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THE CORRELATION BETWEEN CONCEPTUAL UNDERSTANDING SKILLS AND SELF-REGULATED LEARNING IN MATHEMATICS

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ABSTRACT

The skill to understand mathematical concepts is closely related to the comprehensive and functional mastery of mathematical ideas. In learning, an important aspect of material comprehension apart from the skill of understanding mathematical concepts is students' learning independence. This study aims to examine the relationship between mathematical concept comprehension skills and students' learning independence. A correlational method with a quantitative approach was employed in this study. The research was conducted at a junior secondary school in Karawang Regency, namely SMPN 1 Cibuaya, involving 35 students from class VIII-F as the research subjects. The research instruments used were a mathematical concept comprehension skill test and a learning independence questionnaire. The comprehension test consisted of five essay questions, while the questionnaire comprised 28 items. The study involved four stages of data analysis. Specifically, for the learning independence data, the ordinal data were first transformed into interval data using the Successive Interval Method (MSI). The results showed that the correlation test, conducted to determine the strength of the relationship between the two variables, produced a coefficient of 0.606. According to the interval coefficient table, this value falls into the "very strong" category, as it is close to 1. This indicates a positive correlation between the two variables. The influence of mathematical concept comprehension skills and learning independence was found to be 36.72%, with the remaining percentage influenced by other factors. In other words, the higher the students' learning independence, the higher their mathematical concept comprehension skills and vice versa.

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INTRODUCTION

Education is a fundamental component in realizing one's full potential. Therefore, to support the development of the learning process, systematic preparation and active involvement from

all parties are required to achieve educational goals. One of the general objectives of mathematics learning, as stated in the Regulation of the Minister of National Education (Permendiknas) Number 22 of 2006 concerning Content Standards, is for students to develop the skills to understand mathematical concepts, explain the skillss between concepts, and apply concepts or algorithms flexibly, accurately, efficiently, and precisely in problem-solving (Aledya, 2019).

The skills to understand mathematical concepts refer to the skills to grasp mathematical ideas comprehensively and functionally. In line with this, conceptual understanding is a fundamental skill that plays a crucial role in mathematics learning, as it enables the solution of problems related to mathematics. Mathematical conceptual understanding is a student's skill in mastering various mathematical topics, where students are not only expected to know or memorize a set of learned concepts, but also to be able to represent them in different, more understandable forms and apply those concepts based on their knowledge without altering the meaning (Utari & Utami, 2020).

Mathematical conceptual understanding is one of the fundamental skills that is essential for students. By understanding mathematical concepts, students can interpret the meaning and purpose of the learning process they are undergoing (Nurfajriyanti & Pradipta, 2021). A deep understanding of mathematical concepts can support students in solving mathematical problems, communicating effectively, thinking logically, and identifying skills between concepts (Yustiara et al., 2023). Therefore, conceptual understanding plays a vital role in mathematics learning, as it significantly influences students' learning outcomes.

However, in reality, the mathematical conceptual understanding of students in Indonesia remains relatively low. This low level of conceptual understanding is evident in the results of both national and international surveys. According to the 2022 PISA survey, Indonesia ranked 66th out of 81 countries, with an average score of 366, significantly below the OECD average score of 472, OECD (Afifah et al., 2024). Thus, the mathematical conceptual understanding of Indonesian students is classified as low.

An important aspect that supports material comprehension in learning aside from mathematical conceptual understanding is students' ability to learn independently. Self-regulated learning refers to students' ability to study independently without relying on others, accompanied by a sense of responsibility in identifying their own learning needs (Yani et al., 2022). In line with this, the level of student independence plays a crucial role in determining their success in understanding mathematical concepts through their approaches to learning. Students with a high level of independence tend to be more successful in understanding mathematical concepts. This independence serves as a supporting element to ensure the learning process runs optimally. Students who possess self-regulated learning generally have clear goals, are capable of self-evaluation, have confidence in their potential, and maintain a positive outlook and self-belief throughout the learning process (Kidjab et al., 2019). Therefore, learning to be independent plays a vital role in students' academic success.

However, field observations indicate that students' self-regulated learning is still categorized as low. A study by (Febriyanti & Imami, 2021) reported that the level of independence in learning mathematics reached only 28.9%. Additionally, research by (Wulandari, 2022) showed that the self-regulated learning of eighth-grade students was 50.52%. These low percentages are based on assessments of the overall indicators measured. However, not all indicators fall into the low category.

The low level of self-regulated learning is caused by several factors, one of which is the abstract nature of mathematics learning, which leads to a decline in students’ interest and motivation in studying mathematics (Ansori & Herdiman, 2019). In addition, internal factors contributing to

low self-regulated learning include students' lack of initiative in learning and their low self-confidence in expressing opinions. External factors that trigger low student self-regulated learning include limited parental involvement in assisting with learning at home, monotonous and unvaried teaching methods, and an unconducive learning environment. Moreover, inadequate facilities and limited teacher competence are also significant obstacles (Masitoh & Herman, 2024).

The indicators of self-regulated learning include: (1) learning initiative, (2) diagnosing learning needs, (3) setting learning targets or goals, (4) viewing difficulties as challenges, (5) utilizing and seeking relevant resources, (6) selecting and applying learning strategies, (7) evaluating the learning process and outcomes, and (8) self-efficacy (self-concept) as proposed by (Hendriana et al., 2017). These indicators of self-regulated learning in mathematics instruction serve as a benchmark for measuring the extent to which students exhibit independent attitudes during the mathematics learning process (Masitoh & Herman, 2024).

Several previous studies examining the correlation between mathematical conceptual understanding and self-regulated learning have yielded varying results. A study by (Yani et al., 2022) found a positive correlation between students' mathematical conceptual understanding and their self-regulated learning, accounting for 71.4% of the variance in students' conceptual understanding skills. Additionally, research by (Winata et al., 2021) revealed a correlation between self-regulated learning and students' mathematical conceptual understanding. Based on these prior studies, the researcher is interested in further investigating the correlation between mathematical conceptual understanding and self-regulated learning. Therefore, this study aims to determine the correlation between mathematical conceptual understanding and the self-regulated learning of eighth-grade students at a junior high school in Karawang Regency.

METHOD

The method used in this study is correlational, employing a quantitative approach. In correlation analysis, two approaches can be applied. If the data are normally distributed, the Pearson Product-Moment correlation test is used. Conversely, if the data are not normally distributed, the analysis is conducted using the Spearman Rank correlation test. (Fauziah et al., 2018).

The research was conducted at one of the junior high schools in Karawang Regency, namely SMPN 1 Cibuaya, with 35 students from class VIII-F as the research subjects. The research instruments used in this study were a mathematical concept comprehension skill test and a learning independence questionnaire. The mathematical concept comprehension test was administered to assess students' skills in understanding mathematical concepts. In addition, to determine the level of students' learning independence, data were collected using a learning independence questionnaire. The mathematical concept comprehension skill test consisted of five essay questions, while the learning independence questionnaire comprised 28 items.

In this study, four stages of analysis were used. Specifically for the learning independence questionnaire data, the ordinal data were first transformed into interval data using the Successive Interval Method (MSI).The first stage was a normality test. The second stage was a correlational test designed to measure the strength of the correlation between students' mathematical conceptual understanding and their self-regulated learning. The interpretation of the correlation results is presented in the following table.

Table 1. Interval correlation

Interval Koefisien	Strength of correlation
0,000 - 0,199	Very weak
0,200 - 0,399	Weak
0,400 - 0,599	Moderate
0,600 - 0,799	Strong
0,800 - 1,000	Very strong

Source : Riduwan (Fauziah et al., 2018)

The third stage is the determination coefficient test. The symbol for the coefficient of determination is r^2, which indicates that the result of the correlation is squared and is generally used to determine the contribution of the variable's mathematical conceptual understanding skills to self-regulated learning. It is calculated using the following formula.

$$KP = r^2 \times 100\ \%$$

(Fauziah et al., 2018)

The final stage is the regression test, which aims to determine whether one variable affects another. The data analysis described above was processed using SPSS version 23 software.

RESULTS AND DISCUSSION

Several stages of data analysis were employed in this study. The data used included the results of the mathematical conceptual understanding test and the self-regulated learning questionnaire from students of class VIII-F at SMPN 1 Cibuaya. Statistical data analysis was conducted using SPSS version 23 software. The results of the descriptive statistical analysis of mathematical conceptual understanding and self-regulated learning are presented in Table 2.

Table 2. Descriptive statistic

Descriptive Statistics			
	N	**Mean**	**Std. Deviation**
Conceptual Understanding	35	72,99	11,629
Self-regulated learning	35	69,32	12,682
Valid N (listwise)	35		

Based on the analysis results presented in Table 2, the average scores for students' mathematical conceptual understanding and self-regulated learning are 72,99 and 69,32, respectively. According to the assessment categories used, both scores fall into the moderate level. This indicates that both students' conceptual understanding and self-regulated learning are at a reasonably adequate level, although there is still room for improvement.

The normality test was conducted to determine whether the analyzed data are typically distributed. If the data are normally distributed, the analysis proceeds with the Pearson Product-Moment correlation test. However, if the data are not normally distributed, the Spearman Rank correlation test is used. The criteria used for the normality test are as follows:

If the Sig. A value ≥ 0.05 indicates that the data are typically distributed.

If the Sig. value < 0.05, the data are not normally distributed.

The normality test was conducted using the Shapiro-Wilk test, as the sample size used in the study was less than 50 (Sugiyono, 2019). The results of the statistical analysis for the normality test are presented in Table 3 below.

Table 3. Normality test

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Conceptual Understanding	0,978	35	0,704
Self-regulated learning	0,978	35	0,684

Based on the results of the normality test and the statistical analysis presented in Table 3, the significance values for mathematical conceptual understanding and self-regulated learning were 0.704 and 0.684, respectively. According to the criteria for the normality test, both values are greater than or equal to 0.05, indicating that the data for both mathematical conceptual understanding and self-regulated learning are typically distributed. Since both data sets have significance values ≥ 0.05, indicating normal distribution, the analysis proceeds to the second stage using the Pearson Product-Moment correlation test.

Since the results of the statistical normality test showed that the data were normally distributed, the analysis continued with the Pearson Product-Moment correlation test. The Pearson Product-Moment correlation is used when the data are continuous and discrete. This correlation test aims to measure the strength of the correlation between mathematical conceptual understanding and self-regulated learning. The correlation test hypotheses used are as follows:

H_0: There is no correlation between mathematical conceptual understanding and self-regulated learning in mathematics learning.

H_a: There is a correlation between mathematical conceptual understanding and self-regulated learning in mathematics learning.

Table 4. Correlation

Correlations			
		Understanding	**Independence**
Conceptual Understanding	Pearson Correlation	1	,606
	Sig. (2-tailed)		,000
	N	35	35
Self-regulated learning	Pearson Correlation	,606	1
	Sig. (2-tailed)	,000	
	N	35	35

Based on the correlation test analysis results presented in Table 4, the output value was 0.606. According to the correlation coefficient interval in Table 1, this value falls into the strong category, as it is close to 1. The significance value for the correlation between mathematical conceptual understanding and self-regulated learning was 0.000, which is less than 0.05. According to the hypothesis testing criteria, H_0 is rejected, indicating a significant correlation between mathematical conceptual understanding and self-regulated learning in mathematics.

The next stage is the coefficient of determination test. To determine the influence or contribution of mathematical conceptual understanding on self-regulated learning, the coefficient of determination test was conducted. The variability in statistical models that can be explained by specific data is represented by the coefficient of determination. The coefficient of determination is the ratio of the explained variability to the total variability in the original data. This test is conducted to determine the extent to which learning independence influences mathematical concept comprehension skills. The results of the coefficient of determination test are presented in Table 5.

Table 5. Determinant Coefficient Test Results

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,606[a]	,367	,348	9,394	2,050

Based on the output in Table 5, the correlation value between the two variables is 0.606, and the R-squared value is 0.367. This indicates that 36.7% of the variance in mathematical concept comprehension skills can be explained by learning independence, while the remaining 63.3% is influenced by other factors. The coefficient of determination shows that learning independence contributes 36.72% to students' mathematical concept comprehension skills. This illustrates a positive influence of learning independence on mathematical concept comprehension in mathematics learning.

The final stage of the data analysis is the regression test. This test was conducted because the results of the correlation analysis indicated a significant correlation between mathematical conceptual understanding and self-regulated learning in mathematics. The purpose of the regression test is to examine the influence of the independent variable and the dependent variable. If the data are normally distributed, the regression test can be used for data analysis. However, if the data are not normally distributed, Theil's analysis is applied. Since the data analyzed in this study are typically distributed, regression analysis was conducted. The results of the regression analysis are presented in Table 6.

Table 6. Regression Test Result

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	1686,252	1	1618,252	19,109	,000[b]
	Residual	2912,036	33	88,244		
	Total	4598,287	34			

Based on the output presented in Table 6, the significance value obtained was 0.000. According to the hypothesis testing criteria: (1) If the significance value is < 0.05, then H_0 is rejected; (2) If the significance value is > 0.05, then H_a is accepted. The hypotheses are as follows:

H_0: There is no correlation between mathematical conceptual understanding and self-regulated learning in mathematics learning.

H_a: There is a correlation between mathematical conceptual understanding and self-regulated learning in mathematics learning.

The significance value shown in Table 6 is 0.000, which means that Sig < 0.05, thereby leading to the rejection of H_0. Therefore, it can be concluded that there is a significant influence of mathematical concept comprehension skills on learning independence in mathematics learning. Since the significance value of 0.000 is less than 0.05, this indicates that the level of students' mathematical concept comprehension skills significantly affects their learning independence in mathematics learning at the junior high school level, with a significance level of $\alpha = 5\%$.

The regression equation obtained is Y = 34.496 + 0.555 X. This means that the constant value of mathematical conceptual understanding is 34.496, while the coefficient for self-regulated learning is 0.555, both of which are positive. Therefore, there is a positive influence of

mathematical conceptual understanding on self-regulated learning in mathematics learning. Based on this explanation, the higher the level of students' conceptual understanding, the higher their level of self-regulated learning.

Based on the data analysis conducted from the initial to the final stage, the correlation test aimed at determining the strength of the correlation between the two variables produced a coefficient of 0.982. According to the coefficient interval table, this value falls into the "very strong" category because it is close to 1, indicating a positive correlation between the variables. The coefficient of determination indicates that students' mathematical conceptual understanding explains 96.43% of the variance in self-regulated learning, while the remaining percentage is attributed to other factors. These findings are consistent with the study by (Winata et al., 2021), which also reported an influence of self-regulated learning on students' conceptual understanding of mathematics in an e-learning environment using Google Classroom. Their study yielded an R-squared value of 34.1%, with the remaining 65.9% attributed to other factors.

Discussions

Suhendi (Mulianty et al., 2018) found in his study that there is a significant positive skills between mathematical intelligence and self-regulated learning in mathematics learning outcomes. This indicates a positive correlation between mathematical conceptual understanding and self-regulated learning. Every student should possess both conceptual understanding and self-regulated learning, not only in the learning process but also in everyday life activities (Setiawan & Anawati, 2021).

Self-regulated learning can be defined as an attitude that enables students to make decisions and complete tasks without the assistance of others. It is a quality that plays a crucial role for students, as having self-regulated learning allows them to more easily understand the mathematical concepts being taught (Priyastutik et al., 2018). According to (Setiawan & Anawati, 2021), self-regulated learning is a crucial factor that must be considered in the teaching and learning process. This refers to students' ability to engage independently in learning activities, seek information from various sources beyond the teacher, and possess intrinsic motivation to master the material without being compelled by any external party. Students with a high level of self-regulated learning tend to find it easier to understand mathematical concepts. Conversely, students with low self-regulated learning often struggle to grasp the mathematical concepts being taught. In line with this, (Mulianty et al., 2018) stated that the higher the level of students' mathematical conceptual understanding, the higher their self-regulated learning tends to be. In contrast, students with low conceptual understanding typically also demonstrate low self-regulated learning.

Students who possess self-regulated learning tend to have full concentration and are better prepared for the learning process, which makes it easier for them to understand the learning material (Satriani et al., 2020). On the other hand, students with low self-regulated learning often struggle to concentrate, making it more difficult for them to comprehend the material. Several factors contribute to students' low levels of self-regulated learning. According to (Rahayu & Aini, 2021), a lack of initiative and self-confidence are among the key causes of low self-regulated learning. In addition (Sembiring & Wardani, 2021) emphasized the importance of identifying learning needs and designing appropriate learning strategies. Other contributing factors to low student independence include a lack of parental involvement in supporting learning at home, monotonous and unvaried teaching methods, and an unconducive learning environment. Furthermore, limited facilities and insufficient teacher competence also pose significant challenges (Masitoh & Herman, 2024). These factors collectively contribute to the low level of self-regulated learning among students.

A lack of self-regulated learning in students can lead to difficulties when facing problems, as they may lack the confidence to make decisions. For example, in completing the mathematical conceptual understanding test, students with a high level of self-regulated learning tended to achieve superior scores. Conversely, students with low self-regulated learning generally received lower scores. Therefore, the higher a student's level of self-regulated learning, the better their academic performance tends to be, particularly in mathematics learning.

When students have a high level of self-regulated learning, they are more confident and courageous in solving problems, which in turn enhances their mathematical conceptual understanding. Conversely, students with low self-regulated learning often struggle when working through problems, which negatively affects their numeracy skills. Therefore, an increase in students' self-regulated learning has a significant impact on their academic achievement.

Based on a review of previous studies (Ambiyar et al., 2020), it was found that there was a relationship between learning independence and the mathematical problem-solving skills of students in class XI MIA 2 at SMAN 1 Lubuk Basung, with a learning independence questionnaire score of 67.93 and an average problem-solving skill test score of 57.70. Meanwhile, according to a study by (Ramadoni & Fatma, 2023), a significant relationship was found between learning independence and the conceptual understanding skills of students in class VIII at SMPN 39 Padang, with a coefficient of determination of 53.57% and a correlation value of 0.733. In addition (Ismail & Zulkarnaen, 2023) reported that the results of their analysis indicated a significant negative correlation between mathematical anxiety and mathematical concept understanding, meaning that although the correlation was negative, a relationship still existed between the two variables. Furthermore (Zulpani et al., 2023), found a positive linear relationship between students' self-confidence and mathematical concept comprehension among 11th-grade MIPA 1 students at SMAN 1 Muara Bungo. Similarly, (Nastiti & Syaifudin, 2020) reported that the analysis results showed a relationship between conceptual understanding skills and mathematical learning outcomes in class VIII D at SMPN 1 Plosoklaten, with a correlation coefficient of 0.317 or 31.7%.

CONCLUSION

The findings of this study indicate that there is a strong correlation between mathematical concept comprehension skills and learning independence, and that this correlation is positive, meaning that the higher the students' mathematical concept comprehension skills, the higher their learning independence. Mathematical conceptual understanding has a significant influence on learning independence, but it is not the dominant factor, as there are many other factors that influence learning independence. This study is limited to the subjects studied and may produce findings that do not necessarily apply in other environments with different characteristics. Therefore, further research is recommended for broader generalization and to analyze factors that influence learning independence other than mathematical concept comprehension skills.

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