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THE INFLUENCE OF MATHEMATICAL UNDERSTANDING, REASONING, AND RESILIENCE ON MATHEMATICAL LITERACY OF JUNIOR HIGH SCHOOL STUDENTS IN KARIMUN REGENCY

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ABSTRACT
Mathematical literacy remains a significant concern among students in Indonesia, as reflected in low scores on international assessments such as PISA and TIMSS. This study aimed to examine the impact of mathematical understanding, reasoning, and resilience on the mathematical literacy of 100 8th-grade students in public junior high schools in Karimun Regency. A quantitative approach with a survey design was employed, and data were collected using validated questionnaires and tests. The data were examined using multiple linear regression approach. The results indicated a significant positive relationship between mathematical understanding, reasoning, and resilience on students' mathematical literacy. These findings highlight the need for comprehensive teaching strategies that integrate these three aspects to effectively enhance mathematical literacy. More varied teaching methods and strong support from educators are recommended to optimize students' mathematical literacy.

Keywords: Comprehension Ability, Mathematical Comprehension, Mathematical Literacy, Mathematical Reasoning, Mathematical Resilience

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INTRODUCTION

The importance of education in Indonesia is underscored by its fundamental role as a foundational pillar in developing high-quality, competitive human resources (Aritonang, 2017). Indonesia's Human Development Index (HDI) score of 71.92 in 2020 reflects significant progress in public welfare, which is directly linked to educational advancements (BPS, 2020a). However, despite this progress, significant challenges persist, particularly in certain geographic regions where educational quality continues to struggle to meet national expectations (BPS, 2020b). The Sustainable Development Goals (SDGs) set by the United Nations emphasize the critical importance of quality education for all, focusing particularly on ensuring equitable access to quality education (Sachs et al., 2023).

One of the critical areas in education that requires attention is mathematical literacy, an essential skill necessary for students' academic success and future careers. Mathematical literacy involves not only basic arithmetic skills but also the ability to understand, apply, and

interpret mathematical concepts in various real-life contexts (OECD, 2019). Unfortunately, international assessments such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) have consistently highlighted the low performance of Indonesian students in mathematics. For instance, the 2022 PISA report ranked Indonesia 73rd out of 79 participating countries in mathematical literacy, with an average score significantly below the OECD average (OECD, 2022). Similarly, TIMSS results from 2003 to 2015 have shown that Indonesia's performance in mathematics is consistently below the international average (Nizam, 2016). These findings indicate a pressing need for targeted educational policies that prioritize the enhancement of mathematical literacy among Indonesian students.

Mathematical literacy is not merely about mastering mathematical concepts; it also involves the development of reasoning and resilience in mathematics. The ability to reason mathematically and to persist in the face of mathematical challenges are essential skills that contribute to students' overall mathematical literacy (Kollosche, 2021; Henderson, 2003). Resilience in mathematics, in particular, enables students to overcome difficulties in learning mathematics and is crucial for their long-term academic success (Attami et al., 2020).

Given the importance of mathematical literacy, it is crucial to understand the factors that influence it, particularly in regions where educational outcomes are lower than the national average. This study focuses on the impact of mathematical understanding, reasoning, and resilience on the mathematical literacy of 8th-grade students in public junior high schools in Karimun Regency. This research seeks to provide insights into the simultaneous and partial effects of these variables on mathematical literacy. The findings are expected to contribute to the development of more effective teaching strategies and educational policies that enhance students' mathematical literacy, thereby improving their academic performance and future opportunities.

METHOD

The research employed a quantitative approach to investigate the impact of mathematical understanding, reasoning, and resilience on the mathematical literacy of 8th-grade students in public junior high schools within Karimun Regency. This study utilized a survey methodology to collect numerical data, allowing for statistical analysis and interpretation. The participants in this study were drawn from three public junior high schools in Karimun Regency, namely SMP Negeri 1 Meral, SMP Negeri 1 Karimun, and SMP Negeri 1 Meral Barat. These schools were selected to represent different geographical areas within the region, ensuring a diverse and representative sample. A total of 100 students were chosen through purposive sampling, targeting 8th-grade students to capture their mathematical abilities and attitudes at a critical stage of their education.

Data were collected using a combination of validated instruments, including multiple standardized tests and questionnaires. Mathematical Understanding was assessed through a standardized test designed to measure students' comprehension of key mathematical concepts relevant to the 8th-grade curriculum, with indicators developed by Febriyani et al. (2022). Mathematical Reasoning was evaluated using a separate test specifically designed to assess students' ability to apply logical thinking and problem-solving skills in mathematical contexts, utilizing indicators established by Iqbal (2015). To measure Mathematical Resilience, the study employed a questionnaire adapted from the work of Kooken et al. (2016), which used a Likert scale to assess the students' persistence and adaptability when confronted with mathematical challenges. Finally, Mathematical Literacy was evaluated through a comprehensive test that gauged the students' ability to apply their mathematical knowledge to real-world situations, aligning with the definition of mathematical literacy provided by the OECD (2019). This aspect of the study was measured using indicators developed by Nolaputra et al. (2018).

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The data collection process was conducted over a one-month period, with students completing the tests and questionnaires during school hours under the supervision of the researchers and trained assistants. This supervision ensured the reliability and accuracy of the data collected. The data collected from the tests and questionnaires were analyzed using multiple linear regression. Multiple linear regression analysis is used to determine the direction and how much influence the independent variable has on the dependent variable (Ghozali, 2018). This method was chosen to determine the extent to which mathematical understanding, reasoning, and resilience simultaneously and partially affect mathematical literacy among students. The analysis involved testing for assumptions such as normality, multicollinearity, and heteroscedasticity to ensure the validity of the regression model. The significance of the regression coefficients was evaluated to understand the strength and direction of the relationships between the variables. The results from the regression analysis were used to interpret how each variable (mathematical understanding, reasoning, and resilience) influences mathematical literacy and to provide recommendations for educational strategies that could enhance students' mathematical literacy effectively.

RESULT

Descriptive Analysis

The descriptive analysis provides an initial overview of the data collected, focusing on the levels of mathematical understanding, reasoning, resilience, and literacy among 8th-grade students in public junior high schools in Karimun Regency.

Table 1. Descriptive Analysis Scale

Scale Range	Interpretation
1,00 – 1,75	Poor
1,76 – 2,50	Not Good
2,51 – 3,25	Good
3,26 – 4,00	Excellent

Source: Sugiyono (2015)

Based on Table 1, the descriptive analysis scale range has a range of 1-4 ranging from poor to excellent. This scale is used as a conclusion of the results based on the frequency of data that often appears (mode). The greater the mode value produced, the higher the general picture of the respondent's understanding will be in the category. The results of the descriptive analysis as presented in Table 2 indicate that students generally exhibited a moderate level of proficiency across these domains.

Table 2. Results of the Descriptive Analysis

Variable	Mode	Interpretation
Mathematical Understanding	2	Not Good
Mathematical Reasoning	2	Not Good
Mathematical Resilience	3	Good
Mathematical Literacy	3	Good

As shown in Table 2, the mode scores suggest that students generally have a Not Good level of mathematical understanding and reasoning, indicating some challenges in fully grasping mathematical concepts and effectively applying logical thinking. However, their resilience and literacy are rated as Good, reflecting a strong ability to persevere through challenges and apply their mathematical knowledge in various situations. These findings highlight the importance of targeted educational interventions to improve students'

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mathematical understanding and reasoning, while also leveraging their strengths in resilience and literacy to further enhance their overall mathematical skills.

Validity and Reliability Testing

Validity testing was conducted by distributing questionnaires to 30 randomly selected 8th-grade students, with data analysis performed using SPSS. Out of the 46 indicators tested, all were confirmed as valid, as indicated by r-values greater than the critical r-value of 0.361 at a 5% significance level. Based on the validity testing, All indicators show r-values exceeding the r-table value, confirming the validity of each item.

The reliability test results indicate that the Cronbach's Alpha values for each variable—mathematical understanding, mathematical reasoning, mathematical literacy, and mathematical resilience—exceed 0.6. This confirms that all items in the questionnaire demonstrate good consistency in responses from the participants, indicating that the data collected is reliable.

Classic Assumption Test Results

Before conducting the multiple linear regression analysis, it is crucial to ensure that the data meets the classic assumptions required for a valid regression model. The classic assumption tests conducted in this study included tests for normality, multicollinearity, and heteroscedasticity. The normality test was conducted using the One-Sample Kolmogorov-Smirnov test to determine whether the residuals from the regression model were normally distributed. The results of the normality test are shown in Table 3.

Table 3. Normality Test Result

Asymp. Sig. (2-tailed)	**Interpretation**
0,200	Normal

Based on Table 4.5, the significance value obtained was 0.200, indicating that the residuals are normally distributed. Therefore, the normality assumption for the regression model in this study is fulfilled. The results of the multicollinearity test are presented in Table 4. This test was performed to check for high correlations among the independent variables by examining the Variance Inflation Factor (VIF) and Tolerance values.

Table 4. Multicollinearity Test Results

Variable	Tolerance Value	VIF	Interpretation
Mathematical Understanding	0,567	1,764	No Multicollinearity
Mathematical Reasoning	0,506	1,976	No Multicollinearity
Mathematical Resilience	0,713	1,402	No Multicollinearity

Based on Table 4, all variables have VIF values below 10 and Tolerance values above 0.1, indicating that there is no multicollinearity problem among the independent variables. Thus, the multicollinearity assumption is met. The results of the heteroscedasticity test are shown in Figure 1. This test was conducted by analyzing the scatterplot of the residuals to examine whether there is a constant variance in the residuals across all levels of the independent variables.

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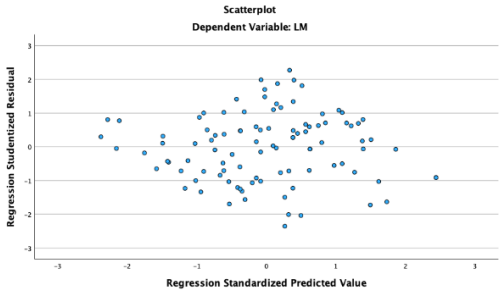

Figure 1. Heteroscedasticity Test

Based on Figure 1, the scatterplot shows that the points are scattered above, below, and around zero without forming any specific pattern, such as waves, widening, or narrowing. This indicates that there is no clear pattern of heteroscedasticity, confirming that the data in this study do not suffer from heteroscedasticity issues. In conclusion, the data used in this study meets all the necessary assumptions for conducting a valid multiple linear regression analysis. This ensures that the regression results are reliable and interpretable for understanding the influence of mathematical understanding, reasoning, and resilience on mathematical literacy among 8th-grade students in Karimun Regency.

Model Feasibility Test Results

The feasibility of the regression model in this study was evaluated using several tests, including the Coefficient of Determination (R^2) test, F-test (Simultaneous Significance), and t-test (Partial Significance). These tests help determine the suitability and validity of the model for predicting the influence of independent variables on the dependent variable.

The Coefficient of Determination, denoted as R^2, indicates how much variation in the dependent variable can be explained by the independent variables in the model. An R^2 value closer to 1 suggests that the model explains a high proportion of the variance. The results of the R^2 test are shown in Table 5.

Table 5. Coefficient of Determination (R^2) Test Results

R	R-Square	Adjusted R-Square	Std. Error of the Estimate
0,815	0,665	0,654	4,69353

Based on Table 5 the adjusted R-Square value is 0.654. This means that 65.4% of the variability in mathematical literacy can be explained by the mathematical understanding, reasoning, and resilience variables. The remaining 34.6% (100% - 65.4%) is explained by other factors not covered in this study. Next, The F-test is used to examine the effect of mathematical understanding, mathematical reasoning, and mathematical resilience simultaneously on mathematical literacy. The results of the F-test are presented in Table 6.

Table 6. F-Test Results

	Sum of Squares	df	Mean Square	F	Sig.
Regression	4193,438	3	1397,813	63,453	<.001
Residual	2114,802	96	22,029		
Total	6308,240	99			

Based on Table 6, F-test result shows a significance of <0.001 and an F-calculated value of 63.453, which is greater than the F-table value of 2.70. The significance value is less than 0.01, and the calculated F-value is greater than the F-table value, indicating that mathematical understanding, mathematical reasoning, and mathematical resilience simultaneously have a

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significant effect on mathematical literacy. Thus, H_4 is accepted. Next, The t-test is used to examine the effect of mathematical understanding, mathematical reasoning, and mathematical resilience individually on mathematical literacy. The results of the t-test can be seen in Table 7.

Table 7. t-Test Results

Variable	t-calculated	t-table	Sig.	Status Hipotesis
Mathematical Concept Understanding	4,937	1,985	<0,001	Accepted
Mathematical Reasoning	7,801	1,985	<0,001	Accepted
Mathematical Resilience	9,409	1,985	<0,001	Accepted

Based on Table 7, mathematical understanding, mathematical reasoning, and mathematical resilience have a significant partial effect on mathematical literacy, as indicated by the t-calculated values (4.937, 7.801, and 9.409) being greater than the t-table value (1.985) and significance values of less than 0.001. Therefore, the hypotheses for each independent variable (H_1, H_2, dan H_3) are accepted. In conclusion, the results of the R^2, F-test, and t-test confirm the feasibility and validity of the regression model used in this study. The model demonstrates good explanatory power, and each independent variable significantly contributes to predicting mathematical literacy among 8th-grade students in Karimun Regency.

Regression Analysis Results

The multiple linear regression analysis was conducted to determine the influence of mathematical understanding, mathematical reasoning, and mathematical resilience on mathematical literacy among 8th-grade students in Karimun Regency. The regression results provide insights into the relationships between the independent variables and the dependent variable, as well as the strength and direction of these relationships. The results of the multiple linear regression analysis are shown in Table 8.

Table 8. Multiple Linear Regression Test Results

Variabel	Unstandard-ized B	Coefficients std. Error	Standardized Coefficient Beta	t	Sig.	Collinearity Statistics	
						Tolerance	VIF
(Constant)	-36,641	4,780		-7,665	<0,001		
Mathematical Concept Understanding	0,754	0,153	0,388	4,937	<0,001	0,567	1,764
Mathematical Reasoning	1,911	0,245	0,648	7,801	<0,001	0,506	1,976
Mathematical Resilience	0,376	0,040	0,658	9,409	<0,001	0,713	1,402

Based on Table 4.10, the multiple linear regression equation can be formulated as follows:

$$Y = -36{,}641 + 0{,}754X_1 + 1{,}911X_2 + 0{,}376X_3$$

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Description:
Y = Mathematical Literacy
X_1 = Mathematical Understanding
X_2 = Mathematical Reasoning
X_3 = Mathematical Resilience

The constant of -36.641 indicates that if the values of Mathematical Understanding (X_1), Mathematical Reasoning (X_2), and Mathematical Resilience (X_3) are zero or have no effect, the value of the outcome variable (Y) would be -36.641 at a certain confidence level.

Mathematical Understanding (X_1) has a regression coefficient of 0.754, which is positive, indicating a positive relationship between Mathematical Understanding and the dependent variable (Y). This means that for every 1-unit increase in Mathematical Understanding, the value of Y will increase by 0.754, assuming other variables remain constant.

Mathematical Reasoning (X_2) also has a positive regression coefficient of 1.911. This coefficient shows that there is a positive relationship between Mathematical Reasoning and Y. Thus, for every 1-unit increase in Mathematical Reasoning, the value of Y will increase by 1.911, assuming other variables remain constant.

Mathematical Resilience (X_3) has a regression coefficient of 0.376, which is positive as well. This indicates a positive relationship between Mathematical Resilience and the dependent variable (Y). Therefore, for every 1-unit increase in Mathematical Resilience, the value of Y will increase by 0.376, assuming other variables remain constant. Overall, the regression analysis shows that all three independent variables—Mathematical Understanding, Mathematical Reasoning, and Mathematical Resilience—have a significant positive effect on Mathematical Literacy among the students. This suggests that enhancing these aspects could lead to better mathematical literacy outcomes for students in educational settings.

DISCUSSION

The findings of this study offer significant insights into the factors influencing mathematical literacy among 8th-grade students, particularly focusing on the roles of mathematical understanding, reasoning, and resilience. The analysis confirms the positive and significant effects of these variables on mathematical literacy, providing a comprehensive understanding of how these cognitive and affective factors contribute to students' mathematical competencies.

Mathematical Understanding and Mathematical Literacy

The results of the regression analysis show that Mathematical Understanding has a positive and significant effect on Mathematical Literacy, with a regression coefficient of 0.754 and a p-value of less than 0.001. This finding aligns with prior research emphasizing the importance of mathematical understanding as a predictor of mathematical literacy (Pratiwi, 2024; Zuhri et al., 2024). Mathematical understanding involves the ability to classify objects based on their properties, represent concepts in various ways, and apply these concepts in problem-solving, which are crucial for enhancing mathematical literacy. Students with a robust understanding of mathematical concepts demonstrate superior problem-solving abilities in real-life scenarios, an essential component of mathematical literacy (Katrancı & Şengül, 2019). This underscores the need for educational strategies that prioritize conceptual understanding to improve students' literacy in mathematics.

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Mathematical Reasoning and Mathematical Literacy

Mathematical Reasoning has the highest regression coefficient among the independent variables, at 1.911, and a p-value of less than 0.001. This suggests that reasoning skills are the most critical factor influencing mathematical literacy. The significance of this relationship highlights the critical role that reasoning plays in the development of mathematical literacy (Aqillah, 2023). Mathematical reasoning encompasses the ability to analyze, solve problems, and apply logical thinking in complex situations, which significantly enhances students' capacity to understand and apply mathematical concepts in everyday life (Norhidayah, 2023). This finding supports the notion that fostering mathematical reasoning is crucial for equipping students with the skills needed to navigate mathematical challenges effectively (Supianti et al., 2022). The emphasis on reasoning from an early stage in education can lay a strong foundation for students to excel in mathematical tasks and transfer their knowledge across various contexts, thereby improving their overall mathematical literacy (Kabael & Baran, 2023).

Mathematical Resilience and Mathematical Literacy

The regression analysis also reveals that Mathematical Resilience has a positive and significant effect on Mathematical Literacy, with a regression coefficient of 0.376 and a p-value of less than 0.001. Mathematical resilience, defined as the ability to persist and overcome challenges in learning mathematics, plays a crucial role in enhancing mathematical literacy (Fembriani et al., 2023). Students with high mathematical resilience are better equipped to stay focused and not give up when faced with difficult mathematical problems, which ultimately improves their ability to understand and apply mathematical concepts in real-world situations (Yusmi, 2024). This finding emphasizes the importance of cultivating resilience in students as a way to foster positive attitudes toward mathematics and improve their mathematical literacy. The role of educators in promoting mathematical resilience is crucial, as effective teaching methods, such as realistic mathematics education, have been shown to positively impact students' mathematical literacy levels (Tambunan, 2021).

Simultaneous Effects of Mathematical Understanding, Reasoning, and Resilience on Mathematical Literacy

This study shows that Mathematical Understanding, Mathematical Reasoning, and Mathematical Resilience simultaneously have a significant effect on Mathematical Literacy among students. Based on the results of the multiple linear regression analysis, these three variables together have a significant impact on mathematical literacy, with a Coefficient of Determination (R^2) value of 0.665 and an adjusted R-Square of 0.654. This means that 65.4% of the variance in students' mathematical literacy can be explained by the combined effects of mathematical understanding, reasoning, and resilience, while the remaining 34.6% is influenced by other factors outside the model. This result highlight the importance of an integrated approach to mathematics education that incorporates these elements (Fembriani et al., 2023). The simultaneous influence of these factors underscores the need for comprehensive educational practices that not only address the cognitive aspects of learning mathematics but also support students emotionally and mentally to build resilience. This holistic approach is essential for developing well-rounded mathematical proficiency in students, enabling them to apply mathematical concepts confidently and resiliently in real-world scenarios (Miraj et al., 2021).

CONCLUSION AND SUGGESTIONS

Based on the results, the conclusion drawn is that there is a significant positive influence of mathematical understanding on mathematical literacy, indicating that better comprehension of mathematical concepts enhances students' ability to apply mathematics in real-life contexts.

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Mathematical reasoning also significantly contributes to mathematical literacy, with students who can logically reason and connect mathematical concepts displaying higher literacy levels. Additionally, mathematical resilience positively impacts mathematical literacy, as students who demonstrate persistence in overcoming mathematical challenges tend to have better mathematical literacy. The simultaneous influence of mathematical understanding, reasoning, and resilience highlights that a holistic approach, strengthening all three aspects, positively impacts students' mathematical literacy.

The suggestions from this study include focusing on educational strategies that simultaneously develop mathematical understanding, reasoning, and resilience. Teachers should employ teaching methods that not only reinforce conceptual knowledge but also encourage logical thinking and persistence in the face of challenges. By doing so, students will be better equipped to achieve higher levels of mathematical literacy, which is crucial for their academic success and practical application of mathematics in everyday life.

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