(JIML) JOURNAL OF INNOVATIVE MATHEMATICS LEARNING
Volume 8, No. 3, September 2025
P-ISSN 2621-4733
E-ISSN 2621-4741
https://dx.doi.org/10.22460/jiml.v8i3.p23932

THE RELATIONSHIP BETWEEN MATHEMATICAL REASONING ABILITY AND SELF-EFFICACY ON JUNIOR HIGH SCHOOL STUDENTS

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ARTICLE INFO

Article history:

Received Jul 05, 2024
Revised Mar 19, 2025
Accepted Apr 07, 2025

Keywords:

Mathematical Reasoning Ability
Self-Efficacy
Junior High School

ABSTRACT

This research is motivated by the significance of mathematical reasoning in problem solving, while self efficacy is considered to influence its development. The objective of this study is to the level of mathematical reasoning ability and self efficacy while also investigating the relationship between these two variables in SPLDV material. The study employs a quantitative approach with a correlational design. The research participants numbered 32 people from class VIII at a junior high school in Karawang Regency. Data collection was done using a mathematical reasoning ability test and a self efficacy questionnaire, both of which were analyzed through descriptive and inferential statistics. The descriptive analysis provides an overview of students mathematical reasoning ability and self efficacy levels, while the inferential analysis applies the Pearson Product Moment correlation test to determine the relationship between the two variables. The descriptive analysis revealed that the average score for students mathematical reasoning ability was 40.63, lacing it in the moderate category, indicating that not all indicators of mathematical reasoning were well achieved. The average self efficacy score was 86.34, which also falls within the moderate range. The inferential analysis showed a strong and significant relationship between mathematical reasoning ability and self efficacy, with a correlation coefficient value of 0,803 and Sig.(2-tailed) = 0,000 where 0,000 < 0.05. This reveals the greater the students self efficacy, the better their ability in mathematical reasoning.

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How to Cite:

Sari, L. M., Sumarmo, U., & Supriatna, T. (2025). The Relationship Between Mathematical Reasoning Ability and Self-Efficacy on Junior High School Students. *JIML*, 8(3), 306-314.

INTRODUCTION

The objective of mathematics education in schools is to equip students with skills in logical, analytical, systematic, critical, creative, and generalization thinking (Nababan, 2020).

According to Permendikbud Regulation Number 58 of 2014 regarding Junior High School (SMP) and Madrasah Tsanawiyah (MTs), it is stated that the goals of mathematics education include performing mathematical operations to make generalizations, using reasoning in patterns and properties, and developing proofs or explaining mathematical concepts and statements. Reasoning is one of the skills that should be nurtured in mathematics education. In this context, the goal of mathematics learning is for students to enhance their mathematical reasoning abilities, which are crucial for problem solving (Nababan, 2020).

Mendrofa (2021) expressed that the capacity to reason mathematical is the starting point for students in solving mathematical problems because, through good reasoning, students can draw logical conclusions. This capability enables students to grasp mathematical concepts more deeply and also fosters critical thinking and systematic problem solving. Furthermore, Romadhina, et al*.,* (2019) explained that mathematical reasoning is not just memorizing facts, rules, or procedures for solving problems, but also allows students to connect the concepts they have learned and apply them in broader situations. Thus, mathematical reasoning plays a role in building meaningful learning.

According to Bieda, et al., (2014), mathematical reasoning helps students understand the ideas and concepts underlying a problem solving procedure. Thus, when students develop mathematical reasoning, they not only memorize formulas and procedures but also understand the concepts behind them. Therefore, one can conclude that reasoning ability is of great importance.

In reality, although reasoning ability is important, students in Indonesia still have low reasoning ability. This is demonstrated by the 2011 Trends in International Mathematics and Science Study (TIMSS), which reported that Indonesia ranked 38th out of 42 countries in eighth grade, with an average score of 386. This represented a decline from the 2007 TIMSS results, where the average score was 397. Based on the data from the 2011 TIMSS report, the percentage of students' mathematical ability passing in Indonesia was knowing (37%), applying (23%), and reasoning (17%). Where specifically reasoning ability is 17%, which turns out that this percentage is very far below the average international passing percentage of 30% for reasoning (Fauziah, et al., 2021).

This condition is also reinforced by various studies showing that understudies mathematical reasoning abilities are still relatively low (Aprilianti & Zanthy, 2019; Rohmah, et al., 2020). This is influenced by several factors such as students not having ideas in solving problems, difficulty in understanding problems and students not understanding the formulas used in resolving mathematical issues (Asari, et al., 2022). Students are more accustomed to solving routine problems than non-routine ones. In addition, students also often have difficulty translating problems into mathematical models and are less careful in reading and understanding the meaning of the problem (Septian, et al., 2021).

Learning success does not only depend on cognitive abilities but also affective aspects such as self efficacy. According to Nurussalamah & Marlina (2022), in addition to mathematical reasoning abilities, students also need to have effective aspects that can support their success in solving problems, self efficacy is one of them. Self efficacy plays a role in learning by building students self confidence in completing academic tasks. This trains students to be certain in their capacities, set out to confront challenges, not allow up easily in solving problems and identify their shortcomings and weaknesses (Sajiman & Hasbullah, 2021). In this case, whether or not students can solve problems that measure reasoning abilities depends on how much confidence the student has in solving the problem. Self-efficacy can influence someone to get the desired results.

Previous studies have shown that self efficacy influences mathematical reasoning ability. Hadiat & Karyati (2019) emphasized that self efficacy is a key factor in achieving success in learning. This finding aligns with the study executed by Umaroh, et al., (2020), which found that self efficacy positively and significantly influences students mathematical reasoning abilities, with a coefficient determination of 8.11%. This means that an increase or decrease in students mathematical reasoning ability can be explained by self efficacy by 8.11%, while other factors influence 91.89%. Bandura (Himmi, 2017) also emphasized that self efficacy serves as the foundation for a persons decision-making process, influencing how determined they are to perform an activity and their persistence in overcoming challenges. The greater a persons self efficacy, the greater his efforts, perseverance and flexibility. In mathematics, there are many application problems related to everyday life, including SPLDV, the solution of which requires good reasoning to translate complex problems and self efficacy so that students are confident and do not give up easily.

This study aims to examine whether a correlation exists between junior high school students mathematical reasoning abilities and their self efficacy.

METHOD

This study employs a quantitative approach with a correlational design, which aims to analyze the relationship between two variables namely mathematical reasoning ability and self efficacy. Correlational research is conducted to examine the relationship and the strength of the connection between two or more variables, without attempting to influence or manipulate them (Tanjung, 2022). In this study, self efficacy acts as the independent variable (X), while the mathematical reasoning ability of the students is the dependent variable (Y).

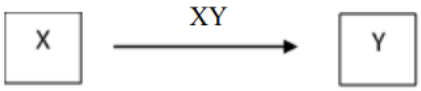

Figure 1. Research Design

Variable X: Self-Efficacy
Variable Y: Mathematical Reasoning Ability

The research participants numbered 32 people from class VIII at a junior high school in Karawang Regency. The sampling technique applied was probability sampling, specifically simple random sampling. This approach ensures that each member of the population has an equal likelihood of being chosen. According to Sugiyono (2018), this technique is suitable for choosing sample members randomly from the entire population, without regard to any subgroups.

The research used two types of instruments, which were test questions and questionnaires. Test questions to measure mathematical reasoning ability with SPLDV material were adopted from Alwi (2020) and questionnaires to measure students self efficacy were adopted from the book by Hendriana, Rohaeti, & Sumarmo (2017). The data analysis in this research involved both descriptive and inferential analysis. Descriptive analysis provides a general understanding of the mathematical reasoning ability and self efficacy levels of the students. Meanwhile, inferential analysis was performed using the pearson product moment correlation test to examine the relationship between students reasoning in mathematics and their self efficacy.

The total score for students mathematical reasoning ability is transformed into a scale of 0-100 using the following formula:

$$Value = \frac{total\ score}{maximum\ score}\ x\ 100$$

This study categorized students mathematical reasoning ability and self efficacy into 3 levels high, medium, and low. The scale or score range used to determine the category of each variable is as follows:

Table 1. Formula for Determining Criteria

Interval Score	Criteria
$x \geq \bar{x} + SD$	High
$\bar{x} - SD < x < \bar{x} + SD$	Medium
$x \leq \bar{x} + SD$	Low

(Arikunto, 2010)

Note: SD = Standar Deviasi
$\bar{x}$ = Mean

Table 2. Correlation Interpretation

Interval Coefficient	Level od Relationship
$0 < r < 0{,}1$	The positive correlation is very weak
$0{,}1 \leq r < 0{,}3$	Weak positive correlation
$0{,}3 \leq r < 0{,}5$	Moderate positive correlation
$0{,}5 \leq r < 0{,}8$	Strong positive correlation
$0{,}8 \leq r < 1$	The positive correlation is very strong

(Cohen, 2007)

RESULTS AND DISCUSSION

Results

To make it easier to analyze, here is a descriptive statistical table of mathematical reasoning ability and self efficacy:

Table 3. Descriptive Statistics of Mathematical Reasoning Ability and Self Efficacy

	Reasoning Ability	Self Efficacy
N	32	32
Mean	40,63	86,34
Std.Deviasi	10,15	12,42

Furthermore, the mathematical reasoning ability scores obtained (scale 0-100) are then classified into reasoning ability intervals as illustrated in Table 4:

Table 4. Criteria for Mathematical Reasoning Ability

Interval Score	Amount	Percentage (%)	Criteria
$x \geq 51$	4	13%	High
$30 < x < 51$	21	66%	Medium
$x \leq 30$	7	22%	Low
Amount	32		

According to Table 4, most students fall into the medium category for mathematical reasoning ability, which is 21 students (66%). Meanwhile, 4 students (13%) have high mathematical reasoning ability, and 7 students (22%) are in the low category.

These findings indicate that most students fall into the middle category, with only a few exhibiting high reasoning abilities. However, 22% of students still have low ability, suggesting that the mathematical reasoning ability of junior high school students in one of the Karawang districts is not good, meaning that all indicators of the reasoning ability have not been achieved properly.

Furthermore, the self efficacy questionnaire data was transformed from a numerical to a categorical format. The numerical data were categorized into 3 distinct levels: low, medium, and high. The outcomes of this data transformation are presented in Table 5:

Table 5. Criteria for Self Efficacy

Interval Score	Amount	Percentage (%)	Criteria
$x \geq 99$	6	19%	High
$74 < x < 99$	17	53%	Medium
$x \leq 74$	9	28%	Low
Amount	32		

According to Table 5, it is evident that the majority of students possess moderate self-efficacy, which is 17 students (53%). Then, 6 students (19%) have high self efficacy, while 9 students (28%) have low self efficacy.

The results show that over half of the students (53%) have a fairly good level of self efficacy in facing academic challenges, but there are still 28% of students with low self efficacy, which indicates a lack of confidence in completing mathematics tasks.

The next stage is inferential analysis using a correlation test. However, before conducting a correlation test using the Pearson product moment correlation test, several assumption tests must be fulfilled, specifically the normality test and the linearity test.

The Normality Test

The normality test is performed as a preliminary stage, if the data shows a normal distribution, the Pearson Product Moment correlation test can be continued. However, if the data does not conform to a normal distribution, the Spearman correlation test is chosen. The level of significance $\alpha \geq 0{,}05$ seen from Shapiro-Wilk ($n < 50$) then the data is normally distributed. The table below presents the results of the normality test:

Table 6. Normality Test

	Shapiro-Wilk		
	Statistic	df	Sig.
Reasoning_Ability	.937	32	.066
Self_Efficacy	.946	32	.112

According to the findings of the normality test on Table 6, the significance value for the mathematical reasoning ability data was 0,066 and the self efficacy data was 0,112. Thus, because the significance values are $\alpha \geq 0.05$, it is justifiable to infer that both data distributions are normal, indicating that the data meets the assumption of normality.

The Linearity Test

The linearity test is performed to assess if a linear relationship exists between mathematical reasoning ability and self efficacy. This test is one of the assumptions that must be met before conducting the Pearson Product Moment correlation test. Linearity testing is carried out by

examining the significance value (Sig.) presented in the linearity table from the SPSS output. If the significance value (Sig. Linearity) < 0.05 suggests that a linear relationship exists between the variables. However, if the Sig. Linearity value > 0.05 it implies that the relationship between the variables is non-linear. The table below presents the results of the linearity test:

Table 7. Linearity Test

			Sum of Squares	df	Mean Square	F	Sig.
Reasoning_Ability* Self_Efficacy	Between Groups	(Combined)	2940.875	20	147.044	7.594	.001
		Linearity	2186.736	1	2186.736	112.930	.000
		Deviation from Linearity	754.139	19	39.692	2.050	.112
	Within Groups		213.000	11	19.364		
	Total		3153.875	31			

According to the outcome of the linearity test the significance value for the linearity row in Table 7 is 0.000. Since 0.000 < 0.05, this confirms the presence of a linear relationship between mathematical reasoning ability and self efficacy.

According to the results of the classical assumption test, it was obtained that the results of the normality test and linearity test were fulfilled so that a correlation test can then be performed using pearson product moment to see the relationship between students mathematical reasoning ability and self efficacy.

The Pearson Correlation Test

After ensuring that the required assumptions are met, the next step is to conduct a pearson correlation test. The purpose of this test is to determine whether a relationship exists between the variables and to measure their strength. A significance value < 0.05 from this test suggests a statistically significant correlation The detailed findings of the pearson correlation test are provided in the table below:

Table 8. Pearson Product Moment Correlation Test

		Reasoning_Ability	Self_Efficacy
Reasoning_Ability	Pearson Correlation	1	.803**
	Sig. (2-tailed)		.000
	N	32	32
Self_Efficacy	Pearson Correlation	.803**	1
	Sig. (2-tailed)	.000	
	N	32	32

According to the findings of the Pearson Product Moment correlation analysis in Table 8, a Sig. (2-tailed) value of 0,000 was obtained, where 0,000 < 0,05. This result indicates a significant relationship between mathematical reasoning ability and self efficacy among junior high school students. To see the level of correlation relationship, you can use the r-value interpretation table (see Table 2). The Pearson correlation coefficient is 0,803, signifying a strong correlation between mathematical reasoning ability and self efficacy.

Discussions

Since this correlation is positive, it suggests that the relationship between the two variables is one-directional, meaning that an increase in students self efficacy leads to an improvement in their mathematical reasoning ability. Conversely, if the students self efficacy is low, at that point their mathematical reasoning abilities also tend to be low. This result is consistent with the findings of Aprisal & Arifin (2020), which demonstrated a positive association between mathematical reasoning ability and self efficacy. This is also in line with Aprillianti & Dewi (2022), who found a relationship between self efficacy and student learning achievement. Where student self-efficacy makes a great contribution to mathematics learning achievement, by increasing student self efficacy, better the students learning achievement.

Other studies have shown that students mathematics learning achievement is influenced by two main factors, namely academic attitude and self efficacy. In this research, learning achievement refers to students ability to solve several problems using mathematical reasoning (Taat & Rozario, 2014). This strengthens the finding that self efficacy not only affects students self confidence in learning, but also has an impact on their academic results and mathematical thinking skills. In line with this, Russel (Himmi, 2017) argued that reasoning is fundamental to the mathematics learning process. Reasoning is used as a tool to comprehend and abstract complex mathematical concepts and is the foundation for developing individual character, including self efficacy. In this context, self efficacy plays a role in building student resilience in facing academic challenges, including solving a SPLDV.

Furthermore, Bandura explained that self efficacy plays a crucial role in determining how a person thinks, feels, acts, and motivates themselves. Students with high self efficacy will find it easier to overcome difficulties, such as challenging math problems, with an independent and never-give-up attitude (Firdaus & Rosyidah, 2023). Therefore, increasing students self efficacy in learning mathematics may serve as a valuable approach to enhancing their mathematical reasoning abilities.

CONCLUSION

According to the presented research findings, it can inferred that the mean mathematical reasoning ability of the students studied was 40.63, which falls within the medium category, this implies that not all indicators of mathematical reasoning ability have been achieved properly. Whereas the mean result of students self efficacy is 86.34 which falls within the medium criteria, this indicates that, overall, the majority of students lack a high or medium level of self efficacy in their abilities to accomplish the duty. With a correlation score of 0.803, which demonstrates a relationship positive strong between students mathematical reasoning ability and self efficacy, it can inferred that there is a relationship between mathematical reasoning ability and self efficacy in the topic of two-variable linear equation systems among junior high school students in one of the Karawang Regencies. So it is very possible that with the assumption of good self-efficacy or individual self-confidence, it will support better mathematical reasoning ability, and vice versa.

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