

Implementation of the RME Approach on the Fluency of Mathematical Procedures and Students' Interest in Learning

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Article Info	Abstract
<i>Keywords:</i> learning interest Realistic Mathematic Education procedural fluency <i>Article History:</i> Received: February 20, 2025 Accepted: May 12, 2025 Publish: September 2, 2025 <i>DOI:</i> 10.33830/jp.v26i2.12971.2025	The Realistic Mathematics Education (RME) approach integrates real-world contexts to enhance both aspects simultaneously. This study aimed to examine: (1) the effect of the RME approach on procedural fluency and learning interest, (2) its effect on procedural fluency, and (3) its effect on learning interest. A quasi-experimental post-test-only control group design was employed. Data were analyzed using multivariate analysis (Henze–Zirkler, Box’s M, Hotelling’s T²) and univariate analysis (Shapiro–Wilk, F-test, t-test) with R. The results showed 1) there is a significant difference ($p\text{-value} = 0,0484 < 0,05$), 2) there was no significant difference in student’s mathematical procedural fluency ($p\text{-value} = 0,2068 > 0,05$), and 3) there was no significant difference in student’s learning interest ($p\text{-value} = 0,0509 > 0,05$). Nevertheless, effect size analysis revealed a small practical effect of the RME approach on procedural fluency ($d = 0.374$) and a moderate effect of the expository approach on learning interest ($d = 0.585$). These findings highlight the interconnection between cognitive and affective aspects in mathematics learning, suggesting that the RME approach is effective when both aspects are considered simultaneously. Therefore, integrating the RME approach into mathematics instruction, potentially combined with expository methods, can optimize students’ learning outcomes.

INTRODUCTION

In the era of globalization and rapid development, Indonesia as a developing country is faced with complex challenges in preparing high-quality human resources. Education holds a vital role in shaping individuals who are not only knowledgeable and skilled but also capable of adapting to future demands (Sulastri et al., 2023). Furthermore, education contributes to the personal and social development of students through meaningful and direct learning experiences (Hidayah et al., 2023). In this context, teachers play a central role in facilitating the learning process effectively (Kamal & Istiyono, 2023). However, the success of learning is not solely determined by the teacher’s role; it also depends on the active engagement and

participation of students in the learning activities (Leniati & Indarini, 2021).

One subject that contributes significantly to the development of students' logical, critical, and systematic thinking skills is mathematics (Asih & Imami, 2021; Murtadha & Mardhiyana, 2023). Mathematics also serves as an essential tool in advancing science and technology. This implies that learning mathematics is not only about understanding mathematical concepts or theorems, but also about developing students' ability to use logical reasoning to solve problems and predict phenomena (Kamal & Istiyono, 2023). However, in practice, mathematics learning at the junior high school level still faces various challenges, particularly regarding students' ability to carry out mathematical procedures accurately and efficiently. According to Government Regulation No. 4 of 2022, the goal of mathematics learning is for students to understand, explain, and apply mathematical concepts and algorithms fluently, efficiently, and accurately in problem-solving. Thus, mathematics learning should emphasize not only conceptual understanding but also the ability to apply those concepts in solving real problems (Kamal & Istiyono, 2023). One essential cognitive component in achieving this goal is mathematical procedural fluency. As cited by Damayanti in Pratidiana & Muhayatun, (2021), the National Assessment of Educational Progress (NAEP) identifies procedural fluency as a central focus of mathematics assessment, and it is also emphasized in the Learning Principles of the National Council of Teachers of Mathematics. Procedural fluency refers to the ability to understand how and why something is done in a certain way (Faulkner et al., 2023). Therefore, procedural fluency is a crucial aspect that students must develop in learning mathematics.

According to Rittle-Johnson and Schneider in Dorner et al., (2025), a procedure is defined as a sequence of steps that can be systematically carried out to solve specific types of problems. In line with this, Sari in Nurkhasanah & Ruli, (2023) describes a procedure as a series of steps that are arranged in a precise and orderly manner. Kilpatrick defines procedural fluency as a cognitive ability that encompasses the mastery of procedural knowledge, the selection of appropriate strategies, and the implementation of these procedures effectively, efficiently, and flexibly in solving mathematical problems (Nurkhasanah & Ruli, 2023; Pratidiana & Muhayatun, 2021; Safitri & Lestari, 2022). Consistent with this view, Star in Dorner et al., (2025) emphasizes that procedural fluency enables students to solve problems appropriately according to the given context. Students' ability to apply a concept or algorithm encompasses not only solving mathematical problems using formulas or algorithms, but also demonstrating understanding and fluency in the use of concepts, algorithms, and procedures (Afianti et al., 2022).

However, various studies have shown that students' procedural fluency remains low due to difficulties in identifying patterns, performing accurate calculations, and applying mathematical concepts (Pratidiana & Muhayatun, 2021; Safitri & Lestari, 2022). Initial interviews with mathematics teachers at SMP Negeri 5 Pekalongan indicated that students' mathematical procedural fluency is still relatively weak. In solving mathematical problems, students often struggle to determine the appropriate procedures to use. Furthermore, they are not yet able to develop the procedures they have previously learned, nor are they able to select and evaluate the most suitable procedures for solving the problems they encounter.

Based on the interview results, the researchers found it necessary to examine issues related to procedural fluency. An effective approach is needed to enhance students' mathematical procedural fluency. One such approach that can be applied is the Realistic Mathematics Education (RME) approach. This is supported by Palinussa et al., (2021), who state that the RME approach utilizes real-life situations to enable students to construct their own understanding and knowledge. RME was first introduced and developed in the Netherlands in the 1970s by the Freudenthal Institute (Méndez-Parra et al., 2022; Sya'Bani et al., 2021). This approach emphasizes that mathematics should be connected to real life and

viewed as a human activity (Kutluca & Gündüz, 2022; Palinussa et al., 2021; Purnama et al., 2023). According to Sulastri et al., (2023), RME is one of the approaches in mathematics learning that links instructional content to everyday life situations. This is in line with the view that a solid foundation of mathematical knowledge is essential for solving problems in a contextual manner (Kamal & Istiyono, 2023).

The main principle of RME is that learning begins with real-world contexts to promote active participation and problem-solving (Amir et al., 2021; Zulfayanti, 2024). In line with this, Darto, (2021) stated that the RME approach helps students understand concepts, solve problems using their informal knowledge, and provides opportunities for students to demonstrate their abilities. According to Hauvel-Panhuizen in Kutluca & Gündüz, (2022), students are given the opportunity to explore mathematical ideas through interaction with their environment in a process known as *mathematization*, which occurs both horizontally (connecting real-world problems to mathematical models) and vertically (developing concepts toward more abstract understanding). The learning syntax of the RME approach, as outlined by Zulkardi & Putri, (2010), includes the use of contextual problems, the use of models, the incorporation of student contributions, the presentation of group work results (interactivity), and the formulation of conclusions.

In addition to cognitive aspects, mathematics learning is also influenced by affective factors, such as students' interest in learning. Learning interest affects students' enthusiasm and academic success (Ermawati et al., 2023; Hidayah et al., 2023; Rahmayani & Istiyono, 2022). Students with high interest tend to make greater efforts in learning (Sulastri et al., 2023), whereas low interest can hinder the achievement of learning objectives (Murtadha & Mardhiyana, 2023). In the 21st century, teachers are expected to understand how to stimulate students' learning enthusiasm in accordance with the characteristics of today's learners. According to Hidayah et al., (2023), learning interest refers to an individual's attraction or preference for something that generates focused attention, encourages enthusiastic behavior, and fosters motivation in the learning process. The indicators of learning interest used in this study include feelings of enjoyment, student attention, engagement, and participation in learning activities.

Based on an interview with one of the mathematics teachers, in addition to issues with procedural fluency, students' interest in learning mathematics remains relatively low. This is due to the perception that mathematics is a difficult, boring, and unappealing subject. Teachers play a crucial role in helping students understand mathematical concepts (Kamal & Istiyono, 2023). However, when the learning approach lacks variation, students tend to lose interest, especially when teachers continue to rely on the expository approach. The expository approach is a teaching method that emphasizes the direct explanation of material to students, with the goal of helping them understand and master the subject matter (Ragin et al., 2020; Woli et al., 2023). In line with this, the expository approach is categorized as a teacher-centered learning method (Richana & Masithoh, 2023; Suweta, 2020; Zulfayanti, 2024). According to Amalia et al., (2022), mathematics is often perceived as a daunting subject; therefore, teachers need to create a fun and interactive learning environment to help students feel comfortable and ensure that the material presented is meaningful. In this regard, students' interest in learning mathematics can be enhanced through contextual, collaborative, and enjoyable learning, such as the RME approach which encourages students' interaction with mathematics (Arthur et al., 2022).

Several findings related to the RME approach show significant developments in mathematics learning. For instance, Ermawati et al., (2023) and Sulastri et al., (2023) demonstrated that the RME approach can increase students' interest in learning. Additionally, research by Widana (2021) showed that the RME approach can improve students' mathematical problem-solving abilities. Meanwhile, the findings of Fredriksen, (2021) show

that RME has a significant effect on students' mathematical reasoning and communication skills. [Lukman et al., \(2023\)](#) also found that the RME approach enhances students' learning processes and outcomes in mathematics education. This is consistent with the findings of [Purnama et al., \(2023\)](#), who reported that the RME approach is more effective in improving students' learning outcomes based on average post-test scores. Moreover, research conducted by [Zulfa, \(2024\)](#) revealed that the RME approach significantly influences students' learning interest and computational thinking skills.

Based on the literature review, several research gaps have been identified: first, some previous studies focused solely on affective aspects ([Ermawati et al., 2023](#); [Sulastri et al., 2023](#)); second, other studies addressed only cognitive aspects ([Lukman et al., 2023](#); [Purnama et al., 2023](#)); and third, a few studies examined both cognitive and affective aspects simultaneously ([Zulfa, 2024](#)). This indicates that most existing research has examined cognitive and affective domains separately, without considering their combined effects. In fact, both aspects are essential and interrelated in effective mathematics learning. A balanced focus on procedural mastery and learning interest is crucial to meet the demands of 21st-century education and the implementation of the *Merdeka* curriculum. Therefore, the objectives of this study are to determine: (1) the simultaneous effect of the RME approach on students' mathematical procedural fluency and learning interest; (2) the effect of the RME approach on students' mathematical procedural fluency; and (3) the effect of the RME approach on students' learning interest.

RESEARCH METHODS

This research employs a quantitative approach with a quasi-experimental design. The specific design used is a posttest-only control group design, involving two separate classes that receive different treatments: the experimental class and the control class.

Table 1. Research Design

	Treatment	Post-Test
K (E)	X_E	Y
K (K)	-	Y

Description

K (E) : Experiment Class

K (K) : Control class

X_E : The treatment applied to the experimental class was the implementation of the RME approach.

Y : The same final test in both classes

The study population consisted of seventh-grade students at SMP Negeri 5 Pekalongan during the 2024/2025 academic year. The research was conducted from January to June 2025. The sampling technique used was cluster random sampling, which is a form of random sampling in which the population is divided into several groups (clusters) based on specific criteria ([Saefullah, 2024](#)). In this study, two classes were randomly selected from the six available classes. Class 7F was designated as the experimental group, receiving instruction using the RME approach, while Class 7B was designated as the control group, receiving instruction using the expository approach.

The data collection methods used in this study were tests and questionnaires. The tests, consisting of five essay questions, were used to measure students' procedural fluency in mathematics. The questionnaires, consisting of 20 statements in the form of a Likert scale, were used to measure students' interest in learning. Prior to their use, all instruments were

analyzed to ensure their appropriateness. The test instruments were examined for validity, reliability, discriminating power, and level of difficulty, while the questionnaires were analyzed for validity and reliability. Based on the analysis results, both the test and questionnaire instruments were deemed appropriate for use in this study.

Before administering the treatment, a preliminary data analysis was conducted to determine whether the initial conditions of the two groups were equivalent. The initial data used were the midterm exam scores of seventh-grade students in the 2024/2025 academic year. The analysis results showed that the experimental and control classes came from a population that was not normally distributed, had the same variance (homogeneous), and had the same mean. Although the data were not normally distributed, the research could still proceed with these classes. This aligns with [Gall et al., \(2003\)](#), who emphasize the importance of initial data equivalence in experiments to ensure that differences in outcomes at the end of the treatment can be attributed to the treatment itself rather than external variables. In this study, although the initial student data were not normally distributed, the Mann–Whitney test results showed no significant difference between the two classes, indicating that the data could still be validly used in this study.

The data obtained from the instruments were analyzed using descriptive and inferential statistical methods. Descriptive statistics were used to provide an overview of the data, including the mean, maximum value, minimum value, and standard deviation. Inferential statistics were used to test hypotheses and determine whether there were significant differences between the experimental and control groups. The analysis was carried out using both multivariate and univariate approaches.

In the multivariate analysis, Hotelling's T^2 test was used to determine the difference in means between the experimental and control groups simultaneously on two variables. Before performing Hotelling's T^2 test, prerequisite tests were conducted, namely the multivariate normality test using the Henze–Zirkler test and the homogeneity of covariance test using Box's M test. Meanwhile, univariate analysis was conducted for each variable separately using the t-test, with its prerequisite tests being the normality test using the Shapiro–Wilk test and the homogeneity test using the F-test. If the t-test results showed no significant difference, the effect size was calculated using Cohen's d formula. All data analyses were performed using the R software.

RESULTS AND DISCUSSION

Results

The data collected consisted of students' mathematical procedural fluency scores and learning interest scores after receiving different instructional treatments: the RME approach in the experimental class and the expository approach in the control class. The results of the descriptive statistical summary for both procedural fluency and learning interest in the experimental and control groups are presented in [Table 2](#).

The final data obtained from the test instruments and questionnaires were analyzed using inferential statistical methods with the assistance of the R program. Normality testing was carried out to determine whether the data in each group met the assumptions of a normal distribution, both multivariate and univariate. This step is essential to establish the appropriate statistical analysis techniques to be used in the subsequent stages of data analysis.

Based on the results of the multivariate test presented in [Table 3](#), the normality test using the Henze-Zirkler method showed that the group of students taught using the RME approach obtained an HZ statistic of 0.6092 with a p-value of 0.1395. Meanwhile, the group receiving

the expository approach treatment yielded an HZ statistic of 0.7475 with a p-value of 0.0578. Since both groups have p-values greater than 0.05, H_0 is accepted. It can be concluded that the data from both groups follow a multivariate normal distribution.

Table 2. Summary of Students' Mathematical Procedural Fluency and Learning Interest Scores

Statistical	Experiment Class		Control Class	
	Procedural Fluency	Learning Interest	Procedural Fluency	Learning Interest
N	29	29,0	31,0	31,0
Mean	44	82,3	41,3	92,7
Median	42	79,98	40,0	89,3
Mode	40	70,48	36,0	82,5
Standard Deviation	6,351994	18,42184	5,6	16,7
Varians	40,34783	339,364	31,0	287,4
Minimum Score	34	53,89	32,0	68,5
Maximum Score	54	115,25	52,0	131,4
Ranges	20	61,36	20,0	62,9

Table 3. Results of Univariate and Multivariate Normality Tests

Group	Aspect	Henze-Zirkler		Shapiro-Wilk	
		statistic	p-value	statistic	p-value
RME	Procedural Fluency	0,6092	0,1395	0,9434	0,2125
	Learning Interest			0,9342	0,1348
Expository	Procedural Fluency	0,7475	0,0578	0,9502	0,2731
	Learning Interest			0,9215	0,0631

In the univariate normality test using the Shapiro-Wilk method, the results indicated that all variables in each group were normally distributed. In the RME group, the procedural fluency variable obtained a Shapiro-Wilk statistic of 0.9434 with a p-value of 0.2125, while the learning interest variable yielded a statistic of 0.9342 with a p-value of 0.1348. Since both p-values are greater than 0.05, H_0 is accepted, indicating that both variables are normally distributed on a univariate level. Similar results were observed in the expository group. The Shapiro-Wilk statistic for the procedural fluency variable was 0.9502 with a p-value of 0.2731, while the learning interest variable obtained a value of 0.9215 with a p-value of 0.0631. As both p-values exceed 0.05, H_0 is accepted, indicating that the data for both variables are also univariately normally distributed.

Based on the results of both the multivariate and univariate normality tests, the research data met the assumption of normality. Therefore, the data were considered suitable for further analysis under the assumption of homogeneity. The homogeneity test was conducted to ensure the equality of variances and covariances between data groups, which is a prerequisite for further MANOVA analysis. This test was carried out in two forms: a multivariate homogeneity test using Box's M test, and a univariate homogeneity test using the F-test.

Based on the results of the multivariate homogeneity test presented in Table 4, the Box's M test yielded a p-value of 0.035, which is less than the significance level of 0.05 ($p\text{-value} < 0.05$). Therefore, H_0 is rejected, indicating that the variance-covariance matrices between groups are not homogeneous. This implies that there are differences in population variances and covariances. In contrast, the results of the univariate homogeneity test showed different findings. For the procedural fluency variable, the p-value was 0.544, while for the learning interest variable, it was 0.695. Since both p-values are greater than 0.05, H_0 is accepted. This

indicates that there are no significant differences in population variances, and thus the data for each variable can be considered to come from homogeneous populations.

Table 4. Homogeneity Test

Test Type	Variables	Statistic	df	p-value
Box's M (Multivariate)	Procedural Fluency & Learning Interest	$\chi^2 = 8,581$	df = 3	0,035
Uji F (Univariate)	Procedural Fluency	F = 1,294	df1 = 22 df2 = 23	0,544
Uji F (Univariate)	Learning Interest	F = 1,181	df1 = 22 df2 = 23	0,695

The results of the multivariate analysis indicated heterogeneity of covariance matrices. However, the univariate analysis showed that each variable exhibited relatively uniform variance between groups. Subsequently, the data were analyzed using t-tests to examine differences in population means. The purpose of the mean difference analysis between the two groups in this study was to determine whether there were significant differences between the RME and expository learning approaches in terms of procedural fluency and students' learning interest. The testing was conducted using two approaches: multivariate analysis with Hotelling's T^2 test and univariate analysis with the independent two-sample t-test.

Table 5. Multivariate and Univariate Tests of Mean Differences Between Two Independent Populations

Test Type	Variables	Statistic	df	p-value
Hotelling's T^2	Procedural Fluency & Learning Interest	$T^2 = 6,6421$	df1 = 2 df2 = 43,76	0,0484
Uji t	Procedural Fluency	t = 1,2807	df = 45	0,2068
Uji t	Learning Interest	t = -2,0059	df = 45	0,0509

The multivariate test results presented in [Table 5](#), using Hotelling's T^2 test, yielded a p-value of 0.0484 ($p\text{-value} < 0.05$), indicating that H_0 is rejected. This suggests that there is a significant simultaneous difference in the means between the RME and expository groups in terms of mathematical procedural fluency and learning interest. In other words, the learning approach applied has a differential effect on both aspects when analyzed together.

However, further univariate testing provides a more detailed picture of each variable. For the procedural fluency variable, the t-test yielded a t-value of 1.2807 with a p-value of 0.2068 ($p > 0.05$), indicating that H_0 is accepted. Thus, there is no significant difference between the two groups in terms of mathematical procedural fluency. This suggests that the RME learning approach does not have a significant effect on students' procedural fluency in mathematics compared to the expository approach. Meanwhile, for the learning interest variable, the t-test produced a t-value of -2.0059 with a p-value of 0.0509 ($p > 0.05$), and H_0 is also accepted. Although the p-value is close to the significance level, it still indicates that there is no statistically significant difference in learning interest between the two groups. Therefore, the RME learning approach does not significantly affect students' interest in learning compared to the expository approach.

To examine the practical effect of the treatment, even though it was not statistically

significant, the effect size was calculated using Cohen's *d* formula (Cohen, 1988). The results of the effect size calculation are presented in Table 6.

Table 6. Results of the Effect Size Calculation

Variable	Cohen's <i>d</i> Value	Category
Procedural Fluency	$d = 0,374$	Small
Learning Interest	$d = 0,585$	Medium

Based on the effect size calculations presented in Table 6, the effect size for procedural fluency is 0.374, categorized as small. This suggests that although the difference is not statistically significant, the RME approach still has a practical effect on students' mathematical procedural fluency. Meanwhile, the effect size for learning interest is 0.585, categorized as medium. However, this medium effect on learning interest comes from the group that received the expository approach, as they had a higher average learning interest compared to the RME group. This indicates that the expository approach has a greater impact on students' learning interest. Overall, the results of the data analysis show that the RME approach still has a practical impact, particularly in improving students' mathematical procedural fluency.

Discussion

A multivariate analysis using Hotelling's T^2 test was conducted to determine whether there were significant simultaneous differences between the experimental group and the control group on two variables: mathematical procedural fluency and learning interest. The results showed a *p*-value of 0.0484, which is less than the significance level of 0.05, indicating a significant multivariate difference between the two groups. This suggests that the learning approach used had a combined effect on students' learning outcomes, both cognitively and affectively. These findings are consistent with previous studies on the RME approach. Research by [Ermawati et al., \(2023\)](#), [Sulastris et al., \(2023\)](#), and [Widana, \(2021\)](#) found that RME can increase students' interest in learning through contextual activities and real-life experiences. Similarly, studies [Lukman et al., \(2023\)](#) and [Purnama et al., \(2023\)](#) demonstrated that RME can significantly improve mathematics learning outcomes. However, most of these studies examined only one aspect, either cognitive or affective. Therefore, the present study reinforces the importance of the RME approach in influencing both aspects simultaneously. This is further supported by [Rahmayani & Istiyono, \(2022\)](#), who emphasized that cognitive, affective, and psychomotor aspects are all essential and should be considered in research.

Although the multivariate analysis revealed significant differences, separate univariate analyses for each variable did not show significant results. For procedural fluency, the experimental group's mean score was 43.57, compared to 40.33 for the control group. The *t*-test produced a *p*-value of $0.2068 > 0.05$, indicating no significant difference. This suggests that, on a univariate level, the RME approach did not produce a statistically significant improvement in procedural fluency. The difference between the multivariate and univariate results highlights the value of using multiple analytical approaches in educational research. When variables are analyzed simultaneously, significant differences between learning approaches can be detected; however, when tested individually, no significant differences may be evident. This indicates that cognitive and affective aspects are interconnected and cannot be entirely separated in the mathematics learning process. To assess the treatment effect despite the lack of statistical significance in the univariate analysis, an effect size calculation was conducted using Cohen's *d* formula (Cohen, 1988). The results showed an

effect size of 0.374 for procedural fluency, which falls into the small category, indicating a modest but practical impact of the RME approach.

These findings indicate that although the t-test results show no statistically significant differences, the RME approach still exerts a meaningful practical effect on mathematical procedural fluency, while the expository approach demonstrates a practical effect on students' learning interest. This is in line with [Cohen, \(1988\)](#) significance is not the only important indicator; in the fields of social sciences and education, the magnitude of the effect (effect size) often provides a better representation of the real world benefits of an intervention. Therefore, the findings of this study remain relevant to the development of contextual mathematics approaches, even when not all statistical results are significant. These results are consistent with the characteristics of the RME approach, which emphasizes the use of real world contexts, encourages students to develop their own strategies, and promotes interactivity and the interconnection of concepts to foster meaningful mathematical understanding ([Zulfa, 2024](#)). In RME, students first develop understanding through representations of real life situations referred to as model of which is the initial stage where students devise solution strategies relevant to everyday contexts ([Putrawangsa, 2017](#)). Subsequently, the model of is transformed into a model for, a mathematical thinking tool that helps students construct generalized models for similar problems until they arrive at more formal solutions ([Putrawangsa, 2017](#)). The transition from model of to model for is central to RME learning, as it builds deep understanding and meaningful procedural fluency. This process aligns with Jean Piaget's theory of cognitive development. According to Piaget, as cited in [Schunk, \(2012\)](#), learning occurs through two processes: assimilation integrating new information into existing cognitive structures and accommodation modifying or replacing existing knowledge when new information does not fit. Middle school students, according to Piaget, are typically in the concrete operational or formal operational stages, which enable abstract thinking and hypothetical reasoning ([Schunk, 2012](#)). In this context, Piaget's theory aligns closely with the model of and model for progression in RME. Similarly, [Phan et al., \(2022\)](#) notes that the RME approach effectively supports students with average or below-average abilities in understanding abstract mathematical concepts.

For the learning interest variable, the control group had a mean score of 89.42, which was higher than the experimental group's 82.34. The t-test yielded a p-value of $0.0509 > 0.05$, indicating no statistically significant difference between the RME and expository approaches in terms of students' learning interest. However, the effect size calculation showed a value of 0.585, which falls into the moderate category, suggesting that the expository approach had a notable practical impact on students' learning interest.

Based on the effect size value, the expository approach has a practical influence on students' learning interest, as reflected in the higher average learning interest score compared to the RME approach. This finding is notable because it contradicts several previous studies ([Ermawati et al., 2023](#); [Sulastri et al., 2023](#)). The difference may be attributable to contextual factors such as students' academic background, learning styles, or variations in teaching methods. As stated by Mulyasa in [Prastiwi, \(2024\)](#) variations in teaching styles can influence students' enthusiasm for learning. Similarly, [Helmiati, \(2013\)](#) emphasizes that a teacher's ability to vary instructional delivery through voice modulation, eye contact, facial expressions, and body movements can enhance students' attention and participation. Therefore, the increase in learning interest observed in the expository group may be attributed to the teacher's teaching style, which created a more comfortable learning environment for students.

Although the univariate test results did not show statistically significant differences, the

RME approach proved more effective in improving procedural fluency, while the expository approach was more effective in fostering learning interest. Therefore, it is advisable for teachers to combine both approaches flexibly beginning with an expository approach for initial explanations, followed by RME activities involving real world contexts and student discussions. Additionally, teachers should enhance the quality of RME implementation by providing appropriate scaffolding, selecting relevant contexts, and considering students' learning styles. Such an integrated approach can make mathematics learning more meaningful and engaging for students.

CONCLUSION

Based on the research findings, it can be concluded that there is a significant simultaneous effect of the RME and expository approaches on procedural fluency and students' learning interest, as evidenced by the multivariate analysis. In the univariate analysis, the RME approach did not show a statistically significant effect on improving procedural fluency; however, the effect size indicated a meaningful practical impact. Similarly, the RME approach did not yield a significant effect on learning interest when examined separately, whereas the expository approach demonstrated a moderate effect size, indicating a practical impact on enhancing learning interest. Therefore, the application of the RME approach remains relevant in mathematics education, particularly for improving procedural fluency, and can be effectively combined with the expository approach to optimize students' learning outcomes both cognitively and affectively.

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