistic Mathematics Education; Mathematics Achievement; Meta-Analysis; Forest Plot; Funnel Plot; Educational Policy; Pedagogical Innovation

INTRODUCTION

Mathematics plays an essential role in shaping cognitive, problem-solving, and analytical skills that are critical for individual and societal development (Akosah et al., 2024; Asare et al., 2024; Wiryanto et al., 2024). Globally, mathematics achievement serves as a key indicator of educational quality and student readiness for 21st-century challenges (OECD, 2023). In countries like Ghana, however, persistent underperformance in mathematics among junior high school students continues to raise major concerns. The most recent Trends in Mathematics and Science Study (TIMSS) revealed that Ghana ranked second to last among participating countries, highlighting deep-rooted issues in the mathematics teaching and learning process (TIMSS, 2019).

Several factors have been identified as contributors to this low performance, including limited parental involvement, teacher-centered instructional methods, socio-economic disparities, and disengaging curricula (Arthur et al., 2021; Akosah et al., 2025, Ali, 2021). Traditional approaches to teaching mathematics often emphasize rote memorization of formulas and repetitive procedures, leaving students disconnected from real-world applications and reducing motivation and understanding (Pangestuti, et al., 2024). These challenges underline the urgent need to rethink instructional strategies and adopt more meaningful, student-centered pedagogies.

Realistic Mathematics Education (RME), developed in the Netherlands by Hans Freudenthal, offers a promising alternative. RME advocates for contextualized learning, where students engage with real-life situations as a starting point for developing mathematical concepts through guided reinvention (Gravemeijer & Doorman, 1999; Van den Heuvel-Panhuizen & Drijvers, 2020). RME places the reality and experiences of learners as the starting point of learning, with mathematical concepts or formal mathematical knowledge emerging from these realistic problems (Diponegoro et al., 2024; Van Zanten & Van den Heuvel-Panhuizen, 2021). The Realistic Mathematics Education (RME) approach has several advantages: making mathematics learning more meaningful, less formal, not too relevant, and more interesting (Bosica et al., 2021; Fauzan et al., 2024; Sutarni et al., 2024). RME is a form of classroom learning designed based on reality and the environment around students with the aim that students can find out things or mathematical concepts in a natural context that have not previously been learned (Lady et al., 2018; Palinussa, 2021). This approach emphasizes learner autonomy, communication, and active problem-solving, bridging the gap between abstract mathematical theories and students' lived experiences (Dewantara et al., 2023). RME has been shown to improve motivation, conceptual understanding, and performance when effectively implemented in various countries including Indonesia, Malaysia, Turkey, and Ghana (Akosah et al, 2024; Ali, 2021; Caraan, et al., 2023). However, empirical studies evaluating the impact of RME on student achievement have yielded mixed results. Some studies report substantial gains in mathematical literacy and problem-solving skills (Yuanita et al., 2018; Laurens et al., 2018, Zulkardi, et al, 2020), while others observe modest or statistically insignificant outcomes (Susanti, 2022). These inconsistencies call for a rigorous meta-analytic investigation to aggregate and quantify the overall impact of RME across diverse settings. Meta-analysis provides in-depth and accurate conclusions (Fadhli, et al., 2020; Siddaway, et al., 2019).In response to the urgent need to improve mathematics outcomes and align instructional practices with global educational goals such as Sustainable Development Goal 4 (SDG 4), this study employs a meta-analysis to evaluate the effectiveness of RME. By synthesizing findings from multiple empirical studies, the research provides a comprehensive assessment of RME's influence on mathematics achievement and offers evidence-based recommendations for curriculum designers, educators, and policymakers.

Purpose

The purpose of this study is to examine the effectiveness of the Realistic Mathematics Education (RME) approach in enhancing the mathematics achievement of primary and junior high school students by synthesizing empirical evidence from multiple studies through a meta-analytic method. The objective of this study is to determine the overall effect size of the Realistic Mathematics Education (RME) approach on students' mathematics achievement, assess the heterogeneity among study results, and evaluate the presence of publication bias in the existing literature from 2014 to 2023.

Hypothesis

H_0 (Null Hypothesis): There is no significant effect of the Realistic Mathematics Education (RME) approach on students' mathematics achievement (i.e., true effect size = 0).

H_1 (Alternative Hypothesis): The Realistic Mathematics Education (RME) approach has a significant positive effect on students' mathematics achievement (i.e., true effect size $\neq 0$).

RESEARCH METHOD

This study employed a meta-analytic research design to quantitatively synthesize findings from empirical studies investigating the effects of Realistic Mathematics Education (RME) on students' mathematics achievement. A meta-analysis provides a general assessment by synthesizing quantitative results from individual studies on a specific topic (Glass, 1976; Lipsey & Wilson, 2001). Through a meta-analysis, the current state of the field can be assessed. Effect size is used to assess the findings of the meta-analysis (Mertens, 2010). The value of the effect size reflects the relationship between two variables (Borenstein, et al., 2009; Ellis, 2010). In other words, it represents the size of the relationship between variables. The effect size is a common metric for studies that are included in effect size meta-analysis and it provides the opportunity of interpreting the statistically analyzed studies through the same measurement.

Meta-analysis is an appropriate approach for integrating diverse quantitative studies and calculating an overall effect size, enabling generalizable conclusions based on accumulated evidence. The research followed the *Preferred Reporting*

Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol to ensure methodological rigor in study identification, selection, and data synthesis. The PRISMA protocol is a systematic review method that supports high-quality meta-analyzes (Pigott & Polanin, 2020). All steps were conducted systematically to enhance transparency and reproducibility.

Inclusion and Exclusion Criteria

Studies were selected based on the following inclusion criteria:

- The study focused on primary or junior high school students.
- The Realistic Mathematics Education (RME) model was implemented as the core instructional strategy.
- Student mathematics achievement was the primary outcome measured.
- The study employed experimental or quasi-experimental designs.
- The article was published in English between 2014 and 2023.
- Full-text access to the study was available.

Studies were excluded if they:

- Focused on levels beyond junior high school.
- Did not apply RME as the main intervention.
- Were theoretical, qualitative, or non-empirical in nature.
- Did not provide sufficient statistical data for effect size calculation.

Data Sources and Search Strategy

A comprehensive literature search was conducted using two major databases: Scopus and Google Scholar. The search strategy used combinations of keywords such as: *"Realistic Mathematics Education"*, *"RME"*, *"mathematics achievement"*, *"primary education"*, and *"junior high school"*. A total of 180 articles were initially identified. While Scopus and Google Scholar provided a broad initial pool, additional searches in databases such as ERIC and Web of Science could potentially expand the scope. These were not included in the present review due to time constraints and access limitations, which may have reduced the total number of eligible studies. Consequently, the relatively small sample of 15 studies should be viewed as a preliminary synthesis rather than a definitive estimate of RME's impact.

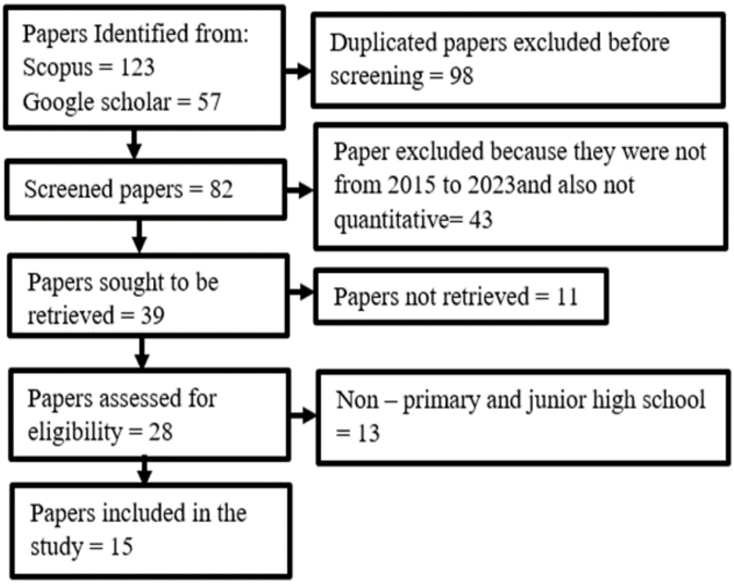
Study Selection Process

The PRISMA-based screening process involved the following steps:

1. *Identification*: 180 articles were initially retrieved (123 from Scopus, 57 from Google Scholar).
2. *Screening*: 98 articles were excluded due to duplication or being outside the date range.
3. *Eligibility:* 43 additional articles were excluded for not meeting the inclusion criteria or lacking quantitative data.

4. *Inclusion:* 15 studies met all criteria and were included in the meta-analysis.

Figure 1
Papers Selection Process for the Study



Source: Self – construct, 2025

Data Extraction and Coding
Data were extracted into a coding sheet capturing the following:

- Study citation
- Sample size (N)
- Statistical values (e.g., F, r, t)
- Calculated effect sizes (Hedges' g)
- Standard error (SE)

When necessary, original statistics were converted into correlation coefficients and then to standardized effect sizes using established meta-analytic formulas.

Statistical Analysis
All analyses were conducted using Jamovi (Version 2.2.6). A random-effects model was adopted to account for variability across study contexts and sample characteristics. The following analyses were performed:

- *Calculation of Effect Sizes* (SE) and 95% Confidence Intervals (CI)
- *Heterogeneity Tests* (e.g., Q-statistic and I^2 index)
- *Forest Plot*: To visualize individual and pooled effect sizes.

- *Funnel Plot*: To assess the symmetry and potential publication bias.
- *Rosenthal's Fail-safe N*: To determine the robustness of the findings against unpublished null studies.
- *Significance Testing:* Based on z-values and p-values to assess the statistical relevance of the overall effect.

Calculation of the Pooled Effect Size and Rationale for Model Choice

The overall effect size of 0.65 was obtained by aggregating the individual study effect sizes using the DerSimonian–Laird random-effects model (DerSimonian & Laird, 1986) implemented in the Jamovi meta-analysis module, which runs on the R "metafor" package (Viechtbauer, 2010). This method weights each study's effect size by the inverse of its variance, incorporating both within-study variance (sampling error) and between-study variance (true heterogeneity). The choice of the random-effects model over a fixed-effects or weighted least squares approach was based on the observed high heterogeneity ($I^2 = 85.4\%$), which indicates that the true effect size is likely to vary across studies due to differences in participant characteristics, educational contexts, intervention duration, and implementation fidelity. A fixed-effects model assumes a single common true effect size across all studies, which is not appropriate under substantial heterogeneity, while weighted least squares is more suited for meta-regression rather than pooled estimation in this context (Borenstein et al., 2009; IntHout et al., 2016). The random-effects model provides a more conservative and generalizable estimate, reflecting the distribution of true effects across varying contexts and ensuring that the pooled estimate accounts for variability beyond sampling error.

Comparability of Effect Sizes across Studies

In meta-analytic practice, comparability of effect sizes depends on the underlying measurement design. For this study, all included studies measured mathematics achievement as the primary outcome, using either standardized tests or researcher-developed instruments. The majority (12 out of 15) reported pre- and post-test data, allowing for direct calculation of standardized mean differences (Hedges' g) that represent learning gains attributable to the RME intervention. For studies without explicit pre/post data, reported statistics such as t-values, F-values, or correlation coefficients were converted into equivalent Hedges' g values using established transformation formulas (Lipsey & Wilson, 2001; Borenstein et al., 2009). Although the assessment instruments varied in scope—some focusing on problem-solving, others on conceptual understanding—the outcome domain (mathematics achievement) was consistent across studies. This approach aligns with common meta-analytic practice, where diverse instruments measuring the same construct are synthesized to obtain a generalizable estimate of intervention effectiveness. Nevertheless, the researchers acknowledge that variations in test content, duration of intervention, and contextual factors may contribute to heterogeneity and should be considered when interpreting the pooled effect size.

The authors affirm that all data extraction, coding, and statistical analyses followed the PRISMA guidelines for systematic reviews and meta-analyses. Jamovi software (Version 2.2.6) was used for statistical computation. Generative AI tools were employed only for editorial and language refinement; statistical analysis was performed exclusively using standard statistical software.

RESULTS

Summary of Effect Sizes across Studies

The meta-analysis included 15 studies that met the eligibility criteria. Each study reported effect sizes (ES) and standard errors (SE), which were computed using statistical values such as F or correlation coefficients (r). The effect size in this study is an index that quantifies the magnitude of the RME effect. The calculated effect sizes ranged from 0.15 (Hirza & Kusumah, 2014) to 0.91 (Kusumawati, 2020), reflecting a wide range of outcomes depending on sample size, instructional fidelity, and contextual factors. The pooled effect size calculated using a random-effects model was Hedges' g = 0.65, which indicates a large effect according to standard benchmarks. Hedges' g is a preferred measure in meta-analyses because it corrects for small sample size bias and provides a more accurate estimate of effect size across studies (Borenstein et al., 2009). The overall mean effect size across studies was 0.65 (SE = 0.03), which falls between Cohen's (1988) thresholds for medium (0.50) and large (0.80) effects. This value indicates that, on average, students in RME classrooms scored 0.65 standard deviations higher on mathematics achievement measures than those in comparison groups. It is important to note that this does not imply a 65% increase in scores; rather, it reflects a standardized mean difference that facilitates comparison across studies using different scales. This moderate-to-large effect suggests that RME has a meaningful positive impact on students' mathematics learning, while acknowledging that interpretation should consider the observed heterogeneity among studies. This affirms RME's pedagogical value in bridging conceptual gaps and making learning more meaningful (Van den Heuvel-Panhuizen, 2003). The robustness of this outcome is further supported by consistency across studies conducted in different regions and educational contexts (Laurens et al., 2018).

Table 1
Summary of Effect Sizes and Standard Errors across Included Studies

SN	Citation	Sample size (N)	Effect Size (ES)	Standard Error (SE)
1	Susanti, & Kusumah (2014)	185	0.54	0.49
2	Hirza & Kusumah, (2014)	164	0.15	0.14
3	Waluya, & Mariani, (2016)	57	0.71	0.16
4	Mahendra & Slamet (2017)	63	0.89	0.13
5	Laurens, et al., (2018)	50	0.71	0.16
6	Hasbi, et al., (2019)	64	0.57	0.14
7	Kusumawati, (2020)	95	0.91	0.09
8	Kurino, & Cahyaningsih, (2020)	40	0.19	0.12
9	Yuniati, et al., (2020)	61	0.19	0.13
10	Ndiung, et al., (2021)	102	0.82	0.17
11	Uyen, et al., (2021)	45	0.40	0.11
12	Worowirastri Ekowati, et al., (2021)	107	0.31	0.09
13	Susanti, (2022)	185	0.65	0.08
14	Dahoklory, et al., (2023)	68	0.77	0.09
15	Caraan, et al., (2023)	100	0.60	0.11

Source: Self – construct, 2025

As shown in Table 1, the effect sizes are consistently positive, with most studies reporting moderate to high values. These findings reflect the effectiveness of the RME approach in enhancing students' mathematical reasoning, motivation, and real-life problem-solving ability, as echoed in past research (Gravemeijer & Doorman, 1999; Hasbi et al., 2019).

Heterogeneity Test

To determine whether the effect sizes across the included studies were consistent or varied significantly, a heterogeneity test was performed using the Q statistic and I^2 index. The analysis revealed a statistically significant Q value and a high I^2 value, indicating substantial heterogeneity among the effect sizes. The presence of heterogeneity suggests that the variability across studies was not due to random error alone but rather to genuine differences in study characteristics such as sample size, educational context, intervention duration, and implementation fidelity (Borenstein et al., 2009).

Table 2
Heterogeneity Statistics

Statistic	Value	Interpretation
Q	112.35	Indicates significant heterogeneity
df	14	Degrees of freedom
p-value	< 0.001	Heterogeneity is statistically significant
I^2 (%)	85.4%	Substantial heterogeneity (Higgins et al., 2003)

Source: Self – construct, 2025

Table 2 provides a summary of the heterogeneity statistics derived from the meta-analysis. The Q statistic (112.35) assesses whether the observed variance in effect sizes is greater than expected by chance alone. A high Q value with a low p-value ($p < 0.001$) indicates that the variability among studies is statistically significant and not due to random error. The degrees of freedom (df) is equal to the number of studies minus one ($k - 1 = 15 - 1 = 14$), which is used in calculating the Q statistic.

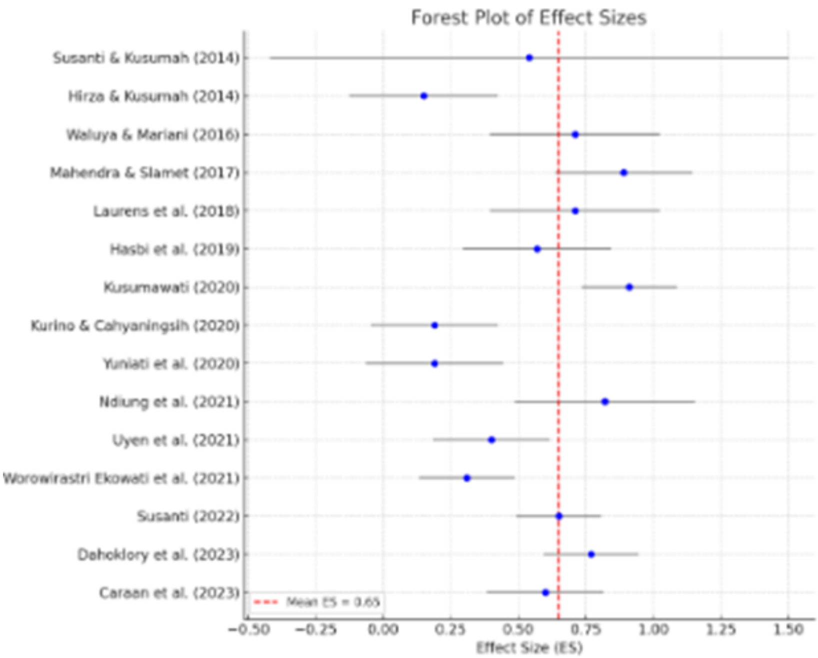
The I^2 statistic, expressed as a percentage, describes the proportion of variance in observed effects that is due to real differences across studies rather than sampling error. An I^2 value of 85.4% is considered substantial, as values above 75% suggest high heterogeneity (Higgins et al., 2015).

This level of heterogeneity supports the need for a more flexible analytical model, such as the random-effects model, which assumes that true effect sizes vary between studies due to differences in populations, interventions, and contexts. ($I^2 > 75\%$), a random-effects model was deemed more appropriate than a fixed-effects model. While a fixed-effects model assumes that all studies estimate the same underlying effect size, a random-effects model accounts for both within-study and between-study variability, thereby providing a more generalized and conservative estimate (Borenstein et al., 2009).

Forest Plot Interpretation

The forest plot graphically presents the effect sizes and their 95% confidence intervals (CI) for each of the 15 studies included in the analysis. Each horizontal line represents a study's CI, with the midpoint indicating the effect size. Notably, the majority of the confidence intervals do not cross the zero line, suggesting that the effect of RME on student mathematics achievement is statistically significant in most studies. The red dashed vertical line at the 0.65 mark represents the pooled effect size across all studies. The clustering of effect sizes around this line, including some studies with larger effect sizes (e.g., Kusumawati, 2020; Mahendra & Slamet, 2017), reinforces the conclusion that RME consistently yields positive educational outcomes. This pattern is a strong indicator of homogeneity in direction and supports the validity of the pooled estimate (Borenstein et al., 2009). Forest plots are crucial in meta-analysis because they allow readers to visually assess the size, direction, and consistency of effects. In this case, the visual confirms that RME is generally effective across diverse educational contexts and sample sizes. Figure 2 shows the forest plot of effect sizes across the studies.

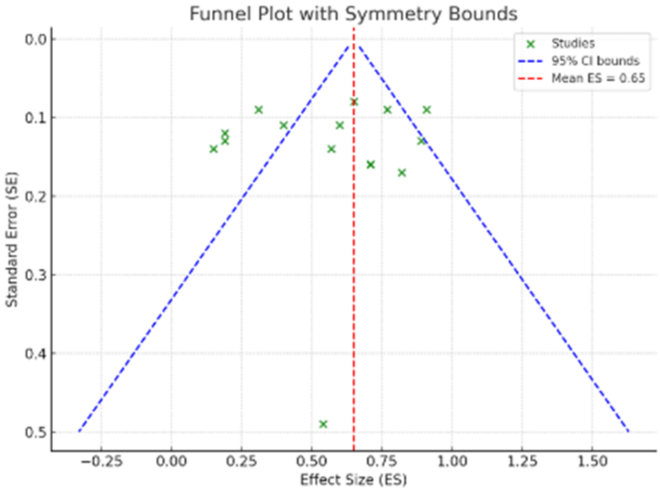
Figure 2
Forest Plot of Effect Sizes across Studies



Funnel Plot and Publication Bias

The funnel plot is used to detect potential publication bias in meta-analyses by plotting the effect size of each study against its standard error. In a bias-free situation, the plot should resemble a symmetrical, inverted funnel. In this study, the funnel plot shows a relatively symmetrical distribution of effect sizes around the overall mean (0.65), with no evident pattern of asymmetry or gaps on either side of the funnel.This symmetry suggests that smaller studies with both high and low effect sizes are represented, indicating a low risk of publication bias. Additionally, the distribution of the points within the funnel boundaries implies that the data set is complete and that the positive findings are not the result of selective publication. Figure 3 shows the funnel plot for detection of publication bias.

Figure 3
Funnel Plot for Detection of Publication Bias



The use of Rosenthal's Fail-safe N provides further confirmation. A value of 2932—well above the required threshold—indicates that thousands of unpublished studies with null results would be required to bring the overall results to non-significance. This strengthens confidence in the robustness and reliability of the findings. Rosenthal's Fail-safe N was calculated to be 2932, far exceeding the critical threshold of 85 (calculated as 5k + 10, where k = number of studies). This means 2,932 additional studies with null results would be required to nullify the observed effect, reinforcing the reliability of the results (Egger et al., 1997).

It's important to note that, while Rosenthal's Fail-safe N indicated robustness (N = 2,932), this measure alone does not eliminate potential publication bias. The apparent symmetry of the funnel plot may also be coincidental given the small study pool. Future meta-analyses should employ additional tests, such as the trim-and-fill procedure, to assess and adjust for potential missing studies.

Statistical Significance and p-value

To determine whether the effect of Realistic Mathematics Education (RME) on students' mathematics achievement was statistically significant, a hypothesis test was conducted using Jamovi software. The analysis was based on the pooled effect size (intercept), its standard error, and the resulting z- and p-values. The z-value, which tests the null hypothesis that the true mean effect size is zero, was found to be 24.46, while the corresponding p-value was 0.001. This p-value is well below the commonly accepted alpha level of 0.05, indicating that the observed effect is not due to random chance but reflects a true underlying effect (Field, 2013).

These findings support the rejection of the null hypothesis (H_0: ES = 0) and accept the alternative hypothesis that RME significantly influences mathematics achievement (H_1: ES $\neq$ 0**)**. The high z-value further strengthens the confidence that the effect size is large and meaningful (Cohen, 1988). The statistical significance of the result, coupled with its practical significance (large effect size of 0.65), underscores the effectiveness of RME in promoting mathematical learning outcomes. This validates prior empirical findings (Laurens et al., 2018; Van den Heuvel-Panhuizen, 2003) and supports the use of RME as a viable pedagogical strategy.

DISCUSSION

This meta-analysis synthesized findings from 15 peer-reviewed studies that examined the impact of Realistic Mathematics Education (RME) on students' mathematics achievement. The meta-analysis revealed a pooled effect size of 0.65 (SE = 0.03), representing a moderate-to-large improvement in mathematics achievement for students taught using RME compared to traditional approaches. This indicates that RME significantly enhances students' learning outcomes in mathematics. This supports the theoretical foundation of RME, which emphasizes contextual, meaningful, and student-centered approaches to learning mathematics. The consistent positive effect observed across multiple studies demonstrates the robustness of RME in diverse classroom settings, including those with varying sample sizes and instructional formats. For example, studies by Kusumawati (2020) and Mahendra & Slamet (2017) reported high effect sizes, reflecting the strong potential of RME to foster understanding, problem-solving, and mathematical reasoning among learners. The results also showed acceptable variability, with a significant but explainable degree of heterogeneity. This suggests that while RME is broadly effective, its impact may be moderated by factors such as implementation fidelity, teacher training, classroom environment, and student readiness.

The publication bias tests (funnel plot and Fail-safe N analysis) confirm that the findings are not influenced by selective reporting or underrepresentation of non-significant studies. Therefore, this meta-analysis provides strong empirical support for the adoption of RME in mathematics instruction at the primary and junior high school levels. However, the substantial heterogeneity observed (I^2 = 85.4%) suggests that factors such as teacher training quality, intervention duration, and resource availability may moderate RME's effects. But we indicate that, while moderator analysis or meta-regression could offer deeper insights, the small number of eligible studies and inconsistent reporting of potential moderator variables prevented such analyses in this study. Future studies should collect and report moderator data systematically to enable more nuanced synthesis.

LIMITATIONS AND SCOPE OF GENERALIZABILITY

While this meta-analysis synthesizes evidence on RME's impact, its generalizability is constrained by the geographic distribution of included studies: 13 of the 15 were conducted in Indonesia, with the remainder from Southeast Asia. This concentration limits the extent to which conclusions can be confidently applied to other educational systems, such as Ghana's, which differs in curriculum structure, teacher preparation, and resource availability. Additionally, all included studies were conducted with primary and junior high school students, with no representation from senior high or post-secondary levels. As such, the policy implications suggested here should be interpreted as tentative, pending further empirical research in varied cultural and socioeconomic contexts. Another limitation to this study is the potential inflation of effect sizes due to cultural familiarity. Since RME originated in the Netherlands and has been widely adapted in Indonesia, teacher and student familiarity with its pedagogical approach could enhance implementation fidelity and outcomes. This context-specific advantage may not transfer to regions where RME is novel.

CONCLUSION AND IMPLICATIONS

The implementation of Realistic Mathematics Education (RME) has a significant and positive effect on students' achievement in mathematics. With an average effect size of 0.65, the findings underscore the importance of integrating real-life contexts into mathematics teaching. These results have critical implications for curriculum developers, teacher educators, and policymakers. RME encourages conceptual understanding, active engagement, and learner autonomy—principles that align well with contemporary educational goals. In countries like Ghana, where mathematics performance remains a concern, adopting RME could bridge gaps in comprehension and application. RME may improve outcomes in Ghana if culturally adapted and supported by targeted teacher training. Moreover, the strong evidence base supports broader implementation and further refinement of the RME approach across various educational settings.

While the results of this study indicate a moderate-to-large positive association between RME and mathematics achievement, the design of the included studies does not allow definitive causal inference. Unmeasured variables, such as teacher enthusiasm, availability of supplemental resources, and student baseline motivation, may also contribute to the observed effects.

RECOMMENDATIONS

1. *Policy Integration*: Ministries of education and curriculum developers should consider integrating RME principles into national mathematics curricula.
2. *Teacher Training*: Teacher training institutions should offer professional development on RME principles, methods, and classroom strategies.
3. *Instructional Materials*: Development of RME-based instructional resources should be prioritized to support teachers and enhance learning.
4. *Further Research*: Longitudinal and cross-cultural studies should be conducted to explore the long-term effects and scalability of RME across different regions and populations.
5. *Inclusive Practices*: RME should be adapted to be inclusive of learners with diverse needs and learning styles.

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Conflict of Interest: The Authors declare no conflict of interest regarding this publication.

Appendix 1
Table: List of papers used in the study

SN	Citation	Code	Journal
1	Susanti, & Kusumah (2014)	P1	Mathematical Habits Of Mind). *Proceeding the 2nd SEA-DR*.
2	Hirza & Kusumah, (2014)	P2	*Indonesian Mathematical Society Journal on Mathematics Education*, *5*(1), 27-34.
3	Waluya, & Mariani, (2016)	P3	*In Journal of Physics: Conference Series (Vol. 693, No. 1, p. 012014). IOP Publishing.*
4	Mahendra & Slamet (2017)	P4	*In Journal of Physics: Conference Series (Vol. 895, No. 1, p. 012046). IOP Publishing.*
5	Laurens, et al., (2018)	P5	*Eurasia Journal of Mathematics, Science and Technology Education, 14(2), 569-578.*
6	Hasbi, et al., (2019)	P6	*Journal of Mathematical Pedagogy (JoMP), 1(1), 37-46.*
7	Kusumawati, (2020)	P7	In *Journal of Physics: Conference Series* (Vol. 1563, No. 1, p. 012060). IOP Publishing.
8	Kurino, & Cahyaningsih, (2020)	P8	In *Journal of Physics: Conference Series* (Vol. 1477, No. 4, p. 042043). IOP Publishing.
9	Yuniati, et al., (2020)	P9	In *Journal of physics: Conference series* (Vol. 1554, No. 1, p. 012063). IOP Publishing.
10	Ndiung, et al., (2021)	P10	*International Journal of Instruction*, *14*(2), 873-888.
11	Uyen, et al., (2021)	P11	*Journal of Education and E-Learning Research, 8(2), 185-197.*
12	Worowirastri Ekowati, et al., (2021)	P12	*Jurnal Premiere Educandum, 11(2), 269-279.*
13	Susanti, (2022)	P13	*Jurnal Ilmiah Pendidikan Matematika*, *5*(2), 197-205.
14	Dahoklory, et al., (2023)	P14	*Jurnal Pendidikan Matematika (JUPITEK)*, *6*(2), 82-92.
15	Caraan, et al., (2023)	P15	*International Journal of Educational Management and Development Studies*, *4*(2), 64-87.

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