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THE EFFECTIVENESS OF RME AND SCIENTIFIC APPROACHES IN TERMS OF MATHEMATICAL LITERACY AND LEARNING INTEREST

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Abstract

Students' low levels of mathematical literacy and learning interest indicate a need for effective instructional approaches that can address both cognitive and affective learning outcomes. Comparative studies on the effectiveness of the RME and scientific approaches in improving mathematical literacy and learning interest remain limited, especially at the SMP level. This study examines the effectiveness of each approach and compares their impact on students' mathematical literacy and learning interest. This study employed a quantitative approach using a pretest–posttest control group design. The population of the study consisted of all seventh-grade students at a public SMP in Yogyakarta. The sample comprised 64 students from two seventh-grade classes. The participants were selected using convenience sampling. The experimental group received RME-based instruction, while the control group was taught using the scientific approach. MANOVA results show that both approaches significantly improve mathematical literacy and learning interest. However, no significant difference was found between the two groups, as indicated by a p-value > 0.05. These findings suggest that both approaches are equally effective. The study provides insight for teachers in applying context-based learning. Future research may explore digital-based strategies to further support mathematical literacy and learning interest.

Keywords: Learning interest; mathematical literacy; realistic mathematics education; scientific.

Abstrak

Rendahnya tingkat literasi matematika dan minat belajar siswa menunjukkan perlunya pendekatan yang efektif untuk mengembangkan hasil belajar kognitif maupun afektif. Penelitian komparatif mengenai efektivitas pendekatan RME dan pendekatan saintifik dalam meningkatkan literasi matematika dan minat belajar masih terbatas, khususnya di tingkat SMP. Penelitian ini bertujuan mengkaji efektivitas masing-masing pendekatan dan membandingkan pengaruhnya terhadap literasi matematika dan minat belajar siswa. Penelitian ini menggunakan pendekatan kuantitatif dengan desain pretest–posttest kelompok kontrol. Populasi penelitian terdiri atas seluruh siswa kelas VII di salah satu SMP negeri di Yogyakarta. Sampel penelitian berjumlah 64 siswa yang berasal dari dua kelas VII. Partisipan dipilih menggunakan teknik convenience sampling. Kelompok eksperimen diajar dengan pendekatan RME, sedangkan kelompok kontrol menggunakan pendekatan saintifik. Hasil analisis MANOVA menunjukkan bahwa kedua pendekatan efektif dalam meningkatkan literasi matematika dan minat belajar siswa. Namun, tidak terdapat perbedaan signifikan antara kedua kelompok (nilai p > 0.05), yang berarti keduanya memiliki efektivitas yang setara. Temuan ini memberikan wawasan bagi guru dalam menerapkan pembelajaran berbasis konteks. Penelitian lanjutan dapat mengeksplorasi integrasi teknologi untuk mendukung pengembangan literasi matematika dan minat belajar.

***Kata kunci**: Literasi matematika; minat belajar; realistic mathematics education; saintifik.*

INTRODUCTION

Students with strong mathematical literacy can use mathematics effectively in daily life and draw logical conclusions (Genc & Erbas, 2019). However, PISA results show that Indonesian students' mathematical literacy remains low with the average score declined from 379 to 366 (OECD, 2023), and fewer than half of junior

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high school students meeting the minimum competency standards (Pusmendik, 2022). Impelementing an appropriate instructional approach serves as one strategic effort to enhance students' mathematical literacy. Findings from interviews with mathematics teacher at a public SMP in Yogyakarta City indicate that mathematics instruction at the school is largely conducted using an expository approach. The expository approach allows students to learn mathematics by memorizing and remembering formulas (Hidayat & Widjajanti, 2018).

The expository approach tends to frame students as passive recipients of knowledge, with learning centered largely on formula memorization. Such conditions may hinder active participation in the instructional process. Accordingly, teachers are expected to recognize and respond to factors that enhance student engagement and interest in learning. According to Hidayat and Widjajanti (2018), learning interest can be defined as an internal disposition that generates enthusiasm for learning activities, reflected in enjoyment, attraction, attention, and willingness to participate. Previous research has shown that learning interest plays a role in determining students' achievement in mathematics. Wulansari and Manoy (2020) states that learning interest plays a role in shaping students' academic performance. Sya'adah et al. (2023) reported that students' interest in learning mathematics remains relatively low, as reflected in mathematics achievement scores that are still below the minimum competency criteria (KKM). Therefore, teachers need to consider wisely the right approach to use in learning mathematics.

Palinussa (2013) stated that the RME approach is superior when compared to conventional that are only teacher-centered. Gravemeijer (1994) explains that the RME approach real-world contexts serve as the foundation from which students build their understanding of mathematics. This approach is grounded in three fundamental principles: 1) guided reinvention and progressive mathematization; 2) didactical phenomenology; 3) self-developed models. Another study mentioned that the RME approach supports students' math problem solving completeness by 80% compared to conventional (Mukaromah et al., 2023). Thus, RME is useful for students in linking mathematical concepts with other things in everyday life.

In addition, RME approach is an approach that has structured and systematic characteristics is the scientific approach. The scientific approach refers to an instructional model grounded in scientific principles that highlights collaboration and cooperative learning among students (Fadhilaturrahmi, 2017). Research conducted by Lestari et al. (2018) found the scientific approach increased learning motivation by 92.28% and learning achievement by 78.13%. These findings suggest that the scientific approach supports students in actively constructing their own knowledge, enabling them to formulate, test, accept, or reject scientific statements and theories through active participation in the learning process. Both approaches serve as potential strategies to enhance students' understanding and meaningful learning of mathematics. RME and scientific approaches are influential and more effective than conventional learning on learning achievement, mathematical reasoning ability, and learning interest (Wibowo, 2017).

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Based on an interview with mathematics teacher, that many students still struggle with ratio problems because they are not accustomed to such tasks. Agnesti & Amelia (2020) found that difficulties with ratio problems stem from textbook-centered instruction. Teachers are encouraged to use approaches that connect mathematics to real-life contexts and provide non-routine problems. Previous studies have examined the effectiveness of the RME and scientific approaches separately, but comparative research on both in terms of mathematical literacy and learning interest is still limited, especially on ratio material. Therefore, this research is important to fill the gap and provide evidence-based recommendations for instructional practice.

In addressing the issue described above, this study aims to investigate the effectiveness of the RME and scientific approach in improving seventh-grade students' mathematical literacy and learning interest in ratio topics. The results of this study are expected to contribute to the development of more effective instructional designs. This investigation is guided by the following research questions:

1. Is the RME approach effective?
2. Is the scientific approach effective?
3. Which of the two approaches is more effective in terms of mathematical literacy and learning interest?

METHODS

This study employed a quasi-experimental method using a pretest–posttest control group design. Such a design incorporates a control group but is constrained in its ability to fully control or observe all factors that may affect the implementation of the experiment (Sugiyono, 2014). The population comprised all Grade VII students from six classes at a public SMP in Yogyakarta City during October – November of the TA.2024/2025. The study applied a convenience sampling technique to select the participants. This method was selected based on the outcome of discussions with mathematics teacher at the school, which indicated that the selected classes were available and willing to participate in the research. The research sample used the classes formed in the school consisting of two classes totaling 64 students. One class served as the experimental group using the RME approach and a control class using the scientific approach.

The study employed test and non-test methods for data collection. Students' mathematical literacy skills were measured using a test instrument, while learning interest was measured using a non-test instrument.

1. Test Instrument

The test instrument consisted of two components, namely a pretest and a posttest. The mathematical literacy test consisted of 3 essay items focused on the ratio material. The mathematical literacy indicators applied in this study were adapted from the OECD (2023), include: 1) formulate mathematical situations (formulate); 2) use facts, concepts, and procedures to solve mathematical problems (employ); 3) interpret and evaluate results according to the context of real-life problems (interpret).

2. Non-test instrument

The non-test instruments in this study used a learning interest questionnaire and a learning implementation observation sheet. The learning interest questionnaire consisted of a pretest and a posttest using a Likert scale with five categories.. The learning interest questionnaire in this study consisted of

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20 statements, comprising 10 positive and 10 negative items. The indicators of learning interest were were adapted from Slameto (2010) which include: 1) interest; 2) attention; and 3) curiosity.

There are several stages used in this research, namely: 1) pretest of mathematical literacy skills and learning interest; 2) providing treatment using a RME approach and scientific approach; 3) posttest of mathematical literacy skills and learning interest; and 4) summarizing the research results. The research design is illustrated schematically in Table 1.

Table 1. Research Design

Class	**Pretest**	**Treat-ment**	**Posttest**
Exp	P_{E1}, A_{E1}	X	P_{E2}, A_{E2}
Control	P_{C1}, A_{C1}	Y	P_{C2}, A_{C2}

Description:

P_{E1} = Pretest of mathematical literacy in experiment class
P_{C1} = Pretest of mathematical literacy in control class
P_{E2} = Posttest of mathematical literacy in experiment class
P_{C2} = Posttest of mathematical literacy in control class
A_{E1} = Questionnaire of learning interest befor treatment in experiment class
A_{C1} = Questionnaire of learning interest before treatment in control class
A_{E2} = Questionnaire of learning interest after treatment in experiment class
A_{C2} = Questionnaire of learning interest after treatment in control class
X = Treatment for the experimental class, RME approach
Y = Treatment for the control class, scientific approach

The data analysis techniques employed in this study consisted of descriptive and inferential statistical analyses. The mathematical literacy test and the learning interest questionnaire were administered twice: pretest and after posttest. Both instruments were distributed to all students two class. Subsequently, several assumption test were conducted to ensure the validity of the multivariate analysis. These included: 1) a multivariate normality test was conducted using the Henze–Zirkler method; 2) a univariate normality test was performed using the Shapiro–Wilk test; 3) homogeneity of the covariance matrices was examined using Box's M test; and 4) homogeneity of variances was assessed using Levene's test. Furthermore, hypothesis testing was performed using MANOVA. This study examined 3 research hypotheses: 1) The RME approach proves effective in fostering mathematical literacy and learning interest; 2) the scientific approach likewise shows effectiveness in promoting these outcomes; 3) compared to the scientific approach, the RME approach exhibits higher effectiveness in terms of mathematical literacy and learning interest.

There are two criteria for effectiveness in the study, namely: 1) whether the average posttest score reaches the KKM, which is 70; and 2) whether the average learning interest questionnaire score reaches the high category, which is more than 56. All statistical analysis in this study were perfomed using a 5% level of significance ($\alpha = 0.05$). Further MANOVA testing was used if H_0 was rejected during hypothesis testing. The purpose is to track the average difference of each variable tested. Data analysis in this study was performed using the R

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software to support statistical calculations and ensure accurate interpretation of the findings.

RESULTS AND DISCUSSION

The results of the study indicated an increase in both mathematical literacy test scores and learning interest questionnaire scores from the pretest to the posttest. The descriptive analysis of these results is shown in Tables 2 and 3.

Data on the Table 2 shows that the average mathematical literacy score of the experimental class increased from 52.09 to 76.25, reflecting an improvement of 24.16 points. Similarly, the control class experienced an increased in the average score from 51.41 to 74.5 indicating a gain of 23.09 points. These results suggest that both the experimental and control classes demonstrated improvement in mathematical literacy following the instructional interventions.

Table 2. Data of Mathematical Literacy

Description	Experiment		Control	
	Before	After	Before	After
Ideal Max Value	100	100	100	100
Max Value	78	100	78	100
Ideal Min Value	0	0	0	0
Min Value	22	44	22	44
Average	52.1	76.3	51.41	74.5
Variance	202.6	190.3	180.9	210.3
St. Deviation	14.2	13.8	13.5	14.5

Table 3. Data of Learning Interest

Description	Experiment		Control	
	Before	After	Before	After
Ideal Max Value	80	80	80	80
Max Value	67	69	67	68
Ideal Min Value	20	20	20	20
Min Value	46	53	45	54
Average	56.1	61.5	54.4	61
Variance	23.1	19.1	23.6	17.1
St. Deviation	4.8	4.4	4.8	4.1

Based on data in the Table 3, the data show that the average learning interest score of students in the experimental class increased from 56.12 to 61.56, showing an improvement of 5.44 points. Likewise, the control class showed an increase in average learning interest from 54.44 to 61.03, representing a gain of 6.59 points. These results suggest that both the experimental and control classes demonstrated improvement in learning interest following the instructional interventions.

A. Normality Assumption Test

Normality test consists of multivariate and univariate normality test. The multivariate normality test was conducted as a condition of the Hotelling's T^2 test. This test was performed to determine whether all

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dependent variables followed a multivariate normal distribution within each group. Multivariate normality was assessed using the Henze–Zirkler test, while univariate normality was evaluated using the Shapiro–Wilk test to examine whether each variable was normally distributed. The results of the normality analysis are presented in Tables 4 and 5.

Table 4. Multivariate Normality

Variable	Henze Zirkler Test	
	Henze-Zirkler	p-value
P_{E1}, A_{E1} and	0.6373	0.1544
P_{C1}, A_{C1}	0.3453	0.7136
P_{E2}, A_{E2} and	0.3036	0.8149
P_{C2}, A_{C2}	0.5034	0.3413

Table 5. Univariate Normality

Variable	Shapiro-Wilk Test	
	SW	p-value
P_{E1}	0.9379	0.0651
A_{E1}	0.9669	0.4193
P_{C1}	0.9397	0.0737
A_{C1}	0.9783	0.7482
P_{E2}	0.9352	0.0548
A_{E2}	0.9608	0.2880
P_{C2}	0.9390	0.0699
A_{C2}	0.9501	0.1451

The results show that all variables have p-values > 0.05 this indicates the assumpsion of multivariate and univariate normality is met.

B. Homogenity Assumption Test

The homeneity test in this study consisted of two parts: the homogeneity of covariance matrix and the homogeneity of variances. The covariance matrix homogeneity test conducted using Box's M test, served as a prerequisite for the Hotelling T^2 test. This test assesses wheter the data groups originate from populations with equal variance-covariance structures. Meanwhile, Levene's test was used to evaluate the homogeneity of variances assumption, which is a prerequisite for perfoming the Two Independent Samples t-test. This analysis evaluates whether the variance within each group is statistically equivalent. The outcomes of bith homogeneity test are presented in Table 6 and Table 7.

Table 6. Homogenity Covariance Matrix

Description	Chi-sq value	p-value
Before	0.7556	0.86
After	0.4239	0.93

The decision criteria in the Box M test are H_0 is rejected if the $chi - sq > x^2_{0,05(3)}$ or 7.815 or H_0 is rejected if the p-value < 0.05. Based on the pretest data, the chi-sq value is 0.7556 < 7.815 (or p-value 0.86 > 0.05), so H_0 is not rejected. Accordingly, it can be inferred that the covariance matrix of the mathematical literacy pretest and learning interest for the experimental class is equivalent to that of the control class. Likewise, in the posttest data, the chi-sq value of 0.4239 < 7.815 (or p-value 0.93 > 0.05). Thus, H_0 is not rejected. Therefore, it can be concluded that the covariance matrices of the posttest scores in the experimental and control groups are equivalent.

Table 7. Homogeneity of Variance

Descrip-tion	Variable	Levene's Test	
		Levene's	p-value
Before	P_{E1} and P_{C1}	0.1151	0.7355
	A_{E1} and A_{C1}	0.0281	0.8674
After	P_{E2} and P_{C2}	0.1949	0.6604
	A_{E2} and A_{C2}	0.0389	0.8443

The decision criteria in Levene's test is H_0 rejected if the value of $F > F_{3,60(0,05)}$ or 2.759 or H_0 rejected if the p-value < 0.05. For the pretest of mathematical literacy, the F value is 0.1151 < 2.759 (or p-value 0.7355 >

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0.05). Thus, H_0 is not rejected. Therefore, it can be concluded that the population variances of the mathematical literacy pretest in the experimental and control groups are equal. Likewise, in other variables, the learning interest pretest variable obtained an F value of 0.0281 < 2.759 (or p-value 0.8674 > 0.05). Thus, H_0 is not rejected. Then, the mathematical literacy posttest variable obtained an F value of 0.1949 < 2.759 (or p-value 0.6604 > 0.05). Thus, H_0 is not rejected. Also, the posttest variable of learning interest obtained an F value of 0.0389 < 2.759 (or p-value 0.8443 > 0.05). Thus, H_0 is not rejected. Therefore, the data of mathematical literacy and learning interest are homogeneous.

C. Hypothesis Test

After the assumptions of MANOVA are met, the next hypothesis test is used to test the effectiveness of several dependent variables between several different groups univariately and multivariately.

1) Test of Differences in Initial Ability (Hotelling T^2)

Before conducting hypothesis testing, it is necessary to conduct the Hotelling T^2 test using pretest data first to determine whether the initial abilities of students in the experimental and control groups are equivalent. The results of the test comparing the mean initial abilities of the students are presented in Table 8.

Table 8. Differences in Initial Ability

Data	**Hotteling's T^2**	**p-value**	**Decision**
Pretest	1.6415	0.4401	H_0 accepted

The result show that the p-value = 0.4401 > 0.05, indicating that H_0 is accepted. This finding indicates that there is no statistically significant difference in the initial abilities of students in the experimental and control groups.

2) Learning Effectiveness Test (*One Sample t-Test)*

Learning is said to be effective if the posttest data of mathematical literacy and learning interest of the experimental and control class student obtain an average score 70 and more than 56. The effectiveness of learning in each class are presented in Tables 9 and 10.

Table 9. Experiment Class

Variable	**p-value**	**Decision**
Math Literacy	0.00764	H_0 rejected
Learning Interest	2.053e-08	H_0 rejected

Table 10. Control Class

Variable	**p-value**	**Decision**
Math Literacy	0.04418	H_0 rejected
Learning Interest	5.011e-08	H_0 rejected

The p-values for all variables are less than 0.05, H_0 is rejected. This result suggests that mathematics learning using the RME approach is effective in promoting mathematical literacy and learning interest. A comparable outcome is observed for the scientific approach, where p-values below 0.05 likewise support the rejection of H_0, indicating its effectiveness in improving both outcomes.

3) Test of Difference in Learning Effectiveness (Hotelling T^2)

The Hotelling T^2 test using posttest data was conducted to see which learning was more effective between the experimental or the control class. The results of the effectiveness of difference test is presented in Table 11.

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Table 11. The Effectiveness of Difference

Data	**Hotteling's T^2**	**p-value**	**Decision**
Posttest	0.43879	0.803	H_0 accepted

The result show that the p-value = 0.803 > 0.05, indicating that H_0 is accepted. The results indicate that there is no statistically significant difference in the post-instruction mean scores of mathematical literacy and learning interest between students taught using the RME approach and those instructed through the scientific approach. Because no significant difference was found between the experimental and control groups, further statistical testing to determine the more effective approach could not be conducted.

Grounded in the theoretical analysis and framework, the study advances the following hypotheses:

1. RME is Effective in terms of Mathematical Literacy and Learning Interest

According to the one-sample t-test results, the implementation of the RME approach enhances students' mathematical literacy and learning interest. Through its well-organized instructional phases, the approach supports active and autonomous student involvement in tackling contextual mathematical problems, thereby deepening conceptual comprehension and increasing motivation to learn.

Farida et al. (2019) stated that learning with the RME approach that pays attention to local conditions (culture, environment, or context) can make students not afraid to express their ideas, dare to help their peers solve different problems, and be more creative in working together to solve problems. The teacher acts as a facilitator, guiding students through directions and encouraging critical thinking so they can derive general principles. How far the teacher guides students depends on their abilities and the material being studied.

According to Gee (2019) the RME instructional approach contributes positively to students' learning development because it focuses on guiding learners to construct mathematical concepts while grounding the learning process in real-world situations. The RME approach will create a meaningful learning atmosphere and will improve students' problem solving skills. The RME approach also supports students in comprehending mathematical concepts and applying them to solve problems (Nugraheni & Marsigit, 2021).

2. Scientific is Effective in terms of Mathematical Literacy and Learning Interest

According to the one-sample t-test, the use of the scientific approach in teaching mathematics contributes positively to students' mathematical literacy as well as their learning interest. Haara (2022) stated that the scientific approach positively impacts mathematical literacy. Furthermore, Pratama et al. (2018) revealed that tis approach also contributes to an increase in students' learning interest.

The scientific stages encourage students to learn actively and independently in solving mathematical problems and increase learning interest. According to Nuralam and Eliyana (2017) the learning approach that gives more space to problem solving for students is the scientific approach. The scientific approach in learning directly plunges into the facts and realities that surround student learning so that what is produced really uses observation and analysis in practice (Aeni et al, 2017).

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The scientific approach is designed to foster students's conceptual understanding through active engagement with diverse sources of information. This method decentralized knowledge acquisition, allowing learners to explore and construct understanding beyond the confines of teachere-centered instruction, making learning a more autonomous and dynamic process (Musfiqon & Nurdyansyah, 2015). Research results Purba & Jailani (2023) also confirm that the scientific approach is effective in developing students' critical thinking, collaboration, and digital literacy skills. If students are used to engaging in scientific work, they will inherit these attitudes and values as an important part of their character development.

3. RME is not more effective than Scientific in terms of Mathematical Literacy and Learning Interest

According to the Hotelling T^2 test, the post-learning mean scores for mathematical literacy and learning interest were not significantly different between the RME and scientific approach groups. Given that the final ability data showed no statistically significant difference between the groups, additional testing with an independent samples t-test was not warranted. This suggests that students' mathematical literacy is not significantly different between the RME and scientific approach groups. Likewise, no meaningful difference was observed in students' learning interest across the two groups.

According to Mutmainah et al. (2023) Both the RME and the scientific approaches are based on constructivism and give students the chance to build their own mathematical literacy by asking them to solve problems and rediscover mathematical ideas and concepts. The comparable levels of students' mathematical literacy and learning interest under the RME and scientific approaches may be attributed to the substantial similarities in their instructional components, including problem solving, collaboration, group work, and active learning. Fundamentally, both approaches are structured to cultivate critical thinking and encourage collaborative problem-solving among students.

Therefore, based on the first and second research results, the RME and the scientific approach proved to be effective. Teachers have the flexibility to choose or combine learning approaches that suit the student's characteristics and the contextual demands of the subject matter. The effectiveness of these two approaches confirms that both approaches are able to facilitate the achievement of mathematical literacy and learning interest. However, the third finding indicated no significant difference in effectiveness, which may be influenced by factors such as teacher quality, the instructional media used, and the level of student engagement. Accordingly, future research is encouraged to examine how the RME and scientific approaches can be combined with technology-enhanced learning. The integration of technology may improve the learning experience by offering real-world visual representations, thereby facilitating more comprehensive analysis.

The originality of this research stems from its comparative analysis of two commonly implemented instructional approaches RME and the scientific particularly within the teaching of ratio topics at the SMP level, a context that has received limited

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attention in previous studies. However, this research also has certain limitations. Since the investigation was confined to one public SMP, the results should be generalized to other educational contexts. Morever, factors such as the short duration of intervention, possible differences in teacher delivery, and environmental conditions may have influenced the results. These limitations highlight the need for further research involving larger and more diverse samples, varied school contexts, and extended intervention periods.

CONCLUSIONS

The study findings lead to several conclusions: both the RME approach and the scientific approach are effective in terms of students' mathematical literacy and learning interest. However, in terms of mathematical literacy and learning interest, the RME approach does not demonstrate greater effectiveness compared to the scientific approach. The future study can examine the RME and scientific approaches integrated with technology in order to see the effectiveness of learning approaches that focus on mathematical literacy and learning interest.

Furthermore, future studies may involve larger samples, investigate long-term impacts, and explore othere cognitive and affective variables. Qualitative researusfiqonch is also recommended to better understand students' learning experiences during the implementatiton of both approaches.

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