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ORIGINAL PAPER

The Influence of Learning Independence and Self-Regulation on the Mathematical Understanding of Junior High School Students

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Abstract
Mathematical understanding ability is an essential 21st-century competence, yet the simultaneous testing of internal variables such as learning independence and self-regulated learning as its predictors remains limited. This associative quantitative study with an *ex post facto* design aimed to analyze the partial and simultaneous effects of learning independence and self-regulation on the mathematical understanding of junior high school students. The research sample consisted of 20 eighth-grade students in Indramayu Regency, selected through a purposive sampling technique. Data were collected using a mathematical understanding essay test instrument (NCTM indicators) and Likert-scale questionnaires, then analyzed using multiple linear regression. The ANOVA test results indicated that, simultaneously, learning independence and self-regulation did not exert a significant influence on mathematical understanding ($F = 2.582$; $p = 0.105$), with a model contribution of 23.3%. Partially, self-regulation had no significant effect ($p = 0.147$), whereas learning independence had a significant but negative influence ($B = -2.376$; $p = 0.041$). This finding indicates the presence of misguided autonomy, where high independence without help-seeking behavior hinders the understanding of abstract concepts. This study recommends the implementation of guided inquiry learning strategies as a form of scaffolding to optimize affective potential into students' cognitive abilities.

Keywords:
Learning Independence
Mathematical Understanding
Self-Regulated Learning

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INTRODUCTION

Mathematical understanding ability is an essential competency in mathematics learning as it serves as the foundation for students to connect concepts, apply procedures appropriately, and solve various contextual problems. In the 21st century, this ability has become a key indicator of success in mathematics education due to its close integration with critical thinking, reasoning, and problem-solving skills. However, various international assessments indicate that students' mathematical performance remains relatively low. Consequently, concerted efforts are required to identify the factors influencing success in learning mathematics, spanning not only cognitive aspects but also affective domains and self-regulation.

In Indonesia, the low level of mathematical understanding remains a persistent challenge in mathematics education at the junior high school level. Numerous studies report that students still encounter difficulties in conceptual comprehension, connecting mathematical representations, and applying concepts to novel situations (Jusra & Liddini, 2022). For instance, Jusra and Liddini (2022) found that students with high levels of self-regulated learning were able to meet almost all indicators of

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mathematical understanding. In contrast, those with low levels of self-regulated learning only met a fraction of these indicators. These findings suggest that the ability to comprehend mathematical concepts is influenced not only by intellectual aptitude but also by the students' capacity to regulate their own learning processes.

In addition to self-regulation, learning independence (autonomous learning) is a crucial factor in mathematical academic achievement. Learning independence fosters student initiative, responsibility, discipline, and decision-making capabilities throughout the learning process. Various studies indicate that students with a high level of independent learning tend to achieve better mathematical performance compared to those who rely entirely on the teacher (Setiawan & Anewati, 2021; [Author], 2024). On the other hand, recent systematic reviews show that the majority of research on learning independence still focuses heavily on mathematical problem-solving skills, while studies directly linking it to mathematical understanding remain relatively limited.

Research on self-regulated learning in mathematics education has also grown rapidly. A literature review conducted by Rahman et al. (2025) concluded that self-regulated learning contributes positively to academic achievement in mathematics by enhancing motivation, self-efficacy, and the ability to manage learning strategies. Similarly, a recent systematic literature review by Noor et al. (2025) indicated that most self-regulated learning research is directed toward mathematical problem-solving skills using descriptive and experimental approaches. Consequently, research exploring the influence of self-regulated learning on mathematical understanding still requires stronger empirical support.

Based on the review of prior research, several gaps justify the execution of this study. The research gap lies in the scarcity of studies simultaneously testing learning independence and self-regulated learning as predictors of junior high school students' mathematical understanding. The empirical gap is evident in prior studies that predominantly correlate these two variables with general academic achievement or problem-solving skills rather than mathematical understanding. The theoretical gap is reflected in the absence of an integrated model that positions learning independence and self-regulated learning as two complementary constructs in explaining the development of mathematical understanding. Meanwhile, the methodological gap is visible in the dominance of qualitative descriptive or experimental designs, whereas correlational research utilizing multiple regression analysis to determine the relative contribution of both variables remains limited.

In light of these gaps, this study is paramount to providing empirical evidence regarding the influence of learning independence and self-regulation on the mathematical understanding of junior high school students. The **novelty** of this research lies in the simultaneous testing of these two internal variables within a single analytical model to explain mathematical understanding, rather than general academic achievement or problem-solving skills, which have dominated previous research. Thus, this study is expected to expand the discourse on psychological factors affecting mathematical understanding and provide an empirical foundation for teachers to design instruction that fosters both student independence and self-regulation concurrently.

Therefore, the objective of this study is to analyze the partial and simultaneous effects of learning independence and self-regulation on the mathematical understanding of junior high school students. The findings of this study are expected to contribute to the theoretical development of internal factors influencing mathematical understanding, while serving as a practical reference for educators in designing mathematics instruction oriented toward cultivating self-regulated and independent learning behaviors in students.

METHODOLOGY

The methods sections should be brief, but they should include sufficient technical information to allow the experiments to be repeated by a qualified reader. Only new methods should be described in detail. Cite previously published procedures in References. This study employed a quantitative approach with an *ex post facto* correlational design, aimed at analyzing the influence of learning independence and self-regulation on the mathematical understanding of junior high school students. The independent variables of the research consisted of learning independence (X_1) and self-regulated learning (X_2). In contrast, the dependent variable was mathematical understanding (Y).

The research was conducted at a junior high school in Indramayu Regency, West Java. The research subjects comprised 20 eighth-grade students selected using a purposive sampling technique, based on the considerations that they had studied the assessed material, fully participated in the entire learning process, and consented to serve as research respondents.

The research instruments consisted of two questionnaires and one test. The learning independence questionnaire was developed based on indicators of learning initiative, responsibility, discipline, self-confidence, and self-evaluation. The self-regulation questionnaire was designed based on Zimmerman's three phases of self-regulated learning: forethought, performance, and self-reflection. Both questionnaires utilized a five-point Likert scale. Mathematical understanding was measured using an essay test referencing the NCTM indicators of mathematical understanding, which include the ability to restate concepts, classify objects, apply appropriate procedures, present mathematical representations, and apply concepts to problem-solving.

RESULTS & DISCUSSION

Results

This study aims to determine the descriptive characteristics as well as the contributions of learning independence and self-regulation to students' mathematical understanding. The analysis was conducted in several statistical stages using SPSS software, beginning with descriptive analysis, followed by simultaneous model-fit testing, and concluding with partial significance testing and multicollinearity diagnostic checks.

Descriptive statistical analysis was performed to provide a general overview of the data distribution from a sample size of N = 20 respondents. The summary of the descriptive analysis is presented in Table 1.

Table 1. Summary of Descriptive Statistical Analysis of Research Variables

Variable	Mean	Std. Deviation	N
Mathematical Understanding	51,75	13,333	20
Learning Independence	40,75	3,024	20
Self-Regulation	41,50	3,236	20

Based on Table 1, the mathematical understanding variable shows a mean score of 51.75 with a relatively high standard deviation of 13.333. This indicates a high level of variability or diversity in cognitive ability among the respondents. Conversely, the learning independence variable (M = 40.75; SD = 3.024) and the self-regulation variable (M = 41.50; SD = 3.236) exhibit relatively small standard deviations, suggesting that the affective characteristics of the sample tend to be homogeneous.

To examine the joint contribution of learning independence and self-regulation to mathematical understanding, a multiple linear regression analysis was performed. The estimated results for the model summary and the model-fit test (ANOVA) are presented in Table 2 and Table 3, respectively.

Table 2. Results of the Coefficient of Determination Analysis (Model Summary)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	0,483	0,233	0,143	12,345	2,503

Predictors: (Constant), self-regulation, learning independence

Table 3. Results of the Simultaneous Significance Test (ANOVA)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	787,019	2	393,510	2,582	0,105
	Residual	2590,731	17	152,396		
	Total	3377,750	19			

Based on Table 2, the correlation coefficient (R) is 0.483, indicating a moderate relationship. The coefficient of determination (R-squared) of 0.233 indicates that learning independence and self-regulation account for 23.3% of the variance in students' mathematical understanding, while other variables outside the scope of this model explain the remaining 76.7%.

However, the ANOVA test results in Table 3 show an F-value of 2.582 with a significance value (p -value or Sig.) of 0.105. Since the significance level is greater than the alpha level of 0.05 (0.105 > 0.05), it can be concluded that, simultaneously (jointly), learning independence and self-regulation do not exert a significant influence on students' mathematical understanding.

Partial Significance Testing (t-Test) and Multicollinearity

Although the simultaneous test yielded non-significant results, a partial test was still conducted to observe the dynamics of each variable's individual influence. The summary of the t-test results along with the multicollinearity diagnostic checks is presented in Table 4.

Table 4. Results of the Partial Significance Test (t-Test) and Multicollinearity Diagnostics

Model	Unstandardized B	Std. Error	Standardized Beta	t	Sig.	Tolerance	VIF
(Constant)	85,482	43,320		1,973	0,065		
Learning Independence	-2,376	1,072	-0,539	-2,216	0,041	0,763	1,310
Self-Regulation	1,520	1,002	0,369	1,518	0,147	0,763	1,310

Dependent Variable: mathematical understanding

Based on Table 4, the multiple linear regression equation obtained is:

$$Y = 85 \cdot 482 - 2 \cdot 376X_1 + 1 \cdot 520X_2$$

The partial test results yield two key findings: 1) The learning independence variable (X_1) has a regression coefficient of -2.376 with a p-value of 0.041 (p < 0.05). This indicates that, partially, learning independence has a significant negative influence on students' mathematical understanding, and 2) the self-regulation variable (X_1) has a regression coefficient of 1.520 with a p-value of 0.147 (p > 0.05). This indicates that, partially, self-regulation does not exert a significant influence on mathematical understanding. Furthermore, the Tolerance value (0.763 > 0.10) and the Variance Inflation Factor (VIF) value (1.310 < 10.00) confirm that this regression model is entirely free from multicollinearity issues, thereby ensuring that the resulting parameter estimations are valid and unbiased.

Discussion

The series of statistical analyses in this study generates a profound discourse on how affective aspects interact with students' cognitive abilities in mathematics learning. The primary finding of this research reveals an incongruity between the simultaneous test (which was non-significant, p = 0.105) and the partial test, wherein learning independence unexpectedly exerted a significant negative influence (B = -2.376; p = 0.041).

First, the non-significant influence of self-regulation (p = 0.147) alongside the non-significant simultaneous regression model provides a theoretical assertion that macro-level affective domains do not necessarily act as direct, linear predictors of cognitive performance in mathematics. The Residual Sum of Squares (2,590.731), which dominates the model, reflects that 76.7% of the variance in students' mathematical understanding is determined by external factors beyond these affective variables. The abstract, cumulative, and concept-dense nature of mathematics demands pure cognitive stimulation, such as mathematical prior knowledge, logical-mathematical intelligence, and the quality of instructional scaffolding provided by educators. Students with robust self-regulation in terms of learning administration (such as time management) will still encounter cognitive hurdles if they are not supported by appropriate conceptual learning strategies.

Second, the anomaly of a significant negative influence of learning independence on mathematical understanding constitutes the most crucial finding of this study. This negative direction indicates that higher levels of student independence are associated with lower mathematical understanding scores. Within the context of developmental psychology and mathematics education, this phenomenon can be understood through the lens of misguided autonomy or overconfidence. Students with high levels of independence tend to manifest their behavior by attempting to solve complex mathematical problems in isolation and often avoid help-seeking behaviors. However, in mathematics, conceptual confirmation from an expert (the teacher) or peer discussion is vital to validate logical reasoning pathways. When independent students refuse to seek consultation upon encountering obstacles, they are highly susceptible to falling into accumulated misconceptions, which ultimately degrades their mathematical understanding scores.

Conversely, the descriptive data show that students' learning independence is homogeneous at a moderate level (SD = 3.024). Students with moderate or lower levels of independence are generally more open to establishing social interactions in the classroom, asking questions to the teacher, or engaging in cooperative learning. It is these interactions that facilitate the prompt correction of misconceptions through real-time feedback, ultimately rendering their conceptual mathematical understanding more structured and adaptive.

The theoretical implication of this study points toward a repositioning of the definition of "independence" (autonomy) in science and mathematics education. Learning independence must not be narrowly interpreted as letting students learn entirely without intervention (free-discovery learning). Educators must be capable of designing learning environments where student independence remains scaffolded through structured instruction (guided inquiry), ensuring that this homogeneous affective potential can be successfully converted into optimal and significant mathematical cognitive achievements.

CONCLUSION

Based on the results of the data analysis and discussion, this study concludes that, simultaneously, learning independence and self-regulation do not exert a significant influence on the mathematical understanding of junior high school students. The theoretical characteristics of mathematical content—which is highly complex and abstract—demand robust cognitive stimulation. Consequently, these affective variables jointly account for only 23.3% of the variance in students' mathematical understanding. Partially, self-regulation shows no significant influence, indicating that administrative self-study skills do not automatically translate to students' mathematical thinking acuity.

The most crucial finding of this study is the significant negative partial influence of learning independence on mathematical understanding. This confirms the phenomenon of misguided autonomy, where students with high levels of learning independence tend to solve mathematical problems in isolation and avoid help-seeking behaviors. Consequently, when confronted with conceptual obstacles, they are highly susceptible to falling into accumulated misconceptions, ultimately leading to lower cognitive scores in mathematical understanding.

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