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EFFECTIVENESS OF THE RME (REALISTIC MATHEMATICAL EDUCATION) APPROACH TO LEARNING ACHIEVEMENT IN VIEW OF STUDENTS' MATHEMATIC REASONING

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Abstract: This study is expected to collect objective information and analyze the potential differences in improving mathematical reasoning abilities between students taught using the Realistic Mathematics Education (RME) approach and students who received conventional learning. The research used a quantitative quasi-experimental method conducted at a public elementary school in Pacitan District. The results of this study indicate that the use of the Realistic Mathematics Education (RME) approach significantly improves students' mathematical reasoning abilities. In particular, students with high mathematical reasoning abilities experienced more significant improvements than those with medium and low mathematical reasoning abilities.

Keywords: Learning Outcomes, RME (Realistic Mathematic Education), Reasoning Ability

INTRODUCTION

Education is the initial step taken to enhance the knowledge and intellectual capacity of the nation, and it is a fundamental goal for the Republic of Indonesia. This principle is reflected in the preamble of the 1945 Constitution, which asserts that one of Indonesia's national objectives is to elevate the intelligence of the nation's life. Through education, the quality of individuals as human resources can be elevated, fostering a spirit of learning and the pursuit of knowledge to attain comprehensive understanding, which serves as a foundation for living within society.

Education is a fundamental need for every individual. It is a process aimed at developing human potential, assisting them in achieving maturity, and transforming behavior in a more positive direction (Atikah, N., Karjiyati, V., & Noperman, 2020)(Cheeseman, A., & Wright, 2019). Education involves a comprehensive effort that includes interconnected components (Diningrat et al., 2020)(Syaiputra Wahyuda Meisa Diningrat, Meyga Agustia Nindya, 2020). The success of education greatly relies on the effectiveness of the learning process. The learning process begins by creating a supportive environment for students.

Stimulate and guide students in learning activities (Astiti, Ni Putu Mia, 2017). Learning is a process of individual behavior change that takes place actively and integratively and continues in line with the psychological development of the individual (Hujjatusnaini, N., Corebima, A. D., Prawiro, S. R. & Gofur, 2022).

They gain knowledge of the process that will produce behavior. This is because the atmosphere is different daily; the problems encountered are various and depend on the available methods and facilities. In the learning process, the teacher and his students interact during the learning process so that students do not become objects but learning subjects (Pristiwanti et al., 2022). Mathematics is a science that must be known and understood by every individual. State that mathematics is a total science that forms the basis of every developing modern technology (Luh Catrining, 2018).

Mathematics and reasoning are things that can be separated from one another. This is because reasoning in mathematics can help reasoning skills (Aprilia et al., 2014). His ability to think logically in mathematics is called mathematical reasoning ability (Agusantia & Dadang Juandi, 2022). Mathematical reasoning is the ability to analyze, generalize, integrand, and provide an appropriate reason for solving a problem. (Mik Salmina, 2018) added an ability that includes looking for a problem relationship with an idea that can eventually solve this mathematical problem called mathematical reasoning. Students' ability in mathematical reasoning can be seen by taking measurements by giving them questions based on aspects of the reasoning itself, namely understanding meaning, thinking logically, being able to understand negative examples, carrying out a systematic, consistent thinking process, compiling reasons, determine the strategy used, carry out a deductive thinking process, determine the method and conclude the results (Annette et al., 2021).

This can be proven by the results of the TIMSS (The International Mathematics and Science Study) test in the mathematics category in 2019, in which Indonesia is still ranked 36th out of 38 countries taking the test. In line with the TIMSS statement, the results of mathematical reasoning in Indonesian students are still low, which is shown by the results of the research "Program for International Assessment (PISA)" (OECD, 2019), which states that Indonesia is in 73rd place out of 80 countries participating in average scores -Indonesia's average score is 379. This means that Indonesia still has a score far from the average of other OED members, namely at 489. the ad, edition, Wardani (in Hasanah, 2019: 3) explains that the questions listed in this PISA have demand for each participant to be able to have abilities in mathematical reasoning.

Looking at the real situation observed directly, it can be stated that students' ability to apply reasoning to mathematical concepts still faces significant challenges. The observations at SD Negeri in Pacitan Regency show that students' learning progress in mathematics subjects is still low, especially in understanding the concept of flat building. There was also a decrease in results in the computer-based national examination (UNBK) from 2020 to 2021, especially in indicators related to reasoning on the concept of flat wake. This challenge arises due to students' lack of understanding of mathematical concepts, which are more inclined to memorize formulas than to understand the core of the material. The impact of this is the difficulty students face when facing more complex math problems.

To improve student achievement, the right learning strategy is essential. The main focus is a mathematics learning approach that can optimize all students' potential. One solution to improve student achievement is to choose an appropriate learning approach, such as the Realistic Mathematics Education (RME) Approach. This approach is rooted in Freudenthal's view, in which mathematics is linked to reality, adapted to the student's experience, and relevant to everyday life. Research indicates that realistic approaches such as RME can improve mathematics learning outcomes. This approach is based on Freudenthal's view (Afriansyah, 2016), which underlines that mathematics should have ties to reality, approach the experience or world of learners, and be relevant to everyday life in society.

Research shows that realistic approaches can improve learning achievement, as evidenced by several studies (Fendrik, 2021). The influence of the Realistic Mathematics Education (RME) approach on students' mathematical reasoning abilities is examined, considering students' capabilities and the school level. The findings of this study reveal that the RME approach in learning can meaningfully improve students' mathematical reasoning skills better than groups of students who follow conventional learning methods. Research from (Lisa Oktapia, Syarifah Yunus, 2022), Application of RME (Realistic Mathematics Education) Approach in Improving the Quality of Mathematics Learning in Elementary Schools. The results of his research RME were successfully used because students felt faster to understand than just the lecture method and reading out the theory, which could cause them to be challenged to understand and quickly feel bored because only in class.

Research by (U. Ulfiana, Agustan Syamsuddin, 2022), The impact of the Realistic Mathematics Learning Model (RME) on the Mathematics Learning Outcomes of Grade IV Elementary School Students shows that students who use a realistic approach have better achieved an increased ability to understand mathematical concepts than students who receive a contextual approach. Research from (Widana, 2021), implementation of Realistic Mathematics Education (RME) to Improve Students' Ability to Solve Mathematical Problems in Indonesia. The findings of this study reveal an average effect of 0.42 in the moderate effect category. Evaluation of the Funnel Plot and Egger's test with a value of $z = 0.075$ and $p = 0.940 > 0.05$ showed no publication bias. Using the RME learning model moderately impacts students' ability to solve mathematical problems. The results of this study provide more robust support to the findings of previous studies. The result of (Dian Opinsi, 2022) showed that applying Realistic Mathematics Education (RME) learning could increase fifth-grade students' perseverance and knowledge achievement at SD Negeri 72 Pagaralam.

In addition, the lack of student achievement can also be caused by difficulties in learning mathematics, especially in solving mathematical problems. It is undeniable that students often fear or even hate mathematics because of its level of difficulty. This illustrates that they may not like the challenges of practicing math problems. Avoiding real math challenges can lead to more significant issues. Observations and interviews regarding fourth-grade math classes reveal that teachers frequently employ the question-and-answer method, supplemented with examples and explanations. Nevertheless, this knowledge's practical application appears less than optimal. One viable approach to enhance the learning process is 'Realistic Mathematics Education (RME)', a methodology that emerged from the Netherlands in 1970 under the auspices of the Fruedenthal Institute.

Realistic Mathematics Education (RME) is a teaching method that provides opportunities for students to investigate and develop mathematical concepts through real-life challenging situations presented by the educator (Abdul Majid, 2017). The use of the RME method has a more significant effect on students' achievement in mathematics compared to the conventional approach implemented in math classes (Ani Minarni, E. Elvis Napitupulu, 2020). When implementing RME as a teaching method, the learning process begins with discussing problems in context with students (Salmaini, S Fauzan, Ahmad and Arnawa, I Made and Darmansyah, Darmansyah and Widada, 2020).

These issues encompass situations present in real life and situations that students might only conceive (Afriansyah, 2016). Furthermore, it is expected that students can attain conceptual understanding through the development of their models (Khan & Mahmood, 2018), progressing from specifics to abstractions for problem-solving (Dove, Barca, Tummolini, & Borghi, 2020), as well as creating more engaging learning experiences for students (Hwa, 2018).

The Realistic Mathematics Education (RME) approach can also be made into an open material model to assist learning (Haji, 2020). RME empowers the student environment so students can carry out learning activities in the mathematics class according to their experience (Harapah, 2018). The Realistic Mathematics Education (RME) approach can improve various students' mathematical abilities, such as conceptual abilities (Fitri et al., 2021), critical thinking (Hajar et al., 2021), creative thinking problem solving (Utami & Ilyas, 2019), Reasoning (Norliyana, 2019). This approach can improve learning outcomes and student activities by presenting material according to everyday life (Budiono, C, Wardono, 2014).

Mathematics subjects cover various components such as calculations, data analysis, problem-solving, and critical thinking skills. In addition, mathematics also requires reasoning abilities, known as Mathematical Reasoning Ability. More than just proving or checking statements, this ability is vital in connecting and inferring intelligent systems. This is why having solid mathematical reasoning skills is crucial for students in facing the challenges of learning mathematics (Susanto, 2015).

Mathematical Reasoning Ability involves analyzing new situations, drawing generalizations, making assumptions, explaining concepts, and providing valid reasons to arrive at logical conclusions (Pahrudin et al., 2020. In addition, it states that mathematical reasoning involves the existence of mathematical objects (Qomariyah, 2017). This study includes innovation compared to previous studies. Researchers went further by exploring the effectiveness of RME in improving mathematical reasoning abilities. The focus of the research was fourth-grade students throughout the Pacitan District. The main objective is to identify differences in learning outcomes between students involved in the RME (Realistic Mathematics Education) approach and those engaged in the Conventional Approach. In addition, this study seeks to determine differences in student learning outcomes of high, medium, and low reasoning abilities and to determine the interaction between learning approaches and reasoning abilities.

METHODS

This study was conducted as an experimental study to assess the efficacy of implementing the Realistic Mathematics Education (RME) learning approach and conventional learning approaches, considering students' mathematical reasoning abilities. This study used a 2 x 3 factorial design with a two-way analysis of variance (ANAVA) technique. The research design can be seen in table 3.2 below:

Table 1. The Research Design

Reasoning Ability (B) / Learning (A)	Reasoning Ability (B)		
	High(B1)	Medium (B2)	Low (B3)
RME (A1)	A1B1	A1B2	A1B3
Konvensional (A2)	A2B2	A2B2	A2B3

Individuals in groups with characteristics that have a quantity with special characteristics are determined by researchers who aim to study (Sugiyono, 2015, 2017). The population is the subject of the overall research (Sekaran, Uma dan Bougie, 2017). Based on this description, the population is an object or subject with certain characteristics.

The population in this study were all fourth-grade students at SDN in Pacitan District, totaling 700 students from 35 elementary schools. Several samples from the 35 elementary schools were randomly selected for the study based on school test scores representing high, medium, and low mathematical reasoning abilities. The sample is part of the amount owned by the population (Sugiyono, 2019). In this study, 174 grade IV students at nine elementary schools in Pacitan were used as samples.

The selection of fourth-grade students is deemed appropriate due to their mathematical knowledge level and readiness to engage with materials or problems that require primary reasoning to comprehend the concepts. With the students' sense of responsibility already in place, fourth-grade classes were chosen for this research, involving two research groups, namely SDN 1 Sirnoboyo, SDN 1 Tambakrejo, SDN Arjowingangun, and SDN Bolosingo, totaling 87 students as the control group, receiving education based on the conventional approach. Meanwhile, SDN Banjarsari, SDN Menadi, SDN 02 Sedeng, SDN 02 Sedayu, and SDN Pucangsewu involved 88 students as the experimental group applying the Realistic Mathematic Education (RME) approach. In the context of this research, three categories of variables were identified: the independent variable, the moderator variable, and the dependent variable. The independent variable encompasses two types of teaching approaches: the Realistic Mathematic Education (RME) approach and the conventional one. The moderator variable in this study is the mathematical reasoning ability, while the dependent variable is the student's learning achievement. Data concerning learning achievement were collected through exams utilizing the fill-in-the-blank type of questions (C4). Data collection in this study was conducted through two methods, namely documentation and testing techniques. The documentation technique was used to gather data from various written sources, such as archives relevant to the research topic. The required documentation includes information about the students' names and initial ability test scores before administering the treatment. The purpose is to identify whether there are differences in students' mathematics learning outcomes before the treatment is applied.

According to (Sugiyono, 2019), a test is a measure obtained from a prior process. The process carried out in this test is conducted before and after implementing the approach treatment. Evaluation instruments that have undergone validation and reliability processes are used to collect data on the performance in understanding mathematics. This examination is given to two classes using the same tool. This action aims to obtain numerical information about students' capacity to visualize mathematical concepts. The obtained data will be processed to test the validity of the hypotheses proposed in the research.

The sample was selected using the Cluster Random Sampling method. Information was obtained from post-test evaluations of student learning achievements that had undergone a pilot test process and analyzed through assessments of open-ended questions, including assessments of reliability, validity, difficulty level, and discriminatory power. The data processing process was carried out by implementing a two-way analysis of variance (ANOVA) followed by the Scheffé test. The instruments used in this study were a test aimed at measuring mathematical reasoning abilities and an examination consisting of open-ended questions designed to evaluate students' mathematics learning achievements. The research method adopted in this study is a Quasi-Experimental research design with a 2 x 3 factorial approach. This research utilized a two-way analysis of variance (ANOVA) as the data analysis method. The research sample was obtained through the Cluster Random Sampling technique. The data collected originated from the post-test results of students' learning achievements, which had undergone a prior pilot testing process. Subsequently, this data was analyzed using open-ended question analysis, encompassing reliability, validity, difficulty level, and discriminatory power assessments. The gathered data was then subjected to a two-way analysis of the variance calculation method, and the Scheffe test was employed to identify significant differences among the compared groups.

One way to measure student learning success is through tests. According to (Dr. Sudaryono, 2018), a test is an instrument used to measure intelligence, knowledge, skills, abilities, or talents individuals or groups possess. The test used in this study was the class IV math test with semester 2 material.

RESULTS AND DISCUSSIONS

Research Data

1. Descriptive

Table 2. Learning Outcome Data with Learning Approach

Class	Amount of data	Min.	Maks.	Average
Eksperimen (RME)	87	65	91	78,85
Kontrol(Konvensional)	87	60	86	71,97

Table 1. shows that the number of students in the experimental class is 87, and the control class is 87. The practical class has a minimum score of 65 and a maximum score of 91. Meanwhile, the control class has a minimum score of 60 and a top score of 91. If you look at each class's average, the experimental class uses the RME (Realistic Mathematics Education), which has a higher average than the control class with a conventional approach.

2. Data on Learning Outcomes of the RME (Realistic Mathematical Education) Approach and the Conventional Approach in terms of Mathematical Reasoning Ability with High, Medium and Low Categories

Table 2. Description Data on Learning Outcomes of the RME (Realistic Mathematical Education) Approach and the Conventional Approach in terms of Mathematical Reasoning Ability with High, Medium and Low Categories

Class	Amount of data	Min.	Maks.	Average
RME-KPM High	33	75	89	80,45
RME-KPM Medium	23	69	74	71,61
RME-KPM Low	32	56	69	64,69
Konvensional-KPM High	33	72	86	77,34
Konvensional-KPM Medium	23	66	71	68,50
Konvensional-KPM Low	32	53	66	61,55

From Table 2. It can be seen that the average mathematical reasoning ability obtained through the Realistic Mathematics Education (RME) approach is 80.45, higher than the conventional approach, which reached 77.34. This applies across various categories, suggesting that the RME approach is more effective in improving learning outcomes than traditional approaches.

3. Initial Ability Data

Table 3. Ability Data

Class	The number of	Average Value *Pretest*	Standard Deviasi
Experiment (RME)	87	60,39	7,696
Control (Konvensional)	87	59,28	7,670

Table 3. The number of students in the initial ability in the experimental group is 87, and the control class is 87. It can be seen that the mean pretest score of the practical class is greater than that of the control class.

4. Initial Normality Test

Table 4. Deskripsi Initial Normality Test

	Learning	Statistic	Df	Sig.		
Value Pretes	Control (Conventional)	0,072	87	0,200	Ho accepted	Normal Distribution
	Experiment (RME)	0,071	87	0,200	Ho accepted	Normal Distribution

Based on Table 4. Above, the initial ability normality test shows the significance of the experimental group (RME) of 0.200 and the control group (conventional) of 0.200, where both show sig. >0.05.

5. Initial homogeneity test

Table 5. Homogenitas Varians *Levene's Test of Equality of Error Variances*

F	df1	df2	Sig.	Decision	Conclusion
0,005	1	173	0,944	Ho accepted	Homogenous

Based on Table 4 above, the significance value is 0.944, meaning the significance level is ≥ 0.05, so the variant value is homogeneous.

6. Balance Test

Table 6. T-Test Analysis Results Pretest Value Data

	F	Sig.	T	Df	Sig. (2- tailed)
Nilai Pretes *Equal variances assumed*	0,05	0,944	-0,956	173	0,340
Equal variancesnot			-0,956	172,989	0,340

Table 6. above shows that the t count is 0.956 with a significance value of 0.340, greater than 0.05, meaning that H0 is accepted.

The Result Hypothesis

1. Anava

The requirements for data analysis using parametric statistics are that the data obtained is normally distributed and homogeneous, so normality and homogeneity tests are carried out before the ANOVA test.

a. Normality

Normality Test of Mathematics Learning Outcomes with RME and Conventional Learning Approaches

Table 7. Normality Test of Mathematics Learning Outcomes with RME and Conventional Learning Approaches

	Statistic	Df	Sig	Information
Conventional	0,984	84	0,8289	Normal
RME	0,0,995	85	0,8351	Normal
Conventional; KPM Low	0,980	28	0,8279	Normal
Conventional; KPM Medium	0,971	21	0,8278	Normal
Conventional; KPM Low	0,979	29	0,8264	Normal
RME; KPM Low	0,981	29	0,8252	Normal
RME; KPM Medium	0,965	20	0,8285	Normal
RME; KPM High	0,978	30	0,8254	Normal
KPM Low	0,986	60	0,8276	Normal
KPM Medium	0,979	44	0,8212	Normal
KPM High	0,982	62	0,8246	Normal

Based on Table 6, if the consequence value for each group is more than 0.05, then H0 is accepted, connotation it is regularly distributed.

b. Homogeneity Test

Table 8. Homogeneity variances, *Levene's Test of Equality of Error Variances*

F	df1	df2	Sig.	Decision	Conclusion
1.825	1	172	.054	Ho accepted	Homogenous

Based on Table 7. The statistical results of the data, an F value of 1.825, are obtained with a significance level of 0.054, which is greater than the significance level of 0.05, so that H0 is accepted, meaning that the variance of the population is homogeneous. So, the homogeneous data requirement for hypothesis testing with two-way Anava has been fulfilled.

Considering the outcomes of the normality and homogeneity assessments, it can be deduced that the research dataset fulfilled the necessary conditions for conducting an Analysis of Variance, enabling the subsequent hypothesis testing using the Two-Way Anova method.

Table 9. Summary of Hypothesis Testing Results

Source	*Type IIISum of Squares*	Df	*Mean Square*	F	Sig.
Learning	416,655	1	416,655	32,103	0,000
Ability Reasoning	8005,492	2	4002,746	308,404	0,000
PP * KPM	0,009	2	0,004	0,000	1,000
Error	2193,431	169	12,979		
Total	10630,137	175			

From Table 8 and the two-way Anova hypothesis test output, it's evident that in the Between-Subjects Effects Tests, the F value is 32.103 with a significance of 0.000, surpassing the significance level of 0.05, leading to the rejection of Ho. Likewise, the test results for variations in high, medium, and low mathematical reasoning abilities yield an F value of 308.404 and a significance value of 0.000, rejecting H0 below the significance level of 0.05. However, the interaction test between learning approaches and mathematical reasoning abilities demonstrates an F value of 0.000 and a significance value of 1.000, exceeding the 0.05 significance level, confirming the acceptance of H0. This indicates no interaction between learning approaches and mathematical reasoning abilities on mathematics learning outcomes. In essence, the analysis results show a significant difference (F count = 32.103, $p = 0.000 < \alpha = 0.05$) in mathematics learning outcomes between students adopting the Realistic Mathematics Education (RME) approach and those following conventional methods.

The ANOVA follow-up test revealed distinctions in student learning outcomes between the RME and conventional approaches. On average, the RME approach surpassed the conventional one. These findings affirm the research hypothesis that the RME method leads to superior learning outcomes, as supported by real-world observations. The RME approach emphasizes practical learning integrated into students' lives, promoting active engagement and independent problem-solving. The research underscores that fostering self-constructed knowledge helps prevent forgetfulness. Linking mathematical learning to real-life contexts minimizes monotony, enhancing students' sustained interest and engagement. The statistical analysis with F count = 308.404 and significance value < 0.05 rejects H0, indicating differences in math outcomes among students with various mathematical reasoning abilities. Notably, the average outcomes of students with higher mathematical reasoning surpass those with moderate or low abilities.

The computed results, supported by mean values, reveal significant differences in mathematics learning achievements between students with solid and moderate to low mathematical reasoning skills. A comprehensive two-way ANOVA analysis suggests evident disparities in learning outcomes among students with varying mathematical reasoning abilities: high, moderate, and low. This follows the hypothesis that there is a difference between mathematical reasoning abilities with high, medium, and low categories. Students with high mathematical reasoning abilities can describe material or math problems so that problems in everyday life can be solved appropriately. In contrast to students with moderate or low mathematical reasoning abilities, changing material or math problems is difficult, so problem-solving is not optimal.

Rusmiati, 2022 supports this research), that the RME approach obtains better mathematical reasoning abilities than conventional approaches. Based on the two-way analysis of variance with the number of cells not the same, the F count value was 0.00 with a significance value of 1.000 > 0.05, indicating that H0 was accepted. This study concluded that there was no significant interaction between the learning approach and mathematical reasoning abilities on mathematics learning outcomes. At all levels of students' mathematical reasoning abilities (high, medium, low), the experimental group showed better learning outcomes than the control group, as seen in Table 8. These results align with research (Afriansyah, 2016), which shows no interaction between the learning approach and learning outcomes regarding students' mathematical reasoning abilities. Thus, it can be concluded that the mathematics learning outcomes of students using the RME approach are better than those using conventional approaches, especially when viewed from students' mathematical reasoning abilities.

Discussion

The results of hypothesis testing are indicated by the value of t-score = 3.627, which is greater than the t-table value = 1.65371. This suggests the presence of inequality between the achievement of students treated with the RME approach and the achievement of students treated with the conventional approach. This finding is reinforced by the fact that the Realistic Mathematics Education (RME) approach in mathematics instruction emphasizes its realism in students' daily lives. This means that students are actively engaged in the learning process, given the freedom to discover and understand problem-solving methods relevant to their everyday activities. (Afriansyah, 2016) also notes that students construct their understanding, implying that the knowledge acquired is less likely to be forgotten. The enjoyable learning atmosphere is created by employing real-life contexts that students face daily, preventing them from feeling bored while learning mathematics.

According to (Afriansyah, 2016), in Realistic Mathematics Education (RME), students are engaged in a process similar to how concepts are discovered. After engaging in this similar process (informal), students are directed towards formal mathematics learning. The students construct Knowledge actively in the classroom, making the learning process less monotonous. In classrooms using the RME approach, students show a greater desire to learn than the conventional approach during the learning process. When responding to presentations from other groups, the RME class is more critical in their approach. They actively participate in discussions, ensuring all group members understand the content outlined in the group worksheets.

According to (Tandailing, 2013), RME has more advantages than the conventional approach. The RME approach provides students with a more concrete and practical understanding of the connections between mathematics and everyday life and the widespread application of mathematics in various human contexts.

The RME approach has advantages in concrete and operational concepts for learners, providing various ways to solve problems or questions and emphasizing that solutions do not have to be unique and can differ among individuals. Furthermore, the RME approach combines the strengths of various other effective teaching approaches.

(Afriansyah, 2016) emphasized that the application of the RME theory in teaching is based on the principle of didactical phenomenology. This research demonstrates that implementing RME supports the natural process of students' mathematical understanding, aligning with educational values and utilizing phenomena emerging within students and their surroundings. The study also confirms that the principle of self-developed model development in RME implementation truly occurs in practice. In this research, students develop and formulate models they discover under the guidance of teachers, drawing from their knowledge and experiences. This encompasses a progression from informal solution models to more formal models, including mathematical models and formulas.

Based on the explanation above, it can be concluded that the findings of this research are in line with the existing theoretical foundation and are reinforced by the findings of previous studies. Therefore, it can be acknowledged that there is a significant difference in mathematical learning achievement between students who participate in learning using the Realistic Mathematic Education (RME) approach and those who follow the Conventional approach.

Considering that the calculated F value of 308.404 exceeds the critical F-table value of 3.05, it can be concluded that hypothesis H2 is accepted. Based on the considerations regarding mathematical reasoning abilities, the analysis of the results indicates a significant difference in mathematical learning achievement among students with high, moderate, and low levels of mathematical reasoning abilities. The results of the descriptive data analysis also depict that the average mathematical learning achievement of students with high mathematical reasoning abilities is higher than that of students with moderate mathematical reasoning abilities. Moreover, the average mathematical learning achievement of students with moderate mathematical reasoning abilities is also higher than that of students with low mathematical reasoning abilities.

The calculations' results are reinforced by inferential analysis, which indicates a significant difference in mathematical learning achievement among students with high, moderate, and low levels of mathematical reasoning abilities. After undergoing statistical analysis using a two-way ANOVA method, it can be summarized that there is a significant difference in mathematical learning achievement among the three groups of students based on their levels of mathematical reasoning abilities: high, moderate, and low.

From the observations, it can be concluded that students with high mathematical reasoning abilities can articulate the material or issues into mathematical notations, enabling them to solve everyday problems accurately. However, students with moderate or low mathematical reasoning abilities encounter difficulties transforming the material or problems into mathematical notation, ultimately impacting their ability to address problems effectively.

According to (Norliyana, 2019), mathematical reasoning plays a significant role in imparting meaning to mathematics, as it allows students to provide justifications for the mathematical conjectures they make. This explains that mathematical reasoning ability encompasses several indicators, including 1) Skill in proposing conjectures. 2) Skill in performing mathematical manipulations. 3) Ability to develop proofs or provide reasons supporting solutions. 4) Ability to infer from given statements. 5) Ability to examine the validity of arguments. 6) Ability to identify patterns or characteristics of mathematical phenomena for subsequent generalization (Harapah, 2018)

From the explanation above, it can be concluded that there is a significant difference in mathematics learning outcomes among students with high, moderate, and low levels of mathematical reasoning.

The results of the two-way analysis of variance involving an unequal cell size indicate that the recorded F value is 0.00. This value is lower than the critical F-table value of 3.05. From this, it can be concluded that hypothesis H3 cannot be accepted. This implies no significant interaction between the teaching approaches (RME and Conventional) and mathematical reasoning abilities (high, moderate, and low) that affect mathematics learning outcomes. These findings diverge from the initial expectations that assumed a significant influence of the teaching approach and mathematical reasoning abilities on mathematics learning achievement.

In the scope of this study, the moderating variable of mathematical reasoning ability did not succeed in strengthening the relationship between the teaching approach and mathematics learning achievement. The analysis results indicate that the interaction between the RME approach and the high level of mathematical reasoning ability consistently yields superior learning achievements compared to the moderate and low levels of mathematical reasoning ability. Similar patterns are observed in the interaction between the Conventional approach and the high level of mathematical reasoning ability, consistently producing better learning outcomes than the moderate and low levels of mathematical reasoning ability. Therefore, in both teaching approaches, the level of mathematical reasoning ability (high, moderate, or low) does not influence the enhancement of mathematics learning achievement differently.

CONCLUSION

Overall, this study concludes that the mathematics learning process for students using the Realistic Mathematical Education (RME) approach yields superior learning outcomes compared to students undergoing conventional instruction. Students with higher reasoning abilities achieve better mathematics learning scores than those exposed to traditional teaching methods. Furthermore, students with moderate mathematical reasoning abilities perform better than those with low mathematical reasoning abilities.

Realistic Mathematics Education (RME) provides better learning outcomes than conventional teaching methods in mathematics subjects. Students taught with the RME approach showed significant improvements in learning achievement. In addition, it was found that students with high thinking skills achieved higher math learning scores than those who followed conventional teaching methods. However, there is no clear correlation between the chosen learning approach and students' overall math learning outcomes, hinting at other factors contributing to individual learning outcomes. Thus, learning system and mathematical reasoning ability do not affect students' mathematics learning outcomes.

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