



Meta-Analysis: The Effectiveness of Realistic Mathematics Education (RME) and Ethnomathematics-Based Learning on Students' Mathematical Problem-Solving Abilities

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ARTICLE INFO	ABSTRACT
ARTICLE HISTORY: Received Jul 06, 2026 Accepted Sep 24, 2026 Published Online Oct 24, 2026	This study aims to estimate the pooled effect size of Realistic Mathematics Education (RME) and ethnomathematics-based learning on students' mathematical problem-solving abilities, as well as to analyze the heterogeneity and potential publication bias of the reviewed studies. This study employed a meta-analysis method, with the study identification, selection, and reporting process guided by PRISMA 2020. Articles were searched through Google Scholar and OpenRead, covering publications from 2020 to 2025. Based on the established inclusion criteria, 22 articles were included, consisting of 11 studies on RME and 11 studies on ethnomathematics-based learning. The included studies employed quantitative experimental or quasi-experimental designs and provided sufficient data on means, standard deviations, and sample sizes to calculate effect sizes. Effect sizes were calculated using Hedges' g and synthesized using a random-effects model. The results showed that the pooled effect size for RME was 1.047, with a 95% confidence interval of 0.7194–1.375, while the pooled effect size for ethnomathematics-based learning was 0.9178, with a 95% confidence interval of 0.6699–1.166. Both effect sizes were categorized as very large. The heterogeneity analysis showed significant heterogeneity in the RME group ($Q = 28.25$; $p = 0.002$; $I^2 = 65.27\%$), whereas the ethnomathematics-based learning group did not show statistically significant heterogeneity ($Q = 17.04$; $p = 0.074$; $I^2 = 40.82\%$). Egger's test indicated no statistically significant evidence of asymmetry in the RME group ($p = 0.310$), whereas the ethnomathematics-based learning group showed evidence of asymmetry ($p = 0.034$). Therefore, the pooled effect size of ethnomathematics-based learning should be interpreted with caution due to the indication of potential publication bias.
KEYWORDS: Ethnomathematics Meta-Analysis Problem Solving Ability Realistic Mathematic Education	



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Introduction

Mathematics education plays an important role in developing students' critical thinking and problem-solving skills. The National Council of Teachers of Mathematics (NCTM) places problem-solving as one of the mathematical process standards that need to be developed in learning (NCTM, 2020). The ability to solve mathematical problems is the students' ability to use mathematical knowledge and concepts to find solutions to the problems they face. This ability involves several processes, namely understanding the problem, formulating a solution plan, executing the strategy, and evaluating the results obtained (Wikasari et al., 2025). However, the ability to solve mathematical problems remains a challenge in mathematics education in Indonesia. Based on the results of the Program for International Student Assessment (PISA) 2022, Indonesia's average mathematics score decreased from 379 in 2018 to 366 in 2022 (OECD, 2023). In line with this, Prameswari & Abadi (2025) show that students' mathematical problem-solving abilities are still relatively low. The low problem-solving abilities indicate the need for learning that provides meaningful experiences and connects mathematical concepts with situations close to students' lives. Learning that tends to be procedure-oriented limits students' opportunities to construct concepts through real-life contexts (Noor & Abadi, 2022). Therefore, learning that can present authentic contexts and encourage students to use mathematical concepts in solving problems is needed.

One of the relevant learning approaches is Realistic Mathematics Education (RME). RME uses contextual problems as a starting point for learning and directs students to build knowledge through the process of mathematization (Sugiarti et al., 2025). Additionally, RME emphasizes the process of guided reinvention, which provides students with the opportunity to rediscover mathematical concepts through teacher guidance. These characteristics enable students to develop strategies in understanding and solving mathematical problems (Mailani et al., 2025). In addition to RME, ethnomathematics-based learning also holds potential for developing mathematical problem-solving skills. Ethnomathematics-based learning integrates mathematical concepts with cultural practices and knowledge that are closely tied to students' daily lives. The use of cultural contexts can make learning more concrete and meaningful and support students' conceptual understanding (Wikasari et al., 2025). Through the connection between mathematical concepts and cultural experiences, students gain the opportunity to understand and apply mathematical concepts in situations relevant to their lives.

Various studies have demonstrated the effectiveness of RME and ethnomathematics-based learning on mathematical problem-solving skills. Sardono et al., (2025) and Sugiarti et al., (2025) found that RME has a positive effect on problem-solving skills, while Masruroh et al., (2022) and Septiani et al., (2023) demonstrated the effectiveness of ethnomathematics-based learning. However, the reported effect sizes vary across studies. This variation highlights the need for a quantitative synthesis to obtain a more comprehensive estimate of the effectiveness of each approach on students' mathematical problem-solving skills. Meta-analysis is one approach that can be used to quantitatively synthesize research findings by calculating the effect size of each study and combining the results to obtain an overall effect estimate. In addition to producing a combined effect size estimate, meta-analysis also allows researchers to identify the level of heterogeneity in research results and assess the possibility of publication bias (Harlan, 2024). Thus, a meta-analysis can provide a more comprehensive picture of the effectiveness of RME and ethnomathematics-based learning on students' mathematical problem-solving skills.

Based on the above discussion, this study aims to: (1) estimate the combined effect size of Realistic Mathematics Education (RME) on students' mathematical problem-solving skills; (2) estimate the combined effect size of ethnomathematics-based learning on students' mathematical problem-solving skills; and (3) analyze the heterogeneity and potential publication bias of the studies reviewed.

Method

Type of Research

This study is a quantitative study using a meta-analysis method, aimed at estimating the effectiveness of Realistic Mathematics Education (RME) and ethnomathematics-based learning on students' mathematical problem-solving skills. Meta-analysis was used to integrate the results of empirical studies through effect size calculations, thereby obtaining a combined effect estimate from the studies conducted. The process of identifying, selecting, and reporting studies followed the PRISMA 2020 guidelines (Page et al., 2021).

Data and Unit of Analysis

The research data consists of secondary data obtained from empirical research articles on the effectiveness of Realistic Mathematics Education (RME) and ethnomathematics-based learning on students' mathematical problem-solving abilities. Articles were obtained through searches on Google Scholar and Open Read within the publication range of 2020–2025. The data collected includes the article title, author names, publication year, journal source, type of learning approach, education level, sample size, mean value, standard deviation, and other statistical data necessary to calculate effect size. The unit of analysis in this study is the empirical research results found in articles that meet the inclusion criteria. The unit of analysis is grouped based on the learning approaches studied, namely Realistic Mathematics Education (RME) and ethnomathematics-based learning. Articles that meet all selection criteria are used as the basis for calculating effect size and synthesizing research results.

Data Collection

The data collection procedure in this research was conducted by gathering secondary data in the form of scientific articles relevant to the research topic. The stages of data collection include, first, Literature Search and Selection. Article searches were conducted using the Google Scholar and Open Read databases within the 2020–2025 range, limited to journals accredited by SINTA 1–6. The keywords used include "Realistic Mathematics Education (RME)", "PMRI", "ethnomathematics", "problem solving", "mathematics", and "students". The identified articles were then selected based on the established inclusion and exclusion criteria. The process of identification, screening, eligibility assessment, and study inclusion refers to PRISMA 2020 (Page et al., 2021). *Second*, coding aims to facilitate data analysis (Yustinaningrum, 2021). Article coding includes article code, author, year of publication, title, and journal source.

Data Analysis

Data analysis was conducted through the calculation of effect size to estimate the magnitude of the influence of Realistic Mathematics Education (RME) and ethnomathematics-based learning on students' mathematical problem-solving abilities. Effect size is calculated using Hedges' g , which is a standardized effect size commonly used in meta-analysis because it corrects for bias that can arise in studies with small sample sizes (Pratama et al., 2024). The calculation of effect size is based on the mean, standard deviation, and sample size of the experimental and control groups using the following formula:

$$g = J \cdot d$$

with

$$d = \frac{\bar{x}_1 - \bar{x}_2}{s_p}$$

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$$

And its correction factor is:

$$J = 1 - \frac{3}{4(n_1 + n_2) - 9}$$

Note : g = Hedges' g ; d = Cohen's d before correction; J = small sample bias correction factor; $\bar{x}_1$ = mean of the experimental group; $\bar{x}_2$ = mean of the control group; s_p = pooled standard deviation; s_1 and s_2 = standard deviations of the experimental and control groups; n_1 and n_2 = sample sizes of the experimental and control groups.

Table 1. Interpretation of Effect Size

<i>Effect size</i>	<i>Interpretation</i>
$0 < ES \leq 0,2$	Small
$0,2 < ES \leq 0,5$	Moderate
$0,5 < ES \leq 0,8$	Large
$ES > 0,8$	Very Large

Next, the effect sizes of each study were combined using a random-effects model, while heterogeneity was analyzed using Q and I^2 statistics. All meta-analysis analyses were conducted using JASP to obtain the pooled effect size, assess heterogeneity, and evaluate the potential for publication bias.

Research Findings

The results of the search and selection of articles based on the established criteria are presented in the PRISMA 2020 flow diagram in Figure 1. Based on this selection process, 22 articles that met the inclusion criteria were obtained and used as the units of analysis for the research.

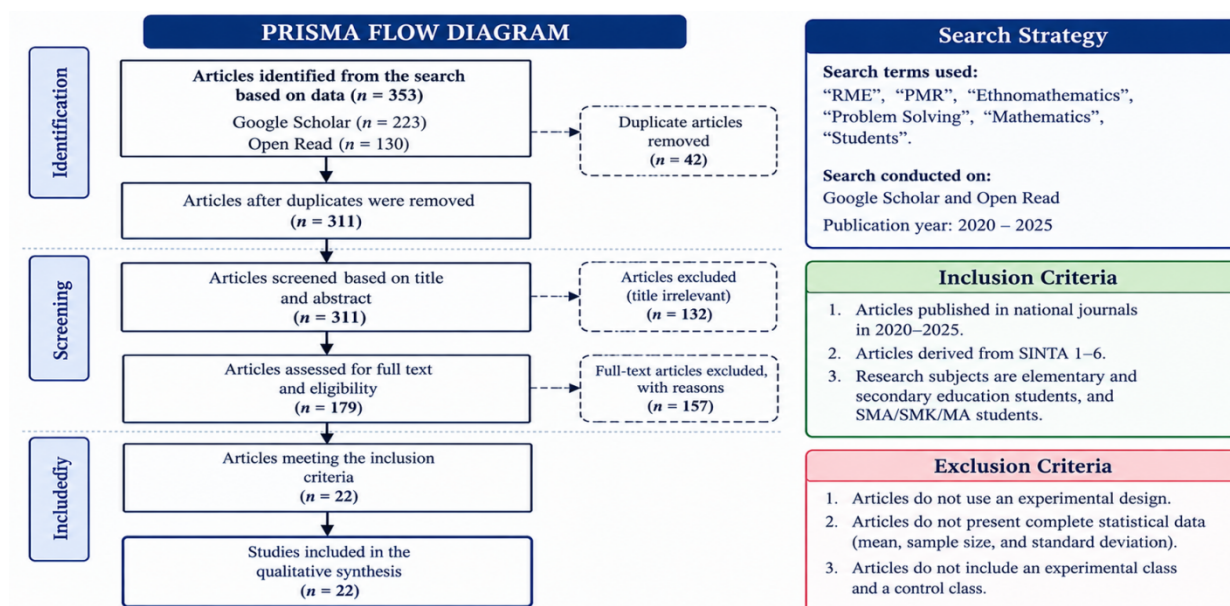


Figure 1. PRISMA Flow Diagram

Based on the literature selection process using the PRISMA method, 11 articles discussing the RME approach to students' mathematical problem-solving abilities (Hafid & Sulfasyah, 2022; Jehadus et al., 2024; Khotimah et al., 2024; W. A. Lubis et al., 2020; Marita et al., 2025; Miharja et al., 2024; Rista et al., 2020; Sugiarti et al., 2025; Sukmawati et al., 2025; Syafitri et al., 2025; Widiastuti & Nindiasari, 2022) and 11 articles discussing the ethnomathematics-based learning to students' mathematical problem-solving abilities (Anjarsari et al., 2025; Aprilyani & Hakim, 2020; Ardiana et al., 2025; Bestari & Sari, 2025; Hiaa et al., 2025; A. N. M. T. Lubis & Widada, 2020; Maulana et al., 2020; Nihaya et al., 2022; Nur et al., 2020; Prawanti et al., 2025; Yunitasari & Zaenuri, 2020). Were obtained. Next, the selected articles were coded to facilitate the grouping and analysis of data.

Table 2. Article Coding

Article code	Researcher's name	Researcher's year	Research title	Source
RME1	Beti Widiastuti, Hepsi Nindiasari	2022	The Application of Realistic Mathematics Education to Develop Elementary School Students' Mathematical Problem-Solving Skills	https://j-cup.org/index.php/cendekia/article/view/1190
RME2	Hasrinah Hafid, Agustan Syamsuddin, Sulfasyah	2022	The Influence of Realistic Mathematics Education Approach on the Mathematical Problem-Solving Ability of Elementary School Students	https://ejournal.iainpalopo.ac.id/index.php/PiJIES/article/view/2973

Article code	Researcher's name	Researcher's year	Research title	Source
RME3	Sukmawati, Mukhlis, Nazwar Muslan	2025	Problem-solving ability and learning interest in realistic mathematics learning with the use of Mathcitymap Application	https://journal.amca2012.org/index.php/ajeb/article/view/394
RME4	Khusnul Khotimah, Aklimawati, Nur Elisyah	2024	The Influence of the Realistic Mathematics Education (RME) Approach on Students' Mathematical Problem-Solving Abilities	https://ojs.unimal.ac.id/jpm/article/view/17423
RME5	Marenda Atika Miharja, Makungu Bulayi, Le Viet Minh Triet	2024	Realistic Mathematics Education: Unlocking Problem-Solving Potential in Students	https://cahaya-ic.com/index.php/IJoME/article/view/1344
RME6	Lana Sugiarti, Eufasia Jeramat, Silfanus Jelatu, Yakobus Frediki Harjo	2025	The Influence of the Realistic Mathematics Education (RME) Learning Approach on Students' Mathematical Problem-Solving Abilities in Terms of Mathematical Anxiety	https://bimaberilmu.com/jurnal/index.php/jagomipa/article/view/1320
RME7	Citra Nur Syafitri, Astuti, Adityawarman Hidayat	2025	The Influence of the Realistic Mathematics Education (RME) Approach on the Mathematical Problem-Solving Ability of Eighth Grade Students at SMP Negeri 2 Kabun	https://jurnal.ummi.ac.id/index.php/peka/article/view/3277
RME8	Lia Rista, Cut Yuniza Eviyanti, Andriani	2020	Improvement of Problem-Solving Skills and Self-Esteem of Students Through Humanistic Learning Based on Realistic Mathematics Education	https://j-cup.org/index.php/cendekia/article/view/345
RME9	Weni Ariyanti Lubis, Suwarno Ariswoyo, Edi Syahputra	2020	Mathematical Problem-Solving Ability Through Realistic Mathematics Education Approach and Guided Discovery Approach Assisted by Autograph	https://ejournal.iainkerinci.ac.id/index.php/edumatika/index
RME10	Emilianus Jehadus, Lana Sugiarti, Yasinta Jelimun	2024	The Influence of the Realistic Mathematics Education (RME) Approach on Mathematical Problem-Solving Ability in Terms of Students' Mathematical Anxiety	https://jurnaldidaktika.org/contents/article/view/698
RME11	Jea Marita, Radhya Yusri, Hafizah Delyana	2025	The Application of the Realistic Mathematics Education (RME) Approach to the Mathematical Problem-Solving Ability of XII Grade Students in Phase F	https://journal.unpas.ac.id/index.php/pendas/article/view/32789
ETN1	Ginanjana Maulana, Zaenur, Iwan Junaedi	2020	Pattern of Problem Solving Skill Reviewed Based on Student Cognitive Style After Experienced Problem Based Learning Model with Ethnomathematics Nuances	https://journal.unnes.ac.id/sju/jpe/article/view/37507
ETN2	Azra Akila Nihaya, Nila Kesumawati, Marvinda Rizki Dita Dirgantara	2022	Improvement of Students' Mathematical Problem-Solving Skills Through Ethnomathematics-Based	https://ejournal.unma.ac.id/index.php/cp/article/view/3265

Article code	Researcher's name	Researcher's year	Research title	Source
			Mathematics Learning in Elementary School	
ETN 3	Sila Karisma Bestari, Elok Fariha Sari	2025	The Influence of Ethnomathematics Learning Based on Regional Specialties on the Problem-Solving Ability of 5th Grade Elementary School Students in Fraction Material	https://jppipa.unram.ac.id/index.php/jcar/article/view/11365
ETN4	Wenni Anjarsari, Neza Agusdianita, Yusnia	2025	The Influence of Ethnomathematics-Based Problem-Based Learning (PBL) Model on Problem-Solving Ability in Mathematics Subjects of Fourth Grade Students at SDN Gugus XIV Bengkulu City	https://jurnal.uns.ac.id/SHES/article/view/107479/0
ETN5	Ragil Yunitasari, Zaenuri	2020	Mathematical Problem-Solving Ability and Self-Efficacy of Eighth Grade Students at SMP Negeri 1 Cepiring in Ethnomathematics-Themed PBL Learning	https://journal.unnes.ac.id/sju/prisma/article/view/37565/15517
ETN6	Andi Saparuddin Nur, Stevanus Budi Waluya, Rochmad, Wardono	2020	Contextual learning with Ethnomathematics in enhancing the problem solving based on thinking levels	https://journals.ums.ac.id/index.php/jramathedu/article/view/11679
ETN7	Nia Aprilyani, Arif Rahman Hakim	2020	The Influence of Assurance, Relevance, Interest, Assessment, Satisfaction Learning Assisted by Ethnomathematics on Problem-Solving Ability	https://jurnal.ugj.ac.id/index.php/JNPM/article/view/2549
ETN8	Ester Hia, Amin Otoni Harefa, Yakin Niat Telaumbanua, Sadiana Lase	2025	The Influence of the Ethnomathematics Approach on the Mathematical Problem-Solving Ability of UPTD Lolofitu Moi State Junior High School Students	https://ojs.mahadewa.ac.id/index.php/emasains/article/view/4555
ETN9	Lailik Ardiana, Baidowi, Ulfa Lu'luilmaknun	2025	The Influence of Ethnomathematics-Based Problem Based Learning Model on the Mathematical Problem-Solving Ability of Eighth Grade Students	https://jurnalkip.unram.ac.id/index.php/MANDALIKA/article/view/9752
ETN 10	Diah Amalia Prawanti, Sudiyah Anawati, Kasih Haryo Basuki	2025	The influence of the Problem Based Learning (PBL) model assisted by ethnomathematics on mathematical problem-solving abilities	https://putrapublisher.org/ojs/index.php/pijar/article/view/960
ETN 11	A. Naashir M. Tuah Lubis, Wahyu Widada	2020	Students' Problem-Solving Abilities through the Bengkulu Ethnomathematics-Oriented Realistic Mathematics Learning Model	https://ejournal.unib.ac.id/index.php/jpmr/article/view/10664

After the coding and data grouping process is completed, the next stage is the calculation of effect size to obtain a broad picture of the influence of each approach on students' mathematical problem-solving abilities. The results of the calculations are then presented in the following table based on the RME and ethnomathematics approaches.

Table 3. Effect Size RME

Article code	N		MEAN		SD		Effect size	Category
	Experiment	control	Experiment	control	Experiment	control		
RME 1	24	24	82,29	80,21	8,467	6,672	0,2684	Moderate
RME 2	26	25	61,85	46,40	12,87	14,42	1,1144	Very Large
RME 3	38	38	80,21	68,42	7,39	13,71	1,0597	Very Large
RME 4	31	31	23,13	14,97	4,86	5,84	1,4998	Very Large
RME 5	30	30	82,4	70,6	6,3	8,1	1,6051	Very Large
RME 6	26	23	80,5385	72,087	5,8394	7,9195	1,2067	Very Large
RME 7	27	27	77,85	72,22	9,412	8,327	0,6244	Large
RME 8	24	24	85,12	75,7	13,668	11,90	0,7231	Large
RME 9	30	30	77,67	69,5	6,39	10,37	0,9362	Very Large
RME 10	30	33	78,067	60,601	10,4944	7,1067	1,9426	Very Large
RME 11	30	30	75,509	63,056	17,51	21,487	0,6271	Large

Table 4. Effect size ethnomathematics-based learning

Article code	N		MEAN		SD		Effect size	Category
	Experiment	control	Experiment	control	Experiment	control		
ETN1	23	26	77,61	67,95	7,83	7,09	1,2766	Very Large
ETN2	29	30	81,48	70,77	14,515	15,774	0,6967	Large
ETN3	25	24	80,04	71,08	10,216	6,990	1,0034	Very Large
ETN4	22	20	80,836	62,430	9,3315	14,2030	1,5179	Very Large
ETN5	32	29	84,2	73,2	9,93	7,06	1,2501	Very Large
ETN6	30	30	69,17	60,30	17,13	13,94	0,5606	Large
ETN7	31	31	80,21	75,84	5,69	4,43	0,8463	Very Large
ETN8	28	28	61,14	55,14	10,80	20,47	0,3615	Moderate
ETN9	30	30	77,70	71,40	8,647	9,651	0,6786	Large
ETN 10	32	32	82	73,12	11,75	10,92	0,7734	Large
ETN 11	34	34	80,24	69,12	6,72	8,69	1,4152	Very Large

After the effect sizes of each study were obtained, a meta-analysis was conducted to estimate the pooled effect size of the implementation of Realistic Mathematics Education (RME) and ethnomathematics-based learning on students' mathematical problem-solving abilities. The results of the pooled effect size estimation are presented in the Table 5.

Table 5. Combined effect size

Group	N	Effect size <i>Gab</i>	SE	95%CI		Q	P	I ²
				lower	upper			
RME	11	1,047	0,1472	0,7194	1,375	28,25	0,002	65,27%
Ethnomathematics	11	0,9178	0,1113	0,6699	1,166	17,04	0,074	40,82%

Table 6. Heterogeneity Test

Group	Q(df)	p-value	I ²
RME	28,25(10)	0,002	65,27%
Ethnomathematics	17,04(10)	0,074	40,82%

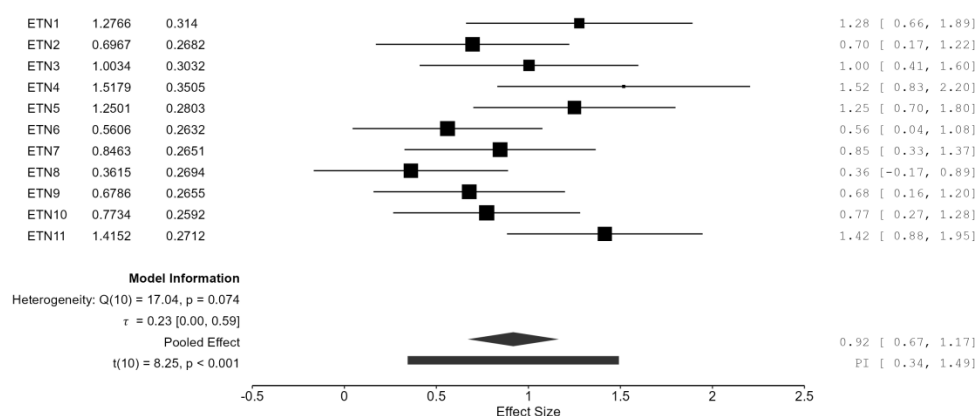


Figure 2. Forest Plot RME

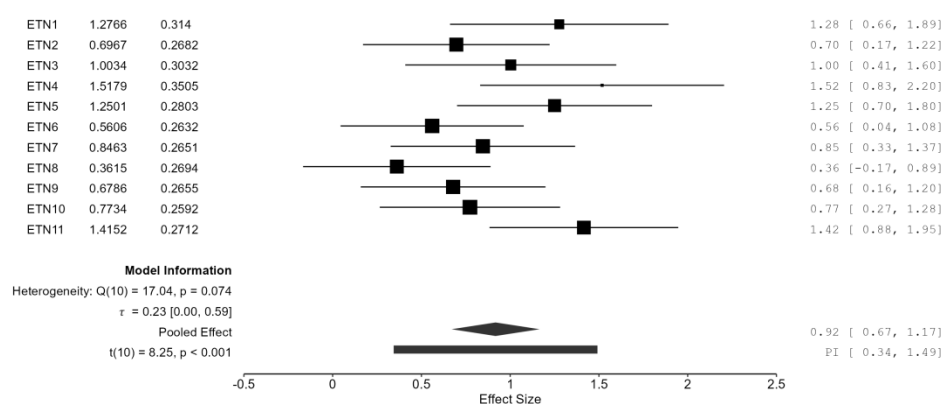


Figure 3. Forest Plot Ethnomathematics

Table 7. Publication Bias Test

Group	N	Egger's t	df	p-value
RME	11	1,075	9	0,310
Etnomatematika	11	2,496	9	0,034

Discussion

Based on [Table 3](#) and [Table 4](#), in the RME group, there is 1 article in the medium category, 3 in the large category, and 7 in the very large category. Meanwhile, in the ethnomathematics-based learning group, there is 1 article in the medium category, 4 in the large category, and 6 in the very large category. This shows that the application of RME and ethnomathematics-based learning generally has a strong influence on students' mathematical problem-solving abilities, although the degree of influence varies in each study.

Based on the results of the meta-analysis in [Table 5](#), the combined effect size value for RME learning is 1.047, categorized as very large. This result indicates that overall, RME learning has a very significant impact on students' mathematical problem-solving abilities. These findings are in line with the research by [Sofyani & Arifin \(2025\)](#), which shows that the RME approach is more effective compared to conventional methods. Additionally, the meta-analysis results by [Purnamasari & Juandi \(2023\)](#) obtained an effect size of 1.516, which falls into the high category, indicating that the application of RME is effective in improving students' mathematical problem-solving abilities.

The high effect size in RME learning is in line with the characteristics of RME that place context as an important part of the learning process. These characteristics are related to the process of mathematization and the principle of guided reinvention, which are important parts of RME learning. Through the use of contexts close to students' experiences, students are directed to understand problem situations and connect them with relevant mathematical concepts ([Tamimi et al., 2025](#)). The process then continues through horizontal mathematization, which involves organizing contextual problems into mathematical forms or models, and vertical mathematization, which involves developing models and strategies toward more formal mathematical concepts. In this process, models serve as a bridge between contextual situations and formal mathematics. Meanwhile, the principle of guided reinvention provides students with the opportunity to rediscover mathematical concepts or strategies through a process guided by the teacher. Students' contributions in developing strategies, interactions through discussions and idea exchanges, as well as the interconnections between concepts, provide space for students to build and strengthen their mathematical understanding. These characteristics theoretically support the process of mathematical problem-solving, starting from understanding the problem, planning the solution, executing the plan, to reviewing the obtained results ([Ayumni et al., 2025](#)). Meanwhile, the combined effect size value in ethnomathematics-based learning is 0.9178, which falls into the very large category. This result indicates that overall, ethnomathematics-based learning has a very significant impact on students' mathematical problem-solving abilities. This finding is supported by [Ayumni et al. \(2025\)](#), who state that ethnomathematics learning is effective in enhancing mathematical problem-solving skills.

In ethnomathematics-based learning, the effect size aligns with the characteristics of learning that emphasize the connection between mathematics and cultural practices and knowledge. The integration of cultural elements in learning provides students with the opportunity to discover and understand mathematical concepts through activities present in

their cultural environment. Cultural practices that contain mathematical concepts can be used as a learning context so that students not only study mathematics abstractly but also understand its application in life (Khadijah & Sutamrin, 2022). Through this connection, students can link their existing cultural knowledge and experiences with the mathematical concepts being studied. This process provides students with the opportunity to explore problems, discover concepts, and develop solution strategies based on meaningful contexts. Thus, ethnomathematics-based learning theoretically supports mathematical problem-solving skills because students gain experience in understanding, connecting, and applying mathematical concepts through practice and cultural knowledge.

The results of the heterogeneity test in Table 6 show a difference in the level of variation in effect size between the RME group and ethnomathematics-based learning. In the RME group, a Q value of 28.25 was obtained with a significance value of 0.002 and an I^2 value of 65.27%. A significance value smaller than 0.05 indicates that there is significant heterogeneity among the studies. The I^2 value of 65.27% indicates that the variation in effect sizes between studies is at a relatively high level. Thus, the magnitude of the influence of RME on students' mathematical problem-solving abilities is not entirely uniform across each analyzed study. In the ethnomathematics-based learning group, a Q value of 17.04 was obtained with a significance value of 0.074 and an I^2 value of 40.82%. A significance value greater than 0.05 indicates that the heterogeneity between studies is not statistically significant. Meanwhile, the I^2 value of 40.82% indicates a moderate level of effect size variation. The results indicate that in the ethnomathematics-based learning group, there is a moderate variation in effect size between studies, while the heterogeneity between studies is not statistically significant.

The variation in effect sizes found may be related to differences in the characteristics of the analyzed studies, such as the level of education, student characteristics, learning materials, sample size, measurement instruments, duration of learning, and implementation of learning. In RME research, differences in the use of context, application of mathematization, use of models, as well as forms of interaction and student contribution can result in different learning experiences. Meanwhile, in ethnomathematics-based learning, differences in cultural practices and knowledge used as learning contexts, as well as the way they are integrated with mathematical concepts, can also affect the results obtained. Therefore, the differences in characteristics and implementation of learning in each study need to be considered in understanding the variations in effect size found.

To determine the possibility of publication bias, an Egger's test was conducted as presented in Table 7. In the RME group, a significance value of 0.310 was obtained, which is greater than 0.05. This result indicates that there is no significant statistical evidence of asymmetry in the distribution of effect sizes, thus no significant publication bias was found based on the Egger's test. Meanwhile, the ethnomathematics-based learning group obtained a significance value of 0.034, which is less than 0.05. This result indicates the presence of asymmetry in the distribution of effect sizes, so the possibility of publication bias needs to be considered when interpreting the meta-analysis results in the ethnomathematics group. Therefore, the combined effect size results in the ethnomathematics group need to be interpreted carefully, taking into account the publication bias test results.

Conclusion

Based on the results of the meta-analysis of research on RME learning and ethnomathematics-based learning on students' mathematical problem-solving abilities, it can be

concluded that the application of RME produces a combined effect size of 1.047 with a very large category. This result indicates that, overall, the analyzed research provides evidence of a very large influence of RME application on students' mathematical problem-solving abilities. In the ethnomathematics-based learning group, a combined effect size of 0.9178 with a very large category was obtained, which also indicates that the analyzed research provides evidence of a very large influence on students' mathematical problem-solving abilities. The results of the heterogeneity test show that the effect size in the RME group has a significant variation with a Q value of 28.25; $p = 0.002$; $I^2 = 65.27\%$, while the ethnomathematics-based learning group shows non-significant heterogeneity with $Q = 17.04$; $p = 0.074$; $I^2 = 40.82\%$. This variation indicates that the magnitude of the effect size between studies can differ and needs to be considered based on research characteristics, such as education level, material, student characteristics, instruments, sample size, learning duration, and learning implementation.

Based on the Egger test, in the RME group, a significance value of 0.310 was obtained, which is greater than 0.05. This result indicates that there is no statistically significant evidence of asymmetry in the distribution of effect size based on the Egger test. Meanwhile, the ethnomathematics-based learning group shows an indication of asymmetry with $p = 0.034$, so the effect size results in this group need to be interpreted with caution. Furthermore, the two groups cannot be entirely regarded as two conceptually equivalent learning approaches. RME is a learning approach based on mathematization and guided reinvention, while ethnomathematics emphasizes the connection between mathematics and cultural practices and knowledge, and in its application, it can be combined with other learning models or approaches. Therefore, the effect size in ethnomathematics-based learning groups needs to be understood in the context of the learning characteristics used in each study.

Declarations

- Conflict of Interest** : The authors declare that there are no conflicts of interest.
- Auhor Contributions** : M.A.: Conceptualization; Investigation; Formal analysis; Writing – original draft.
P.: Methodology; Validation; Writing – review & editing.
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