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Realistic mathematics education and mathematical literacy: a meta-analysis conducted on studies in Indonesia

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ABSTRACT

A considerable body of literature exists pertaining to realistic mathematics education (RME) and its correlation with mathematical literacy, with numerous studies demonstrating incongruent results. The principal objective of this meta-analysis is to systematically investigate the overarching influence of RME on mathematical literacy within the context of Indonesia. The collection of documents comprises a total of seventeen publications that were released between the years 2014 and 2023. The estimation methodologies utilized in this study were grounded on a random-effects model, and statistical computations were conducted utilizing the comprehensive meta-analysis (CMA) software in academic writing. The equation proffered by Hedges was employed for the quantification of effect magnitude. The outcomes of the investigation reveal that the implementation of RME learning yielded a noteworthy and advantageous impact (effect size = 1.031; $p < 0.05$) on the adeptness of students in the domain of mathematical literacy. Moreover, many moderating factors, including class capacity, educational level, geographical location, content of the Programme for International Student Assessment (PISA), and the combination of learning, did not significantly impact students' diverse mathematical literacy proficiency. This study proposes that mathematics educators should consider utilizing the RME as a means of improving students' proficiency in mathematical literacy.

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1. INTRODUCTION

Today's complexities of life are increasingly evident, marked by the advent of multifaceted obstacles and expectations spanning multiple spheres. Individuals need to attain mastery in a diverse range of abilities and skills. The study of mathematical literacy is a necessary educational endeavor [1]–[5]. The cultivation of adept mathematical literacy proficiency assumes paramount significance in contemplation of the integration of the 2013 Curriculum. The revelations stemming from the outcomes of the Programme for International Student Assessment (PISA) 2022 were disseminated on the 5th of December, 2023. According to the results of PISA 2022, Indonesia experienced a decline of 13 points in mathematical literacy scores compared to the PISA results in 2018. In PISA 2018, Indonesia's mathematical literacy score was 379, whereas in PISA 2022, it dropped to 366. The study conducted in 2022 assessed 690,000 students from 81 countries. Therefore, the primary goal in mathematics education at the school level is to prioritize the development of mathematical literacy abilities [6], [7].

Numerous instructional approaches have the potential to enhance pupils' literacy skills. One of the approaches is realistic mathematics education (RME) method [8]. The RME involves students beginning their learning journey by engaging with authentic scenarios and real-world challenges [9], [10]. They then attempt to reconstruct mathematical concepts and thoughts with the teacher's assistance and direction [11]–[14]. The RME approach has been wholly scrutinized in the context of students' mathematical literacy [15]. Many research studies have examined the impact of RME on several aspects of mathematical literacy, including spatial skills, motivation, communication ability, and problem-solving aptitude [16]–[18]. These experiments together demonstrate the effectiveness of learning aids based on the principles of realistic mathematical teaching [19]–[23].

Several studies have explored the potential impact of utilizing RME on enhancing students' mathematical literacy skills in Indonesia. The findings of this study exhibit diversity. Several studies have indicated that using RME has been associated with significantly improving students' mathematical literacy skills [24]–[26]. Research has indicated that using RME learning is associated with a moderately favorable impact on students' mathematical literacy ability [27]–[33]. The research above suggests that the impact of RME learning on students' mathematical literacy skills is variable. Furthermore, the data suggest a diverse range of mathematical literacy abilities among students. Mathematics educators must possess accurate and lucid information about the influence of RME on improving students' proficiency in mathematical literacy.

The application of a quantitative research methodology, specifically the meta-analysis, entails the assimilation of outcomes from diverse antecedent studies to yield comprehensive data delineating the extent of correlation, mutual influence, and association between variables [34]. This method incorporates effect size as a crucial measurement parameter [35]. Notably, meta-analysis investigations have been undertaken to scrutinize the ramifications of the RME on the cultivation of diverse mathematical proficiencies. Multiple meta-analysis investigations have been carried out concerning interventions in RME or mathematical literacy. Juandi *et al*. [36] studied using the RME over the past two decades. Shoffa [37], and Utami and Indarini [38] have appraised the impact of RME on students' aptitude for critical thinking, discerning a discernible albeit moderate influence.

The body of meta-analysis research that has been done on mathematical literacy still needs to be more significant. Ariati *et al.* [39] conducted a further investigation into the effects of RME on the mathematical literacy abilities of students. The results of this study demonstrated that the RME strongly and favorably influences mathematical literacy abilities. The investigation undertaken by Ariati *et al.* [39] did not mainly examine the progression of research on mathematical literacy in Indonesia. The study comprised nine primary investigations from 2016 to 2021, using moderator variables related to the educational levels and demographics of the pupils. The critical contribution of this meta-analysis is its further examination of the evolution of research between 2014 and 2023. The study encompasses 17 primary studies and aims to identify moderator variables, including classroom capacity, educational level, geographical location, PISA content, and learning procedures. This study also thoroughly examines the present condition of mathematical literacy research in Indonesia, encompassing the identification of patterns in mathematics literacy research.

This study focuses primarily on implementing RME and its impact on the development of mathematical literacy competency over ten years. The objective of this study is to evaluate and examine the impact of RME on students' proficiency in mathematical literacy. This analysis will examine variables including class size, grade level, geographic area, PISA content, and the integration of diverse learning modalities. The research questions that drive this study are as follows: i) what is the overall impact of the RME learning intervention on students' fluency in mathematical literacy, and may the incorporation of RME teaching enhance students' proficiency in mathematical literacy?, and ii) what is the magnitude of the impact of the RME study intervention on the mathematical literacy proficiency of pupils while considering factors such as class size, grade level, geographic area, PISA material, and the combination of learning methods?.

2. METHOD

This study employed a meta-analysis approach, explicitly utilizing the random effect model [40]–[42] due to several considerations, such as differences in class capacity, educational level, geographical location, content PISA, and the combination of learning. Several scholarly sources have discussed seven steps in executing a meta-analysis study [43], [44]. Figure 1 depicts these procedures.

2.1. Inclusion criteria

Various inclusion criteria were formulated to delimit the parameters of the investigatory quandary under scrutiny. The criteria for inclusion in this scholarly inquiry comprise the subsequent delineations: i) the utilization of RME learning as an intervention strategy; ii) the target population consists of students in

Indonesia; iii) the main focus of the study is to assess the impact of RME learning on the mathematical literacy of the students; iv) conventional learning is employed as a comparative approach; v) the research methodology employed is experimental research with the inclusion of a control group; vi) for both the experimental and control groups, the statistical data presented primarily includes the mean, standard deviation, sample size, t-value, and p-value; and vii) each record comprises a scholarly journal article or conference paper disseminated during the temporal span spanning 2014 to 2023.

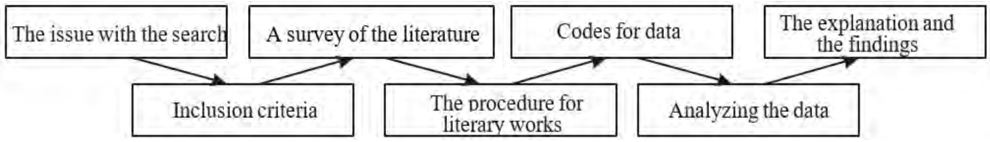

Figure 1. Flowchart of meta-analysis stages

2.2. Literature search and selection

Document searches were performed using the Google Scholar and Semantic Scholar platforms. Using specific terms such as "realistic mathematics education" and "mathematical literacy" enhances the efficiency of the document retrieval process. A total of 17 documents were retrieved from the Google Scholar and Semantic Scholar databases during the conclusive document search, employing a combination of specified keywords. The selection of papers was undertaken through of the preferred reporting items for systematic review and meta-analysis (PRISMA) guidelines [45], [46]. The procedure for selecting literature is outlined in Figure 2.

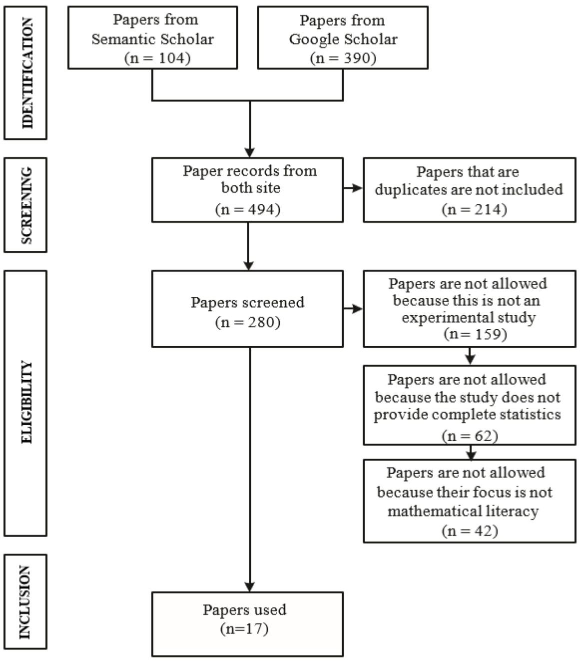

Figure 2. The paper selection procedure

2.3. Data extraction

A coding category sheet was employed in this meta-analysis. The coding form is created using the researcher's name, year of study, class capacity, education level, geographical location, content PISA, and learning combination. Furthermore, the coding form includes the sample size of the two groups, the average, and the standard deviation data. This type of coding was created to improve the dependability of the research concerned. As a result, the two coders fill out the encoding form individually and then compare the results. There were no differences between the two types coded by the researchers. As a result, the data entered in this meta-analysis study is error-free. Table 1 summarizes the study's outcomes.

Table 1. Details regarding the research

Category	Groups	N
Class Capacity	Large Class (≥ 30)	9
	Small Class (< 30)	8
Education Level	Primary School	6
	Middle School	9
	High School	2
Geographical Location	Urban Area	11
	Rural Area	6
Content PISA	Change and Relationship	2
	Space and Shape	10
	Quantity	2
	Uncertainty	3
Combination of Learning	Only RME	12
	RME + Software	2
	RME + Online Platform	2
	RME + Media	1

2.4. Data analysis

This meta-analysis calculated the impact size value using Hedge's equation [42]. This is due to the limited sample size in the RME Class [47]. The categorization of effect size, as outlined by Fuad *et al*. [48], is as follows: g = 0.00 - 0.20 (indicative of a weak effect); g = 0.21 - 0.50 (characterized as modest); g = 0.51 - 1.00 (manifesting as moderate); and g > 1.00 (reflecting a robust effect). Additionally, the Z test was employed to scrutinize the impact of RME on students' proficiency in mathematical literacy [42], [49]. The study utilized the Q Cochrane test to investigate the impact of class capacity, education level, geographical location, material PISA, and learning combination on students' diverse mathematical literacy abilities [50]. The formulation of the Hedge's equation is delineated as follows [42]:

$$g = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}}} \times \left(1 - \frac{3}{4df-1}\right)$$

Examination of publication bias and sensitivity is imperative for ascertaining the integrity and robustness of statistical data in a pivotal investigation. This is because no study outcome can be deemed free from the influence of publication bias [51], [52]. The funnel plot and the fill and trim test were utilized in the publication bias analysis process [47]. Regarding the sensitivity analysis, the "One study deleted" function available in the CMA program [51] was used. Figure 3 demonstrates the symmetrical character of the data distribution depicted by the funnel plot. As seen in Table 2, the fill and trim test was carried out to establish a justification for the experiment. According to the table, data pruning was not necessary, which is consistent with the observation that the funnel plot depicts symmetric data dispersion [46], [48], [50]–[54]. The analysis of seventeen studies reveals that the data dispersion is resistant to publication bias.

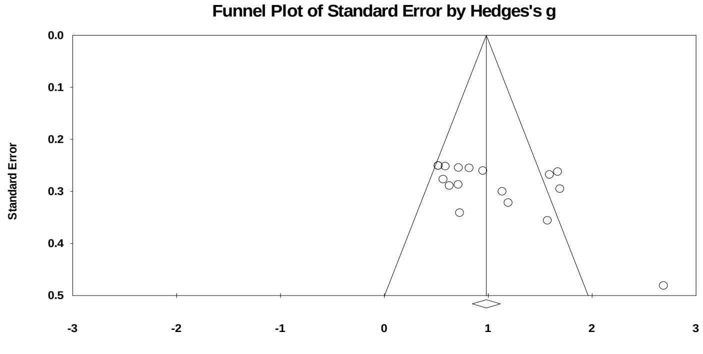

Figure 3. The funnel plot of standard error as measured by hedges' g

Table 2. The fill and trim test

	Studies trimmed	Effect size (g)	Lower limit	Upper limit	Q-value
Observed values		1.031	0.791	1.272	49.622
Adjusted values	0	1.031	0.791	1.272	49.622

3. RESULTS AND DISCUSSION

3.1. The size of the total effect of each study

This study included a total of seventeen papers for analysis. Each manuscript was chosen according to precise inclusion criteria. Table 3 summarizes the size of the effect of RME learning on students' mathematical literacy abilities. Table 3 illustrates that a total of seven documents have reported a robust favorable impact of RME learning on the mathematical literacy ability of pupils [24], [26]. In the interim, ten documents emerged, indicating that RME learning positively impacted pupils' mathematical literacy proficiency [27], [29]–[32], [36]. The effect sizes observed in the analysis of 17 documents ranged from 0.523 to 2.692, with a 95% confidence level. Therefore, the collective impact size of RME learning on the mathematical literacy proficiency of the students was determined to be g = 1.031, indicating a substantial positive effect. The study's findings indicate that the RME favors students' mathematical literacy abilities [36].

Table 3. The article presents data on effect sizes

Study	Effect size	Lower limit	Upper limit	Z-value	p-value
Umbara and Nuraeni [27]	0.821	0.320	1.322	3.211	0.001
Kusuma *et al.* [28]	0.570	0.027	1.114	2.056	0.040
Sutisna *et al.* [24]	1.575	0.876	2.273	4.417	0.000
Fauzana *et al.* [29]	0.523	0.031	1.016	2.082	0.037
Husni *et al.* [55]	1.673	1.158	2.188	6.365	0.000
Ningsi *et al.* [25]	1.594	1.068	2.120	5.940	0.000
Witha *et al.* [56]	0.953	0.441	1.464	3.651	0.000
Istiana *et al.* [57]	1.196	0.565	1.828	3.711	0.000
Herutomo and Masrianingsih [58]	0.718	0.218	1.218	2.816	0.005
Fauzana [30]	0.523	0.0311	1.016	2.082	0.037
Setyawan and Wijaya [33]	0.591	0.096	1.085	2.340	0.019
Sudi *et al.* [31]	0.730	0.060	1.399	2.135	0.033
Budiono and Wardono [32]	0.715	0.152	1.279	2.489	0.013
Ayunis and Belia [59]	0.630	0.062	1.198	2.175	0.030
Azmi *et al.* [26]	1.694	1.114	2.274	5.728	0.000
Handun *et al.* [60]	2.692	1.748	3.636	5.588	0.000
Saraseila *et al.* [61]	1.139	0.549	1.728	2.786	0.000
Overall	1.031	0.791	1.272	8.413	0.000

Additionally, it can be observed from Table 3 that the Z test yielded a significant value below the threshold of 0.05. The findings suggest that the implementation of RME learning has a substantial impact on students' mathematical literacy proficiency. Juandi *et al.* [36], implementing RME learning intervention considerably positively impacted students' mathematical ability. The RME approach offers several advantages, one of which is its foundation in real-world contexts. This aspect can potentially enhance student motivation, as they recognize the practicality of mathematical learning and are more inclined to engage in serious study [62].

3.2. The examination of the moderator aspect

Results of the diversity evaluation for several moderator factors, such as the number of students in each class, the grade level, the geographical area of the school, the subject PISA, and the combination of learning, are detailed in Table 4. According to what is displayed in the table, the p-values of the Q statistic for each moderate aspect were greater than 0.05. According to these findings, factors such as class size, grade level, geographic area, topic PISA, and mixed learning do not significantly impact the mathematical literacy abilities of diverse pupils.

This study categorized the sample size into two categories: those with a group number under thirty and those with thirty or more group numbers. The Q value obtained from the heterogeneity test was 0.121, and the p-value was 0.728, more than 0.05. This means there is no significant difference in the effect size of the RME approach on students' mathematical ability regarding sample size. This means that the sample size is independent of students' mathematical literacy. The effect size produced with a number of the sample of more than or equal to 30 is 1.011, and the effect size made by classes with less than 30 is 1.102. So, these results show that the effect size in the sample size category is not a heterogeneity factor. This result aligns with a meta-analysis of RME on mathematical reasoning skills by Ariati *et al.* [63], which concluded that sample size did not affect the heterogeneity of mathematical reasoning abilities. So, samples of any size can implement the RME approach with good results, and students who study with RME in both sample size categories increase their mathematical literacy abilities not significantly different.

According to the findings that are shown in Table 4 regarding the moderating element of education level, it was noted that the effect size of the study that was done at the primary school level (1.278) was more substantial compared to that of the research that was done at the middle school level (0.855) and high school level (1.194). This impact size for elementary school is high, which suggests that it has a significant influence. In the case of middle school, it was discovered that the effect size is moderate, which suggests that the level of influence is also moderate. The effect size for high school is rated as strong, indicating that it exerts considerable influence. This finding agrees with what was discovered in the research by Doi and Furuya-Kanamori [52]. The diversity analysis results showed a statistically significant difference in the average impact size across all levels of education (Q = 2.522, p = 0.283). Based on the acquired p-value, which is more than the value of 0.05, it is possible to conclude that the effect sizes of the three research characteristics are consistent with one another.

Table 4. The article presents data on effect sizes

Category	Groups	N	Effect Size	The Q Cochrane Test		
				Q-value	Df(Q)	P-value
Class Capacity	Large Class (≥ 30)	9	1.011	0.121	1	0.728
	Small Class (< 30)	8	1.102			
Education Level	Primary School	6	1.278	2.522	2	0.283
	Middle School	9	0.855			
	High School	2	1.194			
Geographical Location	Urban Area	11	0.943	0.976	1	0.323
	Rural Area	6	1.223			
Content PISA	Change & Relationship	2	1.194	2.268	3	0.519
	Space and Shape	10	0.883			
	Quantity	2	0.977			
	Uncertainty	3	1.630			
Combination of Learning	Only RME	12	1.108			
	RME + Software	2	0.704	3.529	3	0.317
	RME + Online Platform	2	1.128			
	RME + Media	1	0.715			

Therefore, there is no conclusive evidence to suggest that implementing the RME strategy substantially affects students' mathematical literacy skills, taking into account their level of education. The effectiveness of the RME approach in improving students' literacy abilities is not influenced by differences in educational level. The finding above is substantiated by a study conducted by Shoffa [37], which investigates the impact of RME on the development of students' critical thinking abilities. The study concludes that using the RME approach yields superior outcomes, particularly within primary education.

The moderator variable of student geographical location revealed that research performed in rural areas (effect size = 1.223) exhibited a more substantial impact than research conducted in urban areas (effect size = 0.943). The magnitude of the observed effect within the rural locale is delineated as substantial, juxtaposed with a more moderate effect size discerned within the urban milieu. The outcomes of heterogeneity testing manifest a discernible variance in the mean impact magnitude across distinct educational strata (Q = 0.976, p = 0.323). Nonetheless, given that the p-value surpasses the threshold of 0.05, it is elucidated that the array of effect magnitudes for both delineations about the students' geographic locational demonstrates homogeneity. Consequently, the repercussions of instituting RME on the mathematical literacy proficiencies of students exhibit parity contingent upon the geographic locales inhabited by the students. Consequently, the efficacy of RME in enhancing students' mathematical literacy skills is unaffected by the geographical context in which the students are situated. The present investigation [40], [48] shows that the heterogeneity of impact sizes was considerably not influenced by the geographical location of students. Adopting RME is best suited for enhancing kids' literacy, particularly in district settings.

However, the assessment of students' mathematical literacy skills, as measured by the content PISA, indicated that the Q value derived from the heterogeneity test was 2.268, with a corresponding p-value of 0.519, beyond the significance level of 0.05. This implies that there is no statistically significant difference in the effect size of the RME strategy on students' mathematical literacy ability, specifically in the content domain of the PISA assessment. The study revealed that the effect size of the research conducted on the topic of uncertainty (1.630) exhibited a greater magnitude in comparison to the effect sizes of change and relationship (1.194), quantity (0.977), and space and shape (0.883). The effect size about uncertainty, change, and relationship has been significant, suggesting a considerable influence. When considering factors such as quantity, space, and shape, the effect size is moderate, indicating moderate impact.

The effect size of learning mathematical literacy was examined in a meta-analysis through mathematical software, online platforms, or media compared to learning mathematical literacy without using any combination of these resources. The heterogeneity test produced a Q value of 3.529, and its corresponding p-value was 0.317; both were significantly higher than the significance level of 0.05. This implies the absence of a statistically significant disparity in the impact magnitude of the RME on the mathematical literacy proficiency of students, particularly in integrated learning. Using a random-effects model indicates that the optimal effect size, at 1.128, is attained when mathematical software is deployed on an online platform. Consequently, the empirical evidence underscores the advantageous role of incorporating technology within the educational milieu to instruct mathematics, thereby substantially enhancing educators' efficacy in fostering the augmentation of students' mathematical literacy competencies.

4. CONCLUSION

This investigation elucidates meticulous and thorough revelations that attest to the efficacy of RME as a pedagogical approach to enhancing students' mathematical literacy acumen. Furthermore, the assimilation of RME learning manifests a noteworthy and advantageous influence on students' mathematical literacy abilities. This study suggests that implementing the RME approach in Indonesia can be beneficial for mathematics instructors in improving students' mathematical literacy skills. As a result, individuals may experience an increase in motivation when they acknowledge the applicability of mathematics education, leading to a greater propensity for engaging in diligent academic pursuits. Moreover, many moderating factors, including class size, educational level, geographical location, topic PISA, and the combination of learning, do not influence the variation in students' mathematical literacy proficiency. This implies that certain moderating elements still need to be well investigated, potentially influencing the disparity in students' mathematical literacy proficiency. Therefore, to enhance the comprehensiveness of research on meta-analysis, researchers must investigate other moderating factors that influence the heterogeneity of mathematical literacy ability.

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REFERENCES

[1] J. Hwang and Y. Ham, "Relationship between mathematical literacy and opportunity to learn with different types of mathematical tasks," *J. Math. Educ.*, vol. 12, no. 2, pp. 199–222, 2021, doi: 10.22342/JME.12.2.13625.199-222.

[2] E. Suprapto, N. Suryani, Siswandari, and Mardiyana, "Students' mathematical literacy skill in term of gender differences: A comparative study," *Int. J. Eval. Res. Educ.*, vol. 12, no. 4, pp. 2280–2285, 2023, doi: 10.11591/ijere.v12i4.27224.

[3] L. M. Rizki and N. Priatna, "Mathematical literacy as the 21st century skill," in *Journal of Physics: Conference Series*, IOP Publishing, 2019, p. 42088.

[4] L. Nurmasari, Budiyono, J. Nurkamto, and M. Ramli, "Realistic Mathematics Engineering for improving elementary school students' mathematical literacy," *J. Math. Educ.*, vol. 15, no. 1, pp. 1–26, 2023, doi: 10.22342/jme.v15i1.pp1-26.

[5] U. Mulbar, N. Nasrullah, and B. Bustang, "Content Analysis of Students' Argumentation Based on Mathematical Literacy and Creation Ability," *Math. Teaching-Research J.*, vol. 15, no. 5, pp. 226–238, 2023, [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85180279424&partnerID=40&md5=7f85f79e6172cef31e010a6bdaffce67

[6] R. Ekawati, Susanti, and J. C. Chen, "Primary Students' Mathematical Literacy: a Case Study," *Infin. J.*, vol. 9, no. 1, pp. 49–58, 2020, doi: 10.22460/infinity.v9i1.p49-58.

[7] A. Susanta, H. Sumardi, E. Susanto, and H. Retnawati, "Mathematics literacy task on number pattern using Bengkulu context for junior high school students," *J. Math. Educ.*, vol. 14, no. 1, pp. 85–102, 2023, doi: 10.22342/JME.V14I1.PP85-102.

[8] N. Listiawati *et al.*, "Analysis of implementing Realistic Mathematics Education principles to enhance mathematics competence of slow learner students," *J. Math. Educ.*, vol. 14, no. 4 SE-Articles, pp. 683–700, Aug. 2023, doi: 10.22342/jme.v14i4.pp683-700.

[9] D. Manurung, P. Siagian, and A. Minarni, "The Development of Realistic Mathematics Education Based Learning Tools to Improve Mathematical Problem Solving Ability and Self-Efficacy on Students in Junior High School 1 Lubuk Pakam," *Budapest Int. Res. Critics Linguist. Educ. J.*, vol. 3, no. 1, pp. 107–118, 2020.

[10] Lisnani, R. I. I. Putri, Zulkardi, and Somakim, "Web-based realistic mathematics learning environment for 21st-century skills in primary school students," *J. Math. Educ.*, vol. 14, no. 2 SE-Articles, pp. 253–274, Mar. 2023, doi: 10.22342/jme.v14i2.pp253-274.

[11] Armiati, A. Fauzan, Y. Harisman, and F. Sya'Bani, "Local instructional theory of probability topics based on realistic mathematics education for eight-grade students," *J. Math. Educ.*, vol. 13, no. 4, pp. 703–722, 2022, doi: 10.22342/jme.v13i4.pp703-722.

[12] M. Van den Heuvel-Panhuizen and P. Drijvers, "Realistic mathematics education," *Encycl. Math. Educ.*, pp. 713–717, 2020.

[13] T. Laurens, F. A. Batlolona, J. R. Batlolona, and M. Leasa, "How Does Realistic Mathematics Education (RME) Improve Students' Mathematics Cognitive Achievement?," *Eurasia J. Math. Sci. Technol. Educ.*, 2017, doi: 10.12973/ejmste/76959.

[14] L. P. Nugraheni and M. Marsigit, "Realistic mathematics education: An approach to improve problem solving ability in primary school," *J. Educ. Learn.*, vol. 15, no. 4, pp. 511–518, 2021, doi: 10.11591/edulearn.v15i4.19354.

[15] S. Sumirattana, A. Makanong, and S. Thipkong, "Using realistic mathematics education and the DAPIC problem-solving process to enhance secondary school students' mathematical literacy," *Kasetsart J. Soc. Sci.*, vol. 38, no. 3, pp. 307–315, 2017.

[16] T. Kutluca and S. Gündüz, "A Meta-Analysis Study on the Effect of Realistic Mathematics Education Approach on Academic Achievement and Attitude," *Hacettepe Egit. Derg.*, vol. 37, no. 2, pp. 802–817, 2022, doi: 10.16986/HUJE.2020064976.

[17] N. Listiawati *et al.*, "Analysis of implementing Realistic Mathematics Education principles to enhance mathematics competence of slow learner students," *J. Math. Educ.*, vol. 14, no. 4, pp. 683–700, 2023, doi: 10.22342/jme.v14i4.pp683-700.

[18] M. S. Ginting, R. C. I. Prahmana, M. Isa, and M. Murni, "Improving the reasoning ability of elementary school student through the indonesian realistic mathematics education," *J. Math. Educ.*, vol. 9, no. 1, pp. 41–54, 2018.
[19] S. K. Putri and E. Syahputra, "Development of Learning Devices Based on Realistic Mathematics Education to Improve Students' Spatial Ability and Motivation.," *Int. Electron. J. Math. Educ.*, vol. 14, no. 2, pp. 393–400, 2019.
[20] T. Trisnawati, R. Pratiwi, and W. Waziana, "The effect of realistic mathematics education on student's mathematical communication ability," *Malikussaleh J. Math. Learn.*, vol. 1, no. 1, pp. 31–35, 2018.
[21] U. P. S. Umar and Z. Zakaria, "The effectiveness of the realistic math education (RME) learning method based on manipulative media in improving the problem-solving abilities of elementary school students," *Ekspose J. Penelit. Huk. dan Pendidik.*, vol. 21, no. 1, pp. 1369–1376, 2022.
[22] M. Nurjamaludin, D. Gunawan, R. K. Adireja, and N. Alani, "Realistic Mathematics Education (RME) approach to increase student's problem solving skill in elementary school," in *Journal Of Physics: Conference Series*, IOP Publishing, 2021, p. 12034.
[23] Y. Yuliana, B. Usodo, and R. Riyadi, "The New Way Improve Mathematical Literacy in Elementary School: Ethnomathematics Module with Realistic Mathematics Education," *AL-ISHLAH J. Pendidik.*, vol. 15, no. 1, pp. 33–44, 2023.
[24] A. P. Sutisna, A. S. Budi, and A. Noornia, "The Influence of the Realistic Mathematics Education Approach and Early Mathematical Ability to Mathematical Literacy," *Int. J. Multidiscip. Curr. Res.*, vol. 6, no. 04, pp. 798–801, 2018, doi: 10.14741/ijmcr/v.6.4.18.
[25] S. Wahyuni Ningsi, K. Kadir, and R. Rahmat, "The Influence of Realistic Mathematics Education Approach on Mathematical Literacy Skills of Junior High School Students," *J. Amal Pendidik.*, vol. 3, no. 1, p. 75, 2022, doi: 10.36709/japend.v3i1.25271.
[26] Azmi, Anisa, Cahyono, and Adi, "Mathematics literacy on creative problem solving with realistic mathematics education approach assisted by e-learning schoology (in Indonesian)," *Unnes J. Math. Educ.*, vol. 7, no. 3, pp. 188–194, 2018, doi: 10.15294/ujme.v7i1.24472.
[27] U. Umbara and Z. Nuraeni, "Implementation of Realistic Mathematics Education Based on Adobe Flash Professional Cs6 To Improve Mathematical Literacy," *Infin. J.*, vol. 8, no. 2, pp. 167–178, 2019, doi: 10.22460/infinity.v8i2.p167-178.
[28] B. J. Kusuma, Wardono, and E. R. Winarti, "The Mathematical Literacy Skills of Eighth Grade Students in Realistic Learning Supported by Edmodo," *Unnes J. Math. Educ.*, vol. 5, no. 3, pp. 199–206, 2016, [Online]. Available: http://journal.unnes.ac.id/sju/index.php/ujme
[29] R. Fauzana, J. A. Dahlan, and A. Jupri, "The influence of realistic mathematics education (RME) approach in enhancing students' mathematical literacy skills," *J. Phys. Conf. Ser.*, vol. 1521, no. 3, pp. 0–5, 2020, doi: 10.1088/1742-6596/1521/3/032052.
[30] R. Fauzana, "Mathematical Literacy Skills and Mathematical Disposition of Junior High School Students through Learning with the Realistic Mathematics Education Approach." Universitas Pendidikan Indonesia, 2019.
[31] W. Sudi, J. Jafar, K. Kadir, and S. Salim, "The Effectiveness of Realistic Mathematics Instruction Approach on Students' Mathematical Literacy," *J. Amal Pendidik.*, vol. 3, no. 2, p. 160, 2022, doi: 10.36709/japend.v3i2.28874.
[32] C. S. Budiono, W. J. Matematika, F. Matematika, D. Ilmu, P. Alam, and I. Artikel, "PISA-Oriented PBM with PMRI Approach Utilizing LKPD Media Enhances Mathematical Literacy of Junior High School Students," *UJME (Unnes J. Math. Educ.*, vol. 3, no. 3, pp. 210–219, 2014, [Online]. Available: http://journal.unnes.ac.id/sju/index.php/ujme
[33] Y. R. Setyawan and A. Wijaya, "The Influence of Realistic Mathematics Education (RME) Approach Assisted by GeoGebra on Students' Mathematical Literacy Skills," *J. Pedagog. Mat.*, vol. 8, no. 2, pp. 134–141, 2022.
[34] G. Cumming, "The New Statistics: Why and How," *Psychol. Sci.*, vol. 25, no. 1, pp. 7–29, 2014, doi: 10.1177/0956797613504966.
[35] J. T. Cleophas and H. A. Zwinderman, *Modern meta-analysis: Review and update of methodologies*. Springer, 2017.
[36] D. Juandi, Y. S. Kusumah, and M. Tamur, "A Meta-Analysis of the last two decades of realistic mathematics education approaches," *Int. J. Instr.*, vol. 15, no. 1, pp. 381–400, 2022, doi: 10.29333/iji.2022.15122a.
[37] S. Shoffa, "Meta-Analysis of Realistic Mathematics Education Approaches on Students' Critical Thinking Abilities," *Vygotsky J. Pendidik. Mat. dan Mat.*, vol. 4, no. 2, pp. 105–116, 2022.
[38] F. N. Utami and E. Indarini, "Meta-Analysis: The Influence of Realistic Mathematics Approach on Students' Critical Thinking Skills in Mathematics at the Elementary School Level," *J. Basicedu*, vol. 5, no. 2, pp. 887–894, 2021.
[39] C. Ariati, V. Anzani, D. Juandi, and A. Hasanah, "Meta-Analysis Study: Effect of Realistic Mathematics Education Approach on Student'S Mathematical Literacy Ability," *AKSIOMA J. Progr. Stud. Pendidik. Mat.*, vol. 11, no. 4, p. 2953, 2022, doi: 10.24127/ajpm.v11i4.6182.
[40] S. Suparman and D. Juandi, "Self-Efficacy and Mathematical Ability: A Meta-Analysis of Studies Conducted in Indonesia," *Pedagogika*, vol. 147, no. 3, pp. 26–57, 2022, doi: 10.15823/p.2022.147.2.
[41] T. Evrenoglou, S. Metelli, and A. Chaimani, *Introduction to Meta-Analysis*. 2022. doi: 10.1007/978-3-319-52636-2_287.
[42] M. Borenstein, L. V Hedges, J. P. T. Higgins, and H. R. Rothstein, *Introduction to meta-analysis*. John Wiley & Sons, 2021.
[43] J. E. Hunter and F. L. Schmidt, *Methods of meta-analysis: Correcting error and bias in research findings*. Sage, 2004.
[44] H. M. COPPER, E. A. PATALL, and J. J. LINDSAY, "Research synthesis and meta-analysis," *SAGE Handb. Appl. Soc. Res. Methods. Thousand Oaks, Calif. Sage Publ. Inc*, pp. 344–370, 2013.
[45] D. Moher, A. Liberati, J. Tetzlaff, D. G. Altman, and P. Group*, "Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement," *Ann. Intern. Med.*, vol. 151, no. 4, pp. 264–269, 2009.
[46] M. Fuad and E. Suyanto, "A Bibliometric Analysis of Technology-Based Foreign Language Learning during the COVID-19 Pandemic: Direction for Indonesia Language Learning," *Int. J. Inf. Educ. Technol.*, vol. 12, no. 10, pp. 983–995, 2022.
[47] M. Harwell, "Growth in the amount of literature reviewed in a meta-analysis and reviewer resources," *Mid-Western Educ. Res.*, vol. 32, no. 1, pp. 31–47, 2020.
[48] M. Fuad, E. Suyanto, U. A. Muhammad, and Suparman, "Indonesian students' reading literacy ability in the cooperative integrated reading and composition learning: A meta-analysis," *Int. J. Eval. Res. Educ.*, vol. 12, no. 4, pp. 2121–2129, 2023, doi: 10.11591/ijere.v12i4.25171.
[49] F. O. Haara, O. H. Bolstad, and E. S. Jenssen, "Research on Mathematical Literacy in Schools--Aim, Approach and Attention.," *Eur. J. Sci. Math. Educ.*, vol. 5, no. 3, pp. 285–313, 2017.
[50] J. Grant and A. Hunter, "Measuring inconsistency in knowledgebases," *J. Intell. Inf. Syst.*, vol. 27, no. 2, pp. 159–184, 2006, doi: 10.1007/s10844-006-2974-4.
[51] R. M. Bernard, E. Borokhovski, R. F. Schmid, R. M. Tamim, and P. C. Abrami, "A meta-analysis of blended learning and technology use in higher education: from the general to the applied," *J. Comput. High. Educ.*, vol. 26, no. 1, pp. 87–122, 2014, doi: 10.1007/s12528-013-9077-3.
[52] S. A. R. Doi and L. Furuya-Kanamori, "Selecting the best meta-analytic estimator for evidence-based practice: a simulation study," *JBI Evid. Implement.*, vol. 18, no. 1, 2020, [Online]. Available: https://journals.lww.com/ijebh/fulltext/2020/03000/selecting_the_best_meta_analytic_estimator_for.8.aspx
[53] K. Karwadi, A. R. Zakaria, and A. Syafii, "A review of the effects of active learning on high order thinking skills: a meta-analysis

within islamic education," *J. Educ. Learn.*, vol. 18, no. 1, pp. 97–106, 2024, doi: 10.11591/edulearn.v18i1.20895.
[54] S. Fajaruddin, H. Retnawati, C. Setiawan, E. Apino, and J. Arlinwibowo, "Technology ' s impact on language learning : Meta-analysis on variables and effectiveness," *J. Educ. Learn.*, vol. 18, no. 2, pp. 512–525, 2024, doi: 10.11591/edulearn.v18i2.21119.
[55] N. Husni, "The Implementation of Realistic Mathematics Education Model on Mathematical Literacy Skills of 11th Grade Students in SMA Negeri 3 Padang (in Indonesian)," *J. Edukasi dan Penelit. Mat.*, vol. 11, no. 3, 2022, doi: 10.24036/pmat.v11i3.14036.
[56] T. S. Witha, V. Karjiyati, and P. Tarmizi, "The Influence of Ethnomathematics-Based RME Model on Mathematical Literacy Skills of 4th Grade Students in SD Gugus 17 Bengkulu City (in Indonesian)," *JURIDIKDAS J. Ris. Pendidik. Dasar*, vol. 3, no. 2, pp. 136–143, 2021, doi: 10.33369/juridikdas.3.2.136-143.
[57] M. E. Istiana, R. Satianingsih, and V. Yustitia, "The Influence of Realistic Mathematics Education on Students' Mathematical Literacy Skills (in Indonesian)," *UNION J. Ilm. Pendidik. Mat.*, vol. 8, no. 3, pp. 423–430, 2020, doi: 10.30738/union.v8i3.8446.
[58] R. A. Herutomo and _ M., "Flipped Classroom Learning with Realistic Mathematics Approach to Support Students' Mathematical Literacy (in Indonesian)," *J. Karya Pendidik. Mat.*, vol. 8, no. 2, p. 45, 2021, doi: 10.26714/jkpm.8.2.2021.45-52.
[59] A. Ayunis and S. Belia, "The Influence of the Realistic Mathematics Education (RME) Approach on the Development of Students' Mathematical Literacy in Elementary Schools," *J. Basicedu*, vol. 5, no. 6, pp. 5363–5369, 2021, doi: 10.31004/basicedu.v5i6.1508.
[60] H. Handun, H. Habudin, and W. Rachmiati, "The Influence of Realistic Mathematics Instruction on Elementary School Students' Mathematical Literacy Skills (in Indonesian)," *Prim. J. Keilmuan dan Kependidikan Dasar*, vol. 12, no. 1, p. 67, 2020, doi: 10.32678/primary.v12i01.2635.
[61] F. Saraseila, V. Karjiyati, and N. Agusdianita, "The Impact of the Realistic Mathematics Education Model on the Mathematical Literacy Skills of Fifth-Grade Students in Primary Schools in Cluster XIV Bengkulu City (in Indonesian)," *J. Math-UMB.EDU*, vol. 7, no. 2, 2020, doi: 10.36085/math-umb.edu.v7i2.724.
[62] A. D. Putri, Y. Yerizon, A. Arnellis, and S. Suherman, "Development of realistic mathematics education-based teaching materials to increase students' mathematical literacy ability," in *AIP Conference Proceedings*, AIP Publishing, 2024.
[63] C. Ariati, D. Juandi, A. Hasanah, and S. Suparman, "The Effect of Realistic Mathematics Education in Enhancing Indonesian Students' Mathematical Reasoning Ability: A Meta-Analysis," *JTAM (Jurnal Teor. dan Apl. Mat.*, vol. 7, no. 2, p. 324, 2023, doi: 10.31764/jtam.v7i2.12493.

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