Akademika 96(1), April 2026
https://doi.org/10.17576/akad-2026-9601-11

The Effectiveness of Realistic Mathematics Education (RME)-Based Strategies on Students' Performance in Lower Secondary

Keberkesanan Strategi Berasaskan Realistic Mathematics Education (RME) terhadap Pencapaian Pelajar di Peringkat Menengah Rendah

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Received: 14-5-2025 /Accepted: 3-2-2026

ABSTRACT

The Realistic Mathematics Education (RME) approach, grounding learning in meaningful real-world contexts, is recognized for enhancing student engagement and learning outcomes. While RME has been widely studied internationally, research in Malaysia particularly at the lower secondary level remains limited. Addressing this gap, this study investigated the effectiveness of RME-based strategies on mathematics performance among lower secondary students from one school in Klang Valley, Malaysia. A quasi-experimental design compared an RME group (utilizing guided practice, graphical representations & manipulatives, collaborative learning, individual tasks) with a traditionally taught control group following traditional methods. Sampling technique used was convenience sampling with 147 samples. The study quantitatively analyzed data from achievement tests to evaluate student performance and from questionnaires to understand their perceptions of the RME interventions. Descriptive statistics, Mann-Whitney U test, and Spearman's correlation were applied to analyze the data. Results revealed statistically significantly higher mathematics performance in the RME group compared to the traditional group, evidencing the intervention's positive impact. Furthermore, a positive relationship between guided practice and student achievement across all mathematics topics covered highlighted it as a preferred, particularly effective RME component. The small, single-school sample is a limitation, affecting external validity, thus necessitating further research with larger, diverse samples for broader generalization of these results in Malaysia. This study contributes to the limited Malaysian literature by highlighting effective RME practices, particularly guided practice, and offering practical insights to help educators foster mathematical literacy and deeper student understanding.

Keywords: Realistic Mathematics Education (RME); Mathematics; Performance; RME-based strategies;Perception

ABSTRAK

Pendekatan Realistic Mathematics Education (RME) meletakkan pembelajaran dalam konteks dunia sebenar yang bermakna telah diiktiraf di peringkat antarabangsa kerana dapat meningkatkan penglibatan serta hasil pembelajaran pelajar. Kajian tentang RME di Malaysia pada peringkat menengah rendah masih terhad. Bagi mengisi jurang ini, kajian ini meneliti keberkesanan strategi berasaskan RME terhadap prestasi matematik dan persepsi pelajar menengah rendah di sebuah sekolah di Lembah Klang, Malaysia. Reka bentuk kuasi-eksperimen digunakan bagi membandingkan kumpulan RME, yang mengaplikasikan latih tubi terbimbing, perwakilan grafik/manipulatif, pembelajaran kolaboratif, dan tugasan individu, dengan kumpulan kawalan yang diajar melalui kaedah tradisional. Kaedah persampelan yang digunakan ialah persampelan kemudahan dengan melibatkan 147 sampel. Data kajian ini dianalisis secara kuantitatif melalui ujian pencapaian untuk menilai prestasi pelajar dan soalan soal selidik untuk memahami persepsi mereka terhadap RME . Statistik deskriptif, ujian Mann-Whitney U, dan korelasi Spearman telah digunakan untuk menganalisis data. Kajian menunjukkan prestasi matematik kumpulan RME jauh lebih tinggi berbanding kumpulan tradisional, membuktikan kesan positif intervensi. Latih tubi terbimbing didapati konsisten meningkatkan pencapaian merentasi topik, menjadikannya komponen RME paling berkesan.Saiz sampel yang kecil dan melibatkan sebuah sekolah merupakan satu batasan yang menjejaskan kebolehgunaan umum, justeru memerlukan kajian lanjutan dengan sampel yang lebih besar dan pelbagai. Kajian ini menyumbang kepada literatur Malaysia yang masih terhad dengan menonjolkan amalan RME yang berkesan, khususnya latih tubi terbimbing, serta menawarkan pandangan praktikal untuk membantu pendidik menyokong literasi matematik dan pemahaman pelajar yang lebih mendalam.

Kata kunci: Pendidikan Matematik Realistik (RME); Matematik; Prestasi;Strategi berasaskan RME; Persepsi

INTRODUCTION

Mathematics is a fundamental subject for everyone. It fosters critical thinking and problem-solving abilities, which play vital roles in formal education and everyday life that give significant real-world advantages. However, many students perceive mathematics as an abstract and complicated subject (Barete & Taja-On, 2024). This perception has led to the growing numbers of research studies on the mathematics education among researchers.

Malaysia faces significant challenges in mathematics education, as reflected in its poor performance in the Programme for International Student Assessment (PISA) 2022, where the national average (409 points) fell below the OECD average of 472 points (OECD, 2023). This underachievement has raised national concerns, particularly regarding the performance of secondary school students. Previous studies have identified several contributing factors to Malaysian students' mathematics performance, especially at the school level, including student engagement, motivation, conceptual understanding, and problem-solving skills (Radzuan et al., 2021; Ling et al., 2022). A predominant issue lies in the widespread reliance on traditional teaching approaches, commonly practiced by Asian teachers (Mohamad et al., 2023), including in Malaysia (Chua et al., 2022; Suliman et al., 2018). These methods such as chalk-and-talk, note-taking, drills, repetitive practice, and rote memorization (Chua et al., 2022; Bature, 2020) which offer limited opportunities for students to engage in exploration, reasoning, or strategic thinking (Mohamad et al., 2023). Consequently, traditional approaches are often ill-suited to help students grasp abstract mathematical concepts (Yuanita et al., 2018). When students face difficulties in understanding mathematical concepts and lack of problem-solving skills, or fail to connect mathematics with real-life contexts, their academic performance is likely to decline (Khalid, 2017).

In response to such educational challenges, various pedagogical theories have been developed including remedial strategies (Poon et al., 2012), collaborative learning (Siller & Ahmad, 2024), problem-based learning (Marchy et al.,2022), inverted problem-based learning (Din et al., 2020) and inquiry-based learning (Liu et al., 2024), with the Realistic Mathematics Education (RME) approach emerging as a prominent strategy (Juandi et al., 2021). RME is founded on the principle of connecting mathematical concepts to relatable, real-life problems, thereby fostering meaningful learning, positive student engagement, and deeper conceptual understanding (Inci et al., 2023; Irdawati et al., 2019). This approach encourages students to actively construct mathematical knowledge from contextual situations.

Previous studies on RME conducted in Turkey (Aytekin-Uskun et al., 2021), Indonesia (Herman, 2019; Susanti, 2025), and Vietnam (Uyen et al., 2021) have primarily focused on elementary school students, examining its effects on students' mathematical achievement. In contrast, the present study extends this line of inquiry by addressing lower secondary school students in Malaysia, specifically those aged 13 to 15 years. It aims to investigate not only the impact of RME on students' achievement but also their perceptions of learning mathematics through this approach. This focus provides new insights into the potential of RME to support mathematical learning at the secondary level. By exploring this under-researched context, the study seeks to fill a significant gap in the literature, offering empirical evidence on the applicability and effectiveness of RME beyond the elementary level.Therefore, this research aims to examine the impact of RME-based strategies on the mathematics performance of lower secondary students in Malaysia. The objectives of the study are as follows:

https://doi.org/10.17576/akad-2026-9601-11

i. To determine the effect on mathematics academic performance between students taught using RME-based strategies and a traditional approach
ii. To investigate the relationship between specific mathematics topics and students' preferred RME-based strategies.

The subsequent sections of this paper review related studies on RME in mathematics, outline the methodology employed, present and discuss the results, and conclude with key findings and their implications.

REVIEW OF LITERATURE

REALISTIC MATHEMATICS EDUCATION (RME)

RME is a pedagogical theory initially developed at the Freudenthal Institute in the Netherlands. According to Cengiz & Eğmir (2022), this theory has been utilized for over three decades in Holland and has been adopted by numerous countries, including England, Spain, the U.S.A., Denmark, Brazil, and Japan. A central tenet of RME is that learning mathematical concepts must be grounded in real-life contexts and meaningful real-world applications (Uyen et al., 2021; Nguyen, 2023). These contexts are not limited to students' actual experiences but can also encompass imaginable scenarios (Nguyen, 2023). Such real-life and imaginable situations serve as a rich source for understanding mathematical concepts, enabling students to apply their knowledge progressively. In this regard, RME has been shown to significantly enhance students' comprehension of mathematical concepts (Nuraina et al., 2021).

Moreover, RME is an innovative pedagogical approach emphasizing student-centered learning, with the teacher acting as a facilitator who guides students through processes of inquiry and problem-solving (Susanti, 2025). Through the RME approach, students are encouraged to explore mathematical ideas and engage in collaborative discussions. This active engagement fosters increased student involvement, deeper conceptual understanding, and the development of critical thinking skills (Dinglasan et al., 2023; Utomo Aji, 2023), alongside creativity in problem-solving (Susanti, 2025) and enhanced reasoning abilities (Worowirastri et al., 2021). Consequently, the wider adoption of the RME approach in the classroom has the potential to significantly improve students’ mathematical proficiency.

Furthermore, the adaptability of RME makes it suitable for implementation across all educational levels, from early childhood to tertiary education. For instance, studies conducted in Greece with children aged 4 to 6 demonstrated that RME improves students’ interest in mathematics and positively contributes to the development of foundational mathematical competency (Nguyen, 2023). Similarly, research among seventh-grade students in Vietnam showed that RME was effective in enhancing several skills essential for statistics (Uyen et al., 2021). Underpinning RME's effectiveness across these diverse contexts is the core process of mathematization.

Mathematization is the process of connecting formal mathematical concepts to daily life, involving two key steps: horizontal and vertical mathematization. Horizontal mathematization involves translating real-world problems from various approaches into mathematical representations using symbols (Uzel & Uyangor, 2006). The subsequent step, vertical mathematization, is the process of reorganizing these symbols within a mathematical framework. According to Uzel & Uyangor (2006), the RME learning process commences with a contextual problem. In our study ,the horizontal mathematization activities require student to represent this real-world problem into mathematical representations using symbols. Following this, students engage in vertical mathematization by implementing activities such as solving, comparing, and discussing to arrive at an accurate mathematical solution. Finally, students learn and can apply mathematical concepts in a meaningful way.

An appropriate instructional strategies must be employed and integrated within the RME framework to support mathematization activities effectively. Several useful instructional strategies can be adapted to enhance students' mathematical abilities, including guided practice, the use of graphical representations & manipulatives, collaborative learning, and individual activities. Guided practice is a teaching strategy wherein an instructor assists students in overcoming learning difficulties and developing a deeper understanding of mathematical concepts. Integrating guided practice within RME offers a comprehensive way to bridge conceptual gaps and significantly impacts students' mathematical abilities (Putra et al., 2024). Representation is using signs, characters, diagrams, objects, pictures, or graphs to convey mathematical ideas as essential (Mainali, 2020). Other common modes including verbal, graphic, algebraic, and numeric representations. These are vital in mathematics education as it form an inherent part of mathematical understanding, offer multiple perspectives on a single concept, help mitigate learning difficulties, and make mathematics more engaging. Manipulatives, as concrete objects like pattern blocks or geoboards, provide students with hands-on experiences, actively engaging them in the learning process (Siller & Ahmad, 2024). Collaborative learning, where students work in groups on teacher-assigned tasks such as discussions, problem-solving, and project completion, further enhances engagement and understanding (Pambudi et al., 2022). Individual activities enable students to reconstruct mathematical concepts based on their experiences, which is essential for meaningful learning (Realistic Mathematic Education on Higher-Order Thinking Skill Mathematics of Students, 2022).

THE EFFECT OF RME ON MATHEMATICS PERFORMANCE

Numerous studies highlight the effectiveness of Realistic Mathematics Education (RME) in improving student performance. Research shows that RME enhances problem-solving, conceptual understanding, and engagement, often outperforming traditional approaches (Sella et al., 2024; Amanda et al., 2025). Meta-analyses further reinforce its potential: Amanda et al. (2025) emphasized RME's broad generalizability, while Öksüz et al. (2022) showed significant gains in Turkey but warned of cultural limitations. However, much of the literature remains focused on achievement outcomes, with limited attention to student perceptions, motivation, or engagement.

At the elementary and primary levels, international findings consistently affirm RME's benefits, though emphases differ by context. In Indonesia, Sella et al. (2024) reported improved problem-solving, while Nuraina et al. (2021) added that integrating RME with ethnomathematics boosted both understanding and motivation. By contrast, Guidon and Cabrera (2022) in the Philippines emphasized foundational arithmetic gains. These contrasts suggest that RME's impact is context-dependent strengthening cognitive skills in some cases, building foundational knowledge in others, or fostering motivation through cultural adaptation.

Meanwhile, at the junior and secondary levels, RME has also proven effective, though with differing emphases across countries. In Turkey, Öksüz et al. (2022) and Aksu (2021) reported achievement gains, particularly in geometry, while Yulianti and Aisyah (2021) in Indonesia found broader improvements in lower secondary achievement. Extending to advanced topics, Tong et al.

(2022) in Vietnam identified gains not only in performance but also in student attitudes. These varying emphases raise questions about whether RME's strength lies primarily in enhancing general performance, supporting specific topics, or shaping affective outcomes.

The absence of Malaysian-based research, particularly in lower secondary schools, leaves open the question of whether RME's effectiveness is generalizable in this context. Equally important, little is known about how Malaysian students themselves perceive RME-based strategies. Thus, the present study investigates the effectiveness of RME-based strategies in Malaysian lower secondary schools, focusing not only on achievement but also on student perceptions. This provides insights into how RME may be adapted to Malaysia's cultural and curricular context. The next section presents the conceptual framework of this study.

CONCEPTUAL FRAMEWORK

FIGURE 1 shows the proposed conceptual framework used in this study. The framework consists of four activities within RME-based strategies including guided practice, graphical representative and manipulative, collaborative activity and individual activity which are applied to selected topics in mathematics to assess the mathematics' performance.

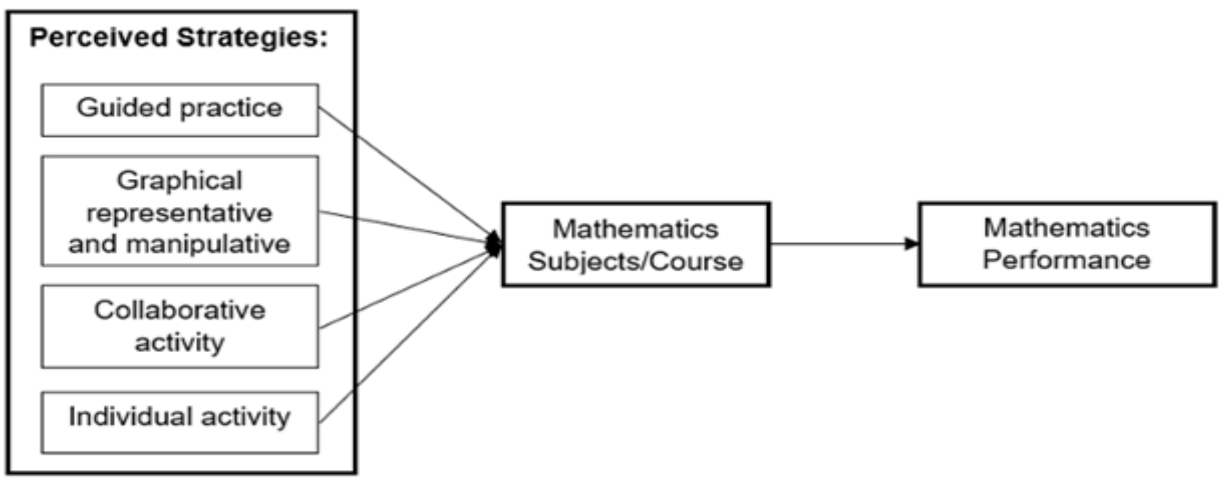

FIGURE 1. Conceptual framework

In guided practice, students gradually build their mathematical understanding with the teacher's support, allowing them to move smoothly from concrete experiences to more abstract reasoning. Similarly, the use of graphical representations and manipulatives enables students to visualize and interact with mathematical ideas, bridging real-world situations with symbolic concepts and making learning more meaningful. Collaborative activities provide opportunities for students to work together, exchange ideas, and solve problems collectively, which not only strengthens their understanding but also fosters confidence through peer learning. At the same time, individual activities encourage learners to apply their knowledge independently, promoting self-reliance and deeper internalization of mathematical concepts.

METHODOLOGY

This study uses a quasi experimental research with post test only, non-equivalent control group research design, as present in FIGURE 2 . This approach was chosen as the most practical for the sample study. Such a design is widely applied in educational settings where random assignment of participants is not feasible (Putri & Kurniawati, 2021) where restrictive policies or institutional interests may impose limitations (Capili & Anastasi, 2024).

Two instruments were utilized in this study : achievement test and perception questionnaires. This research design was chosen due to certain restrictions in implementing the treatment across two different student levels, Form 1 and Form 2. To ensure content validity, achievement test questions were developed from selected syllabus topics and then validated by a mathematics expert with 15 years of teaching experience. A pilot study was subsequently conducted to test the instruments and procedures. During this pilot phase, the internal consistency of the items measuring perceptions of RME was evaluated, resulting in a Cronbach's Alpha of 0.802.

Group	Treatment	Post-test
Experimental	X	O_1
Control	-	O_2

Details
O_1 – post-test for treatment and experimental group
O_2 – post-test for treatment and control group
X – treatment with RME-based strategies

FIGURE 2. Non-equivalent control group with post-test

There are two groups of students; one group was taught using RME-based strategies within 8 weeks of study on selected topics and another group was taught using traditional teaching methods. The RME-based strategies included guided practice, graphical representations and manipulatives, collaborative activities, and individual tasks. Lessons for the RME group began with contextual problems, followed by guided practice which supported students in solving mathematical problems, helping them achieve mastery by progressing through increasingly complex tasks and ultimately developing as independent thinkers and problem-solvers. Graphical representations and manipulatives enabled students to translate images or graphics representing proportions of two objects into mathematical symbols. Collaborative activities allowed students to work together with peers, discuss ideas, and solve problems collectively, enhancing both their understanding and confidence. Individual tasks provided students the opportunity to apply their knowledge independently based on what they had learned during the lessons. In contrast, the teacher instructed the control group using traditional chalk-and-talk methods, directly explaining procedures and assigning individual work without incorporating real-world contextualization or group-based activities. At the end, both group of students answered the achievement test. Group of students who used RME-based strategies answered the structured questionnaire to measure their perceptions on activities conducted in RME-based strategies.

Since random distribution of students was not possible, extraneous variables were controlled through standardization and matching procedures. Both groups were taught over the same duration (eight weeks), covered the same curriculum topics, and were instructed by the same teacher to reduce teacher-related bias. The learning environment and allocated instructional time were also kept constant. By maintaining these conditions and applying statistical controls, the influence of extraneous variables was minimized, allowing differences in post-test achievement to be more confidently attributed to the teaching method (RME-based vs. traditional).

The population for this study consisted of 695 students from Form 1 and Form 2 in a selected secondary school. A total of 147 students were selected as participants, determined using convenience sampling and guided by Yamane's formula (Yamane, 1967), as illustrated in FIGURE 3. According to Yamane's formula, with a population of 695 students and a 10% margin of error, the recommended sample size is approximately 87 students. The sample of 147 participants exceeds this calculated requirement and was considered sufficient for practical purposes, given the accessibility of participants and the feasibility of implementing the RME-based intervention. The sample also captured varying levels of mathematical understanding within the school. Among the participants, there was a slightly balanced representation of gender. This group was chosen to ensure the practical implementation of the intervention while reflecting the diversity of abilities within the population. Selecting students from two different levels also allowed the study to examine the effectiveness of the strategies across a broader range of learners.

$$n = \frac{N}{\left[1 + N\left(e^{2}\right)\right]}$$

FIGURE 3. Yamane formula

This study employed a convenience sampling method for participant selection. As a non-probability technique, convenience sampling was chosen for its practical advantages, including reduced recruitment effort, minimal costs, and time efficiency, particularly due to the easy accessibility of the target population (Golzar et al., 2022). This approach enabled efficient data collection while ensuring the study could be conducted within the available resources and timeframe. Nevertheless, this method may introduce potential biases, as the sample may not fully represent the wider student population, thus limiting the generalizability of the findings. In addition, self-selection bias could occur if students with greater motivation or interest in the subject were more inclined to participate, which may influence the validity of the results.Data analysis was then guided by the research objectives and the instruments administered. Specifically, all collected data were statistically analyzed using IBM SPSS Statistics version 23.0, employing descriptive statistics, the Mann-Whitney U test, and Spearman's correlation to address the study's objectives and evaluate both the effectiveness of RME-based strategies and students' perceptions.

RESULTS AND DISCUSSION

In this study, the normality test was done by using Kolmogorov-Smirnov for achievement test and questionnaire. The p-value resulted 0.001, which is less than 0.05 indicating the data was non-normally distributed. Therefore, the statistical method used for this study were descriptives, Mann-Whitney U test and Spearman's Correlation to answer the research question.

STUDENT DEMOGRAPHIC

TABLE 1 shows the demographics of student involved in this study.

TABLE 1. Student demographics data

Demographic		**Form One & Two**	
		Frequency	**Percentage (%)**
Gender	Male	84	57.1
	Female	63	42.9
Class of Responder	RME	75	51.0
	Non-RME	72	49.0

TABLE 1 shows the demographic distribution of the 147 Form One and Two student participants. Gender was represented with 84 males (57.1%) and 63 females (42.9%), indicating a slightly higher male participation. Regarding the intervention groups, 75 students (51.0%) were in the RME (experimental) class, while 72 students (49.0%) were in the Non-RME (control) class, showing a relatively balanced distribution between the two conditions. These demographics provide a contextual overview of the sample involved in investigating the effectiveness of RME-based strategies and student preferences within this study.

THE DIFFERENCE MATHEMATICS ACADEMIC PERFORMANCE BETWEEN STUDENTS USING RME AND WITHOUT USING RME

TABLE 2 and TABLE 3 show that the significant finding on mathematics performance between group of students Form One. The result shows the effectiveness of RME-based strategies.

TABLE 2. The Mean Ranks Between RME and Non-RME (Form One)

Ranks				
	Class of Responder	n	Mean Rank	Sum of Ranks
Mathematics Result	1 Diamond (RME)	35	56.61	1981.50
	1 Pearl (Non-RME)	40	21.71	868.50
Total		75		

TABLE 3. The Ranks Between RME and Non-RME (Form One)

Test Statistic[a]	
	Mathematics Result Form One
Mann-Whitney U	48.500
Wilcoxon W	868.500
Z	-6.926
Asymp. Sig. (2-tailed)	< .001

[a]Grouping Variable: Class of responder

The result shows that there was a significant difference between these two classes of Form One. Class of responder using RME strategies had significantly higher than class without using RME strategies, U=48.5, z= -6.926, p=<.001. The mean rank for the class used RME strategies was 56.61, while the mean rank for the non-RME strategies class was 21.71. Thus, this suggest that RME strategies significantly affect students' mathematics performance. The performance of student who use RME strategies perform better result as compared with student non-RME strategies.

The statistically significant outperformance of the Form One RME group (1 Diamond) compared to the non-RME group (1 Pearl) provides strong evidence for the effectiveness of RME-based strategies in enhancing mathematics learning at this foundational secondary level. The considerably higher mean rank for the RME group suggests that the intervention facilitated a more profound engagement with and understanding of mathematical concepts. This findings align with the studies conducted by Suyono (2023) and Ndiung (2021), who also designed learning activities in RME to mirror the complex scenarios found in PISA questions, moving students away from abstract algorithms and towards functional application.

TABLE 4. The Ranks Between RME and Non-RME (Form Two)

Ranks				
	Class of Responder	n	Mean Rank	Sum of Ranks
Mathematics	2 Emerald (RME)	40	32.59	1303.50
Result	2 Ruby (Non-RME)	32	41.39	1324.50
Total		72		

TABLE 5 : The Ranks Between RME and Non-RME (Form Two)

Test Statistic[a]	
	Mathematics Result Form Two
Mann-Whitney U	483.500
Wilcoxon W	1303.500
Z	-1.778
Asymp. Sig. (2-tailed)	0.075

[a]Grouping Variable: Class of responder

A Mann Whitney U test was performed to evaluate whether class of Form Two using RME strategies differ from class without using RME strategies The result indicated that there was no significant difference between two classes, U=483.5, z= -1.778, p=. 075.The mean rank for the RME strategies class was 32.59, while the mean rank for the non-RME strategies class was 41.39. Thus, the finding shows that RME strategies does not significantly affect students' mathematics performance. This result was parallel with the result in Cengiz & Eğmir (2022), who also encountered situations where RME did not yield universally superior results, suggesting that contextual factors can indeed mediate RME's impact.

Although many studies have found that RME strategies had positive effect on the student's mathematics performance (Aksu, 2021; Yulianti & Aisyah, 2021; Enriquez et al. ,2024), the result of class Form Two in this study was contrast. Students in class of 2 Ruby were high-performing and able to grasp the subject very well even without implementing RME strategies to them. Meanwhile, students in class of 2 Emerald were weak in fundamental of mathematics and used ineffective learning strategies, which RME alone, within the study's timeframe, may not have been sufficient to overcome completely, despite its inherent strengths. However, the difference of mean rank for these two groups were not much different.

The variation in classroom dynamics, teacher expertise and topics taught could influence the outcome. This inconsistent imply that the effectiveness of RME strategies was depends on how they are adapted and applied in different learning environments.

THE PREFERRED RME -BASED STRATEGIES

The students' preferences RME-based strategies were examined using the median , mode and frequency values. Analysis of these descriptive statistics enabled the researcher to draw conclusions regarding student preferences.

TABLE 6: Level of Preference Class Form One

Item	Median	Mode	Frequency				
			Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I understand better when the teacher guides me to answer questions	5.00	5	0	0	1	6	26
I am more understand in solving Mathematics in terms of graphical representations and manipulatives	4.00	4	1	3	11	12	8
I prefer learning collaboratively with friends when learning to solve problems	5.00	5	0	1	4	9	21
I learn better when I study individually without being interrupted	3.00	3	3	6	14	9	3

A descriptive analysis was conducted on student preference in RME-based strategies. TABLE 6 shows the overall preference for RME-based strategies of student in Form One. The results indicate a clear and consistent preference for teacher-guided instruction and collaborative learning, while individual study was the least preferred method. Teacher-guided instruction emerged as the most highly rated strategy, with both the median and mode at 5.00. This is strongly supported by the frequency data, where 26 out of 33 students strongly agreed that they understand better when the teacher provides guidance. Collaborative learning was also highly valued, with a median and mode of 5.00, and 21 students strongly agreed that they prefer learning with their peers.

TABLE 7. Level of Preference Class Form Two

Item	Median	Mode	Frequency				
			Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I understand better when the teacher guides me to answer questions	5.00	5	0	0	2	9	29
I am more understand in solving Mathematics in terms of graphical representations and manipulatives	4.00	4	1	1	9	19	10
I prefer learning collaboratively with friends	4.50	5	0	3	4	13	20

when learning to solve problems						
I learn better when I study individually without being interrupted	3.00	2	6	11	11	11	1

Similarly, TABLE 7 shows that Form Two students strongly preferred teacher-guided instruction (Median = 5.00, Mode = 5), with 29 students strongly agreeing and 9 agreeing. Collaborative learning was also highly favored (Median = 4.50, Mode = 5), supported by 20 strongly agree and 13 agree responses. The use of graphical representations (Median = 4.00, Mode = 4) gained strong support, with 19 agreeing and 10 strongly agreeing. In contrast, individual study was the least preferred (Median = 3.00, Mode = 2), as 6 students strongly disagreed and 11 disagreed, compared to only 11 who agreed.

Overall, the level of preference student on RME-based strategies were high for both classes Form One and Form Two. Based on the result for Form One and Form Two students was guided practice – 'I understand better when the teacher guides me to answer questions.' This indicates that students value the teacher's presence and prefer working together when facing challenges. This finding is consistent with Noelyn & Hazel (2022), as guided practice was the most preferred by students. The teacher's role in using specific language and hints, as noted, is a hallmark of effective scaffolding within guided practice, making abstract concepts more accessible.

Furthermore, the second preference of both classes Form One and Form Two student was collaborative learning – 'I prefer learning collaboratively with friends when learning to solve problems'. This highlights the social dimension of learning and the perceived benefits of peer interaction, such as shared understanding, diverse perspectives, and mutual support.This preference aligns with research by Pambudi et al. (2022), who reported that collaborative learning increase student enjoyment, stimulate interest, and reduces bored in learning mathematics. Furthermore, as Inawati et. al (2020) describe, collaborative learning is a learning process of student working together to complete tasks given by the teacher. Fostering communication and teamwork skills alongside mathematical understanding. The continued high preference for this strategy in Form Two suggests that even as mathematical topics may become more abstract, students still see significant value in leveraging peer knowledge and support.

The third preference was graphical representations and manipulatives also remained high, indicating their continued utility in making abstract concepts more tangible for these diverse learner, a foundational principle of RME (Mainali, 2021). The consistent lower preference for individual learning activities across both forms perhaps signals a need for more structured support or a greater perceived challenge when students are left to work entirely independently with RME's open-ended problems, further emphasizing the importance of the preceding guided and collaborative phases.

Beyond the statistical measures, these findings are pedagogically meaningful. The strong preference for guided practice underscores students' reliance on teacher scaffolding, while the positive responses to collaboration demonstrate the central role of peer support in knowledge construction. The value placed on visual tools highlights the importance of bridging abstract concepts with concrete representations. Conversely, the reluctance toward independent study reveals that students may not yet feel ready to engage with mathematics autonomously, reinforcing the importance of sequencing RME-based strategies from teacher guidance to collaborative exploration before expecting independent mastery.

RELATIONSHIP BETWEEN TOPICS AND PREFERENCE RME – BASED STRATEGIES

TABLE 8 shows the result of the Spearman's rho on preference strategies of RME by Form One students.

TABLE 8. The Preference Strategies of RME (Form One)

			Guided Practice	**Graphical Represen tation & Manipulat ives**	**Collabora tive Activity**	**Individual Activity**
Spearman's rho	Topic 1 - Ration Number	Correlation Coefficient	.988**	-.261	-.812**	-.364*
		Sig. (2 -tailed)	<.001	.129	<.001	.031
		n	35	35	35	35
	Topic 2 – Factors and Multiples	Correlation Coefficient	.847**	.195	-.808**	-.312
		Sig. (2 -tailed)	<.001	.262	<.001	.068
		n	35	35	35	35
	Topic 3 – Squares, Square Roots, Cubes and Roots of Cubes	Correlation Coefficient	.599**	.498**	-.497**	-.681**
		Sig. (2 -tailed)	<.001	.002	.002	<.001
		n	35	35	35	35
	Topic 4 – Ratios, Rates and Proportions	Correlation Coefficient	.944**	-.157	-.944**	-.157
		Sig. (2 -tailed)	<.001	.367	<.001	.367
		n	35	35	35	35

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

The Spearman's correlation was carried out to determine the relationship between preference strategies and topics were taught to Form One and Form Two students. Based on TABLE 8, the analysis result shows significant findings for topic one. The guided practice strategies in topic one was significantly positive relationship (rs(33) =.988, p =<.001). Conversely, collaborative activity strategies was significant (rs(33) =-.812, p =<.001) with negative correlation between topic one and collaborative activity. Other preference strategies, namely graphical/manipulative use and individual activity, did not show a significant correlation with this initial topic.

In topic two student learnt on topic factors and multiples, the same process was done as topic one to find the relationship. The result shows that guided practice was significantly positive relationship (rs(33) =.847, p =<.001) and collaborative activity strategies was negative significant correlation (rs(33) =-.808, p =<.001). Furthermore, in topic three and four show that guided practice and collaborative activity strategies were significantly correlate. The relationship between guided practice and topic three were positively significant (rs(33) =.599, p =<.001), meanwhile collaborative activity and topic three were negatively significant relationship (rs(33) =-.497, p =<.001). The result of relationship for topic four and guided practice were positively significant (rs(33) =.944, p =<.001), and correlation between topic four and collaborative activity were negatively significant relationship(rs(33) =-.944, p =<.001). The other strategies of RME were not significantly correlate to each topic.

TABLE 9 shows the result of the Spearman's rho on preference strategies of RME by Form Two students.

TABLE 9. The Preference Strategies of RME (Form Two)

			Guided Practice	**Graphical Representation & Manipulatives**	**Collabora tive Activity**	**Individual Activity**
Spearman's rho	Topic 1 – Patterns and Sequences	Correlation Coefficient	.730**	-.012	-.469**	-.686**
		Sig. (2 -tailed)	<.001	.943	.002	<.001
		n	40	40	40	40
	Topic 2 – Factoring and Fractions Algebraic	Correlation Coefficient	.962**	.105	-.791**	-.507**
		Sig. (2 -tailed)	<.001	.520	<.001	<.001
		n	40	40	40	40
	Topic 3 – Algebraic Formulas	Correlation Coefficient	.970**	.	-.774**	-.428**
		Sig. (2 -tailed)	<.001	.	<.001	.006
		n	40	40	40	40
	Topic 4 – Polygon	Correlation Coefficient	.497**	.593**	-.533*	-.685**
		Sig. (2 -tailed)	.001	<.001	<.001	<.001
		n	40	40	40	40

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Based on the TABLE 9, the result shows the relationship between preference strategies and topics were taught for student in Form Two. Topic 1- Patterns and Sequences show that guided practice was significantly positive relationship ($r_s(38)$ =.730, p =<.001) and individual activity was significantly negative relationship (rs (38) = -.686, p = <.001). Meanwhile, the other strategies; graphical representation & manipulatives (rs (38) = -.012, p = .943) and collaborative activity (rs (38) = -.469, p = .002) were not significant.

In addition, topic 2 – factoring and fractions algebraic was taught to the students. Result shows there were three preference strategies significantly to this topic. Guided practice was positively significant ($r_s(38)$ = .962, p =< .001) , while collaborative activity ($r_s(38)$ = -.791, p =< .001) and individual activity ($r_s(38)$ = -.507, p =< .001) were negatively significant recorded. The graphical representation & manipulative was recorded not significant towards the topic 2 ($r_s(38)$ = .105, p = .520). The topic algebraic formula, the result of Spearman's correlation shows that there were two strategies preference by the student were significant. Guided practice shows positively significant relationship towards the topic algebraic formulas ($r_s(38)$ = .970, p =< .001) , meanwhile collaborative activity shows negatively significant relationship on the topics algebraic formulas ($r_s(38)$ = -.774, p =< .001). Whereas the other strategies preferences were not significant.

The last topic was polygon. The result shows in TABLE 10, there were two preferences strategies: guided practice and graphical representation & manipulative. The graphical representation & manipulative shows strong positive relationship ($r_s(38) = .593$, p =< .001) on this topic, whereas the guided practice ($r_s(38) = .497$, $p = .001$).

Student preferences for RME strategies vary by topic, as shown by Spearman's rho correlations. Guided practice consistently showed a positive correlation. This finding regarding the consistent positive correlation of guided practice is supported by broader research such as Cengiz & Eğmir (2022), who found that RME, by engaging students through realistic contexts and guided discovery, not only improves immediate performance but also positively impacts long-term learning and attitude towards mathematics. However, preferences for graphical & manipulative and collaborative strategies depended on the topic. This highlights the need for teachers to adapt RME strategies to specific mathematical content for optimal student engagement.

For years, Malaysia has consistently scored below the OECD average in mathematics, a challenge that has prompted extensive educational discourse. The core of this issue often lies in a pedagogical misalignment: traditional mathematics instruction in the Malaysia has frequently prioritized procedural fluency and rote memorization, whereas PISA assesses mathematical literacy. Thus, the strategies in RME promotes students' ability to apply mathematical concepts to solve complex, non-routine, real-world problems.

RME may have had a stronger impact on Form One students because they are at a foundational stage of mathematical learning, where guided practice tends to be more effective. In contrast, Form Two students often possess stronger prior knowledge, which may lessen the relative impact of RME strategies. Moreover, topics at this level, such as algebra and other abstract problem-solving tasks, may require a longer and more sustained implementation period for RME to produce measurable effects. In Malaysian Form 1 and 2 Mathematics context, effective RME is not about a rigid methodology but about a teacher's skillful ability to use guided practice as a consistent anchor while dynamically adapting collaborative and graphical representational tools to fit the specific mathematical topic and the students' evolving cognitive abilities. To maximize its effectiveness, teachers should implement guided practice more systematically, as it is both the most preferred and most effective; integrate collaborative learning to enhance communication and critical thinking; and balance individual learning activities with appropriate scaffolding.

The study's primary limitation lies in its small, single-school sample, which restricts both external validity and generalizability to the wider Malaysian student population. This limitation is particularly important when interpreting the contrasting outcomes between Form One and Form Two students. The absence of significant gains for Form Two may not necessarily indicate that RME is less effective at this level; rather, it could reflect the unique characteristics of this specific cohort such as differences in prior mathematical proficiency, classroom culture, or learning attitudes. In small samples, such factors can disproportionately influence results, making it difficult to disentangle the true effects of RME from cohort-specific dynamics. Future research should therefore engage larger and more diverse samples across multiple schools and regions, not only to validate these findings but also to ensure that observed differences across grade levels genuinely reflect the impact of RME rather than the idiosyncrasies of a particular student group. Additionally, examining the contextual factors that shape the reception of RME among different cohorts could yield deeper insights into how best to optimize its implementation for varied student populations.

This study contributes to the limited Malaysian literature on RME by showing how student preferences for its strategies vary across mathematical topics, with guided practice emerging as the most consistently effective approach. While international research has long highlighted the benefits of RME, these findings provide locally grounded evidence that effective implementation in Malaysia requires teachers to balance guided practice with adaptive use of collaborative and graphical strategies. The contrasting outcomes between Form One and Form Two students further suggest that RME's impact is developmental, offering valuable insights for tailoring its use across grade levels. Despite its small sample, this study adds an important step toward contextualizing RME within Malaysian classrooms and highlights the need for broader investigations across schools and regions.

CONCLUSION

This study demonstrates that Realistic Mathematics Education (RME)-based strategies hold significant potential for enhancing mathematics learning in the Malaysian context, particularly among lower secondary students. This suggest that RME approaches, especially guided practice and collaborative learning, not only improve performance but also align well with students' preferences, fostering both engagement and understanding. The findings extend theoretical discussions on constructivist and student-centered pedagogies by showing how guided practice and collaborative learning within the RME framework can strengthen both engagement and understanding. For Form One students especially, the results highlight how RME may play a critical role in developing foundational mathematical thinking, thereby supporting theories of scaffolding and progressive mastery in mathematics education.

From a practical perspective, the study underscores the importance of tailoring instructional approaches to different grade levels, acknowledging that student readiness, prior knowledge, and classroom dynamics influence the effectiveness of RME. Educators may draw from these findings to integrate guided practice and collaborative tasks more systematically into their teaching, while policymakers could consider supporting teacher training, curriculum design, and resource allocation that embed RME principles in classroom practice.

While the study's limited sample restricts the generalizability of its conclusions, it nonetheless offers meaningful insights into effective mathematics instruction. It emphasizes that RME strategies should be implemented thoughtfully, with attention to grade level differences and student needs. Future research with broader, more diverse samples is necessary to confirm these findings and refine implementation approaches. Ultimately, the evidence presented supports the promise of RME as a valuable pedagogical framework that, when carefully tailored, can motivate students, enhance mastery, and contribute to more effective mathematics teaching and learning in Malaysia.

ACKNOWLEDGEMENT

The authors would like to thank the school and students who participated in this study. This study was supported by Geran Penyelidikan Dalaman Universiti Teknologi MARA Cawangan Selangor – GT2P (UiTM.800-3/1 DDF.88 (011/2025)). We also appreciate the support given by Universiti Teknologi MARA, especially Center of Foundation Studies, Faculty of Education and ethics commitee approval (ED/REC/F/10566).

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https://doi.org/10.17576/akad-2026-9601-11

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