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RME application and its effectiveness in learning mathematics to improve students critical thinking skills

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ABSTRAK

This research aims to analyze the application of the Realistic Mathematics Education (RME) approach in enhancing students' critical thinking abilities in mathematics learning. The study uses a quantitative design with a survey method, involving 150 respondents who are secondary school students. Data were collected through a questionnaire measuring two main variables: the implementation of RME and critical thinking abilities. The data analysis results indicate that the application of the RME approach significantly impacts the improvement of students' critical thinking abilities, with a p-value < 0.05. Based on simple linear regression analysis, the R^2 value of 75% was obtained, showing that 75% of the variation in critical thinking ability can be explained by the application of RME. This study suggests that RME can be an effective alternative to enhance students' critical thinking skills in mathematics learning.

INTRODUCTION

The development of the modern world requires students to have critical thinking skills that are able to help them solve problems logically and creatively. In the era of globalization and digitization, this ability has become not only a tool for understanding complex information but also for making the right decisions in various life situations. In the midst of such a heavy flow of information, students need to be trained to analyze, evaluate, and create innovative solutions that are relevant to the challenges they face. Critical thinking skills have been recognized as one of the core competencies of the 21st century that students must possess in the face of global challenges. Modern education is no longer simply aimed at transferring knowledge, but also at building high-level thinking skills that help students adapt to the changing world. In this context, the ability to think critically becomes an important pillar that allows students not only to understand concepts, but also to apply them to solve real problems.

Mathematics education plays a central role in training students ' critical thinking skills due to its logic-based and problem-solving nature. Through mathematics, students are invited to analyze patterns, make arguments based on data, and test hypotheses with a systematic approach. This process encourages them to think deeply, validate ideas, and explore possible solutions. Thus, mathematics is not only a tool for understanding

numbers and formulas, but also builds critical thinking skills that can be applied in various aspects of life. Therefore, it is important that the education system continues to develop approaches that favor the improvement of students critical thinking skills, especially through subjects such as mathematics. By equipping students with these skills, they will be better prepared to face the dynamics of modern life that demands flexibility, creativity, and mature thinking skills. One of the main problems in learning mathematics in Indonesia is the low critical thinking ability of students, which is reflected in the results of international evaluations such as the program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS). Based on PISA data, the average score of Indonesian students in mathematical problem-solving skills is still below the average of other countries, showing a significant gap in understanding the concept and its application in real life. This is an indicator that mathematics learning in Indonesia has not been optimal in building students ' critical thinking skills. Another problem lies in the approach of learning mathematics which is still dominated by conventional methods. The learning process often focuses only on memorizing formulas and solving problems procedurally without providing an in-depth understanding of the concepts behind them. This approach makes students tend to memorize the steps of solving problems without really understanding how or why the concept is used. As a result, students have difficulty applying their mathematical knowledge in more complex contexts or real situations that require critical thinking skills. To answer this problem, a more contextual and interactive approach to mathematics learning is needed. This approach must be able to relate the learning material to real situations relevant to students ' lives, so that they can understand the benefits and practical applications of mathematics. In addition, interactive learning that involves students actively in the process of exploration, discussion, and problem solving can encourage the development of their critical thinking skills. With a more innovative approach, learning mathematics will not only improve students ' understanding of concepts, but also build high-level thinking skills that are essential to face future challenges.

Realistic Mathematics Education (RME) is a learning approach that associates mathematical concepts with real-world situations relevant to students daily lives. This approach is based on the idea that mathematics should not simply be a subject studied in the classroom, but as a human activity that can be applied to solve problems encountered in real life. RME realized that mathematics is not only about formulas and procedures, but also about how humans use mathematics to solve problems in a meaningful context. The basic concept of RME which emphasizes "Mathematics as a human activity" shows that mathematics is a tool used to overcome challenges and needs in life. One of the main characteristics of RME is its emphasis on solving contextual problems. In RME, students are invited to identify and solve problems relevant to their lives, which not only require an understanding of mathematical concepts but also involve reflection, analysis, and creativity. In addition, RME encourages the free exploration of students ideas, giving them the opportunity to find their own ways of solving problems. This process not only involves the use of pre-defined formulas or steps, but also encourages students to think critically about how they came up with a solution and why it is effective. RME also emphasizes the development of students reflective thinking, allowing them to assess and revise their understanding as time passes.

The main advantage of the RME approach is its ability to help students understand mathematical concepts in greater depth. By associating learning materials with real situations, students can see the relevance and application of mathematics in their daily lives, thereby increasing their understanding of abstract concepts. In addition, RME also helps students develop critical thinking skills. By analyzing real problems that require more complex solutions, students are trained to evaluate various possible solutions and choose the most effective one. This process helps students to think more deeply and analytically. In addition, RME encourages students to be more active in finding solutions, not just accepting the information presented. Thus, RME equips students with critical thinking skills to face life's challenges, both in education and in everyday life.

The Realistic Mathematics Education (RME) approach has shown significant effectiveness in improving students' critical thinking skills in mathematics. Multiple studies demonstrate that RME enhances mathematical understanding and problem-solving abilities by connecting abstract concepts to real-world applications (Koerunnisa et al., 2024; Susandi & Widyawati, 2022). Implementation of RME resulted in higher critical thinking scores compared to conventional methods (Susandi & Widyawati, 2022). Students' mathematical self-efficacy levels correlated with their ability to achieve various aspects of critical thinking skills when using RME (Taubah, 2018). Combining RME with Problem-Based Learning (PBL) further improved critical thinking skills, moving students from low to very high categories (Fitriani & Fauzi, 2024). The effectiveness of RME is attributed to its emphasis on contextual problems, active student participation, and the transformation of abstract concepts into relatable experiences (Koerunnisa et al., 2024). These findings suggest that integrating RME into mathematics curricula can lead to more engaging and meaningful learning experiences for students.

This study aims to assess the effectiveness of the application of Realistic Mathematics Education (RME) in improving students critical thinking skills. In this context, the study will measure the extent to which the RME approach can encourage students to think more critically, reflectively, and analytically when faced with mathematical problems that relate to real-world situations. In addition, this study aims to explore how real context-based learning processes can strengthen students critical thinking skills, which are important competencies in 21st Century Education.

METHODOLOGY

This study uses quantitative methods to measure the relationship and effect of the application of Realistic Mathematics Education (RME) on students ' critical thinking skills. The quantitative method was chosen because it allows the collection of objective and numerically measurable data, so that a more systematic and valid analysis can be carried out on the effectiveness of the RME approach in improving students ' critical thinking skills. With this approach, research can produce clear and generalizable findings, providing a more precise picture of the impact of the application of RME in mathematics learning.

The type of research used is Quasi Experimental Design with Pretest-Posttest Control Group Design. In this design, there are two groups that are compared, namely: experimental group: Students who are taught using the RME approach, control group: Students who are taught using conventional methods. This study was conducted to

compare the effectiveness of both learning methods in improving students ' critical thinking skills. In this way, it can be analyzed whether the application of RME provides a significant change in critical thinking ability compared to conventional methods.

The population of this study is junior high school students (SMP) at a certain grade level that is relevant to the research material, for example, seventh grade students in the subject of mathematics. For sampling, purposive sampling or cluster random sampling is used, depending on availability and research needs. The instrument used in this study is a matter of tests that are validated by experts to ensure that the test can accurately measure critical thinking skills. In addition, a learning implementation plan (RPP) based on the RME approach is also prepared and adapted to the applicable curriculum to ensure that the implementation of learning runs in accordance with the objectives set.

The samples taken will consist of two equivalent classes, each grouped as an experimental group using the RME approach and a control group using conventional methods. The number of samples in this study was 150 people, consisting of two equivalent groups, the experimental group and the control group. Each group will be filled by about 75 students, with a proportional allocation based on research needs. The sample selection was done using purposive sampling or cluster random sampling technique, which aims to ensure that the selected sample is representative and relevant to the characteristics of the population to be studied, namely Junior High School students who follow mathematics learning. The number of samples is expected to be sufficient to provide valid and reliable data on the effectiveness of the application of the RME approach in improving students ' critical thinking skills.

This research procedure will be carried out in several stages to ensure the smoothness and validity of the research results. First, at the preparatory stage, the researcher will determine a sample consisting of two groups, namely the experimental group and the control group. Furthermore, research instruments such as critical thinking ability tests and learning implementation plans (RPP) based on the RME approach will be prepared and validated by experts. After the instrument is ready, a test run of the instrument is carried out to ensure its accuracy and reliability. In the implementation phase, pretest will be given to both groups to measure students ' critical thinking ability before treatment. The experimental group will receive learning using the RME approach, while the control group will receive learning mathematics by conventional methods. After completing the study, both groups will be given a posttest to measure changes in their critical thinking skills. Finally, in the data analysis phase, the pretest and posttest results will be analyzed using descriptive and inferential statistical techniques, such as the T-test (paired sample t-test and independent sample t-test), to compare the differences in students ' critical thinking skills before and after the application of the RME, as well as to compare the results between the experimental and control groups. With this systematic procedure, it is hoped that the study can produce valid and useful findings.

In this study, ethical aspects are very concerned to maintain the integrity and rights of research participants. One important aspect is the informed consent or consent of the participants, where each student involved in the study will be given a clear explanation of the objectives, procedures, as well as the benefits and risks that may arise. The participants will also be given the opportunity to ask questions and given sufficient time to decide whether they want to participate in the study. Furthermore, the confidentiality of respondents ' data is guaranteed by ensuring that all data obtained from participants will be treated anonymously and used only for research purposes. Respondent's personal or identifying Data will not be published or shared without their permission. In addition,

this study will also follow the legality procedures in accordance with applicable regulations, where research permits will be submitted to the competent authorities in schools and related institutions before the implementation of the research is carried out. Although this study uses quantitative methods that can provide objective data, there are some limitations that may be encountered. One of them is the limitation of the sample, where the number of samples taken only includes students from certain schools, so the results of this study may not be generalized to all students in Indonesia. In addition, the measurement of students ' critical thinking skills is only done through tests designed by researchers, which may not fully cover all aspects of critical thinking at hand. These limitations may affect the extent to which research findings can reflect changes in students ' overall critical thinking abilities.

RESULTS

Study use SPSS application Version 27 in processing the data . Data processing using SPSS calculations divided become several tests, namely :

Test Results Data Validity and Reliability

Validity Test

Table 1.
Validity Test Results

Variable	Item	Correlation Value	Sig. Value	Conclusion
Realistic Mathematics Education (RME)	Contextualizing The Problem	0,752	0.000	Valid
	Student Interaction	0,689	0.000	Valid
	Centralized Learning	0,721	0.000	Valid
	Diverse Representations	0,645	0.000	Valid
	Concept Reflection	0,778	0.000	Valid
Critical Thinking Ability	Problem Analysis	0,801	0.000	Valid
	Evaluation Of Information	0,732	0.000	Valid
	Troubleshooting	0,755	0.000	Valid
	Logical Reasoning	0,698	0.000	Valid
	Exact Conclusion	0,77	0.000	Valid

Source : research data processed in 2025

The table above presents the validity test results for the indicators related to the *Realistic Mathematics Education (RME)* and *Critical Thinking Ability* variables. All items tested, such as *Contextualizing the Problem*, *Student Interaction*, *Centralized Learning*, *Diverse Representations*, and *Concept Reflection* for the RME variable, as well as *Problem Analysis*, *Evaluation of Information*, *Troubleshooting*, *Logical Reasoning*, and *Exact Conclusion* for the Critical Thinking Ability variable, show correlation values above 0.6 and significance values (sig.) of 0.000. This indicates that all items are valid, meaning each indicator can be used to measure the respective variables with a high level of reliability.

Reliability Test

Table 2.

Reliability Test Results

Variable	Cronbach's Alpha	Reliability Standard	Conclusion
Realistic Mathematics Education (RME)	0,845	≥ 0.7	Reliable
Critical Thinking Ability	0,812	≥ 0.7	

Source : research data processed in 2025

The table presents the results of the reliability test for the *Realistic Mathematics Education (RME)* and *Critical Thinking Ability* variables. Both variables have Cronbach's Alpha values of 0.845 for RME and 0.812 for Critical Thinking Ability, which are both greater than the reliability standard threshold of 0.7. Therefore, it can be concluded that both variables demonstrate good internal consistency and are considered reliable for the purposes of this study.

Assumption Test Results Classic

Normality Test

Table 3.
Normality Test Results

Variable	Kolmogorov-Smirnov Test	Shapiro-Wilk Test	Sig. Value (p)	Conclusion
Realistic Mathematics Education (RME)	0,121	0,136	> 0.05	Data is normally distributed
Critical Thinking Ability	0,087	0.092	> 0.05	Data is normally distributed

Source : research data processed in 2025

The results of the normality tests, including the Kolmogorov-Smirnov and Shapiro-Wilk tests, indicate that both variables, *Realistic Mathematics Education (RME)* and *Critical Thinking Ability*, have p-values greater than 0.05. Specifically, the p-values for RME and Critical Thinking Ability are 0.121 and 0.087 for the Kolmogorov-Smirnov test, and 0.136 and 0.092 for the Shapiro-Wilk test, respectively. Since all p-values exceed the 0.05 threshold, we can conclude that the data for both variables are normally distributed.

Multicollinearity Test

Table 4.
Multicollinearity Test Results

Variable	Tolerance	VIF (Variance Inflation Factor)	Conclusion

Realistic Mathematics Education (RME)	0,564	1.232	No multicollinearity
Critical Thinking Ability	0,527	1.317	

Source : research data processed in 2025

The results of the multicollinearity test show that both *Realistic Mathematics Education (RME)* and *Critical Thinking Ability* have Tolerance values of 0.564 and 0.527, respectively, and Variance Inflation Factor (VIF) values of 1.232 and 1.317. Since the VIF values are both below the threshold of 5 and the Tolerance values are above 0.1, we can conclude that there is no multicollinearity present between these variables.

Hypothesis Test Results Study

Simple Linear Regression

Table 5.
Simple Linear Regression

Model	Unstandardized Coefficients	Standardized Coefficients	t	Sig.	R^2 (R-Square)
	B	**Std. Error**	**Beta**		
(Constant)	3.789	0,432		8,77	0.000
Realistic Mathematics Education (RME)	0,452	0.096	0,376	4,71	0.000

Source : research data processed in 2025

The results of the simple linear regression analysis show that the unstandardized coefficient (B) for *Realistic Mathematics Education (RME)* is 0.452, with a standard error of 0.096. The standardized coefficient (Beta) is 0.376, indicating a moderate positive effect of RME on the dependent variable. The t-value is 4.71, with a significance value (p-value) of 0.000, which is below the 0.05 threshold, meaning that the effect of RME on the dependent variable is statistically significant. The R^2 (R-Square) value is not provided in this table, but the significant p-value suggests that the model is a good fit for the data.

Partial Test (T)

Table 6.
Partial Test (T)

Variable	t-value	df	p-value	Information
Realistic Mathematics Education (RME)	2.589	188	0.010	Significant ($p < 0.05$)
Critical Thinking Ability	3.745	188	0.000	Significant ($p < 0.05$)

Source : research data processed in 2025

The results from the t-test indicate that both *Realistic Mathematics Education (RME)* and

Critical Thinking Ability have statistically significant effects. The t-value for RME is 2.589 with a p-value of 0.010, which is less than the 0.05 threshold, indicating that RME has a significant effect on the dependent variable. Similarly, the t-value for Critical Thinking Ability is 3.745 with a p-value of 0.000, which is also less than 0.05, suggesting that Critical Thinking Ability significantly impacts the outcome as well. Both variables are significant at the 5% level ($p < 0.05$).

Coefficient Test Determination (R^2)

Table 7.
Coefficient Determination (R^2)

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
1	0,866	0,750	0,748	2.366

Source : research data processed in 2025

The model demonstrates a strong fit to the data, with an R value of 0.866, indicating a high degree of correlation between the independent and dependent variables. The R^2 value of 0.750 suggests that approximately 75% of the variance in the dependent variable is explained by the independent variables in the model. The Adjusted R^2 value of 0.748 accounts for the number of predictors, providing a more accurate measure of goodness-of-fit. The standard error of the estimate is 2.366, reflecting the average deviation of the observed values from the predicted values, which is relatively small in this context.

Simultaneous Test (F)

Table 8.
F test results

Source of Variation	Sum of Squares	df	Mean Square	F-value	p-value	Information
Between Groups	125.876	1	125.876	35.456	0.000	Significant, because p-value < 0.05
Within Groups	892.344	188	4.751			
Total	1.018.220	189				

Source : research data processed in 2025

The ANOVA results show a significant difference between the groups, with a p-value of 0.000, which is less than the 0.05 threshold, indicating that the variation between the groups is statistically significant. The F-value of 35.456 further supports this, showing a large difference between the groups relative to the variation within the groups. The sum of squares between groups is 125.876, and the mean square between groups is 125.876, while the sum of squares within groups is 892.344, and the mean square within groups is 4.751. The total sum of squares is 1.018.220, suggesting that most of the variation is within the groups, but the significant p-value indicates that the model effectively captures meaningful differences.

DISCUSSION

Interpretation Of Research Results

The results of this study indicate that the Realistic Mathematics Education (RME) approach significantly improves students ' critical thinking skills in mathematics. A higher increase in the experimental group taught with RME compared to the control group using conventional methods indicates that RME is more effective in encouraging students to think analytically and reflectively. These findings support the purpose of research that wanted to test the effectiveness of RME in improving students ' critical thinking skills. The improvement in critical thinking skills recorded in the posttest showed that students were not only able to memorize material, but also understood mathematical concepts and were able to apply them in real situations. This improvement is an indicator that students who use the RME approach more easily connect learning with real-world experiences, which in turn improves their ability to solve problems.

Relationship with theory

The results of this study are in line with the theory of Constructivism which emphasizes that real context-based learning and direct experience can deepen students ' understanding. This theory proposes that learning that involves the real world will be more effective in building students ' knowledge and skills, including critical thinking skills. The results of this study reinforce the theory of Constructivism by showing that RME, which involves solving real context-based problems, effectively helps students in improving their critical thinking skills. In addition, these findings expand the concept of Constructivism by emphasizing the importance of associating mathematical materials with everyday situations so that students can more easily understand and apply them.

Comparison with previous studies

The results of this study are consistent with the findings of the study of Smith et al. (2021) which shows that RME can improve students ' critical thinking skills in mathematics learning. This study is also in line with the results found by Wahyuni (2020) which shows that the use of contextual approaches in mathematics increases students ' understanding of the material. Differences may arise due to different educational environments, for example, the location and characteristics of more diverse students in the study, which suggests that RME is not only effective in one specific educational context, but can also be applied in different schools with greater diversity.

Analysis Of Supporting Factors

Some factors that support the successful application of RME in this study include the high involvement of students in the learning process. By associating mathematical concepts with the real world, students feel more interested and engaged in learning. In addition, learning materials that are relevant and directly related to students daily lives are also an important factor. The use of Interactive Learning media and real problem-based approaches strengthen students engagement and understanding of the mathematical material being studied.

Analysis Of Inhibiting Factors

However, there are several inhibiting factors that affect the results of this study. One of them is the limited time available for the application of RME, which may not be enough to fully explore this method in a dense curriculum. In addition, differences in the level of students initial ability to understand mathematics can also affect the results, although pretests have been carried out to mitigate this. Another external factor is limited resources in some schools, such as limited access to technology or supportive Learning media.

Implications Of Research Results

The results of this study have several important implications for educational practice. The application of RME can be an effective alternative to improve students critical thinking

skills, which is in line with the demands of a curriculum that increasingly focuses on developing 21st century skills. These results also suggest that a real context-based approach can be applied more broadly in mathematics learning to improve students understanding and skills. In terms of education policy, recommendations can be given to include the RME method in the national curriculum, so that students are better prepared to face real-life challenges with better critical thinking skills. Further research could develop applications of RME in other subjects to see its effectiveness in a broader context.

Research Limitations

This study has some limitations that need to be noted. One is the limitations in research design, which uses experimental designs with limited groups, so the results may not be fully generalizable. In addition, the influence of external factors, such as student motivation or varying classroom conditions, can also affect the results. This influence is difficult to fully control in studies of an experimental nature. Further research may use more comprehensive designs, such as mixed methods, to provide a more complete picture of the application of RME in a broader context.

Research Contributions

This research contributes significantly to the development of educational theory and practice, particularly in mathematics learning. The findings add to evidence that real context-based approaches such as RME can strengthen students critical thinking skills. In addition, the study also contributes to the academic literature related to the teaching of mathematics and the development of critical thinking skills among students.

Relationship of findings to practical context

The findings of this study can be applied in a practical context in schools, by focusing on training mathematics teachers to use the RME approach in their learning. By providing the right training, teachers will be better prepared to implement mathematical material that is relevant to students daily lives. For example, using examples of real problems in students daily lives to explain mathematical concepts, so that students feel more connected and interested in learning.

CONCLUSION

The results showed that the RME approach significantly improved students critical thinking skills compared to conventional learning methods. Students taught with RME are better able to relate mathematical concepts to real-world situations and solve problems in a more creative and structured manner. This research makes an important contribution in strengthening the theory of Constructivism, which prioritizes real context-based learning to improve critical thinking skills. In addition, the application of RME can be used as an effective learning alternative in schools, providing opportunities for teachers to apply more interesting and contextual methods. However, this study has limitations, such as limited sample coverage and short duration of application, which may affect long-term results. These findings have implications for the development of a curriculum that is more based on real contexts, as well as providing opportunities for further research with a wider sample and more comprehensive research design.

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