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THE EFFECT OF SELF-REGULATED LEARNING APPROACH ON STUDENTS' MATHEMATICAL UNDERSTANDING

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ABSTRACT

Mathematics is an essential subject that develops students' logical and analytical thinking skills. However, many students still experience difficulties in understanding mathematical concepts because learning activities often emphasize memorizing procedures rather than developing conceptual understanding. As a result, students become less engaged and more dependent on teachers during the learning process. This study aimed to determine the effect of the Self-Regulated Learning (SRL) approach on students' mathematical concept understanding. The research employed a quasi-experimental method using a Pretest–Posttest Control Group Design. The study was conducted at SMP Negeri 1 Suwawa and involved 52 seventh-grade students divided into two classes: an experimental class (26 students) taught using the Self-Regulated Learning approach and a control class (26 students) taught using conventional learning. The research instruments consisted of teaching modules, student worksheets (LKPD), and essay tests designed to measure mathematical concept understanding. Data were collected through pretests and posttests and analyzed using descriptive statistics, normality tests, homogeneity tests, and an independent sample t-test. The results showed that the Self-Regulated Learning approach had a significant effect on students' mathematical concept understanding. The hypothesis test revealed that the calculated t-value (3.881) was greater than the critical t-value (1.675) at a significance level of 0.05. Furthermore, the experimental class achieved a higher mean posttest score (20.85) than the control class (18.39). In conclusion, the Self-Regulated Learning approach significantly improves students' mathematical concept understanding and is more effective than conventional learning in teaching integer number concepts to seventh-grade students.

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INTRODUCTION

Education is a process aimed at developing an individual's potential, abilities, and capacities through experiences and habits formed in daily life. Education is closely related to the learning

process because through education, a person acquires new knowledge that can improve personal quality and competitiveness in various fields, according to Jhon S. Brubacher (in Sofianingsih and Kusmanto 2018).

One of the subjects that has a great contribution to the development of these abilities is mathematics. Mathematics plays an important role in shaping logical, systematic, analytical, and rational mindsets. Therefore, mathematics is taught at every level of education from elementary school to college. However, many students still consider mathematics to be a difficult subject because learning is often understood only to memorize formulas and procedures for solving problems (Muhayana et.al., 2021). In fact, according to Sumarmo (2017), mathematics learning involves various elements such as teachers, students, material characteristics, and learning situations that take place. Through mathematics learning, students are trained to think rationally and understand concepts deeply so that they can help develop their potential. The success of learning mathematics is not only measured by the ability to calculate or memorize formulas, but also by the ability of students to understand concepts, master the material, solve problems, and obtain good learning results (Darmawanti, 2020).

Understanding concepts is a basic skill that students must have in learning mathematics. This ability allows students to reinterpret a concept, connect concepts to others, identify examples and non-examples, and apply the concepts in a variety of situations. Students who have a good understanding of concepts will find it easier to learn advanced math material than students who only memorize formulas without understanding their meaning (Indarta et al., 2022.

The importance of understanding mathematical concepts has been emphasized in Permendikbud Number 21 of 2016 which states that the purpose of mathematics learning is for students to be able to understand mathematical concepts, explain the relationships between concepts, and apply concepts or algorithms appropriately and efficiently in solving problems. Thus, understanding concepts is the main foundation in the success of learning mathematics (Pendidikan, Kebudayaan, and Indonesia 2016).

However, the ability to understand mathematical concepts of Indonesian students is still relatively low. The results of the Programme for International Student Assessment (PISA) show that the mathematics ability of Indonesian students is still in the low category compared to other countries. Indonesia was ranked 64 out of 65 countries in 2012, ranked 69 out of 72 countries in 2015, and ranked 73rd out of 79 countries in 2018 (Tohir 2019). The low achievement indicates that most students still have difficulty in understanding and applying mathematical concepts in various contexts.

A similar problem was found at SMP Negeri 1 Suwawa. Based on the results of observations and interviews with mathematics teachers, it is known that most students still have difficulty understanding basic concepts of mathematics, especially in integer material. Many students are able to memorize integer operation rules but do not understand the reasons for using them. As a result, students often make mistakes when solving problems that are different from the examples given by the teacher.

Table 1. Average Student Mathematics Learning Outcomes

Classes	Number of Students	Average Score	KKM	Number of people who reached the KKM
VII A	26	67	70	9
VII B	26	65	70	6

The impact on the problem of students' ability to understand concepts in mathematics lessons is interesting, because when grade VII students face exams. Their learning achievements can affect the final result at the time of the exam. In addition, there are also concerns that students' interest in math lessons will decrease. Students' lack of ability to face mathematical challenges has an impact on their learning outcomes which can result in the achievement of non-optimal learning objectives, referring to the existing problems it is very important to maximize the ongoing mathematics teaching process in order to support students in improving their skills, which in turn will have a positive effect on their learning outcomes (Santoso et al., 2023)

The ability to understand mathematical concepts is not only limited to memorizing formulas, but also includes the ability to reinterpret concepts using one's own language (Wulan et al., 2020). Therefore, understanding concepts is not just remembering facts or procedures, but the ability to connect concepts and apply them in different situations through a meaningful learning process. According to Wari (2021), understanding mathematical concepts is an ability that is expected to be achieved in mathematics learning, namely the ability to understand the relationship between concepts and apply concepts and algorithms precisely, efficiently, accurately, and flexibly in problem solving. In line with this opinion, (Lestari et.al., 2018) states that mathematical understanding is the ability to absorb and understand mathematical ideas

The low understanding of mathematical concepts is not only influenced by cognitive factors, but also by affective factors. One of the affective factors that plays an important role is self-regulated learning. Self-regulated learning is the ability of individuals to plan, monitor, control, and evaluate the learning process independently to achieve predetermined goals. Learning independence does not mean learning separately from others, but rather allowing learners to discuss, ask questions, or ask for help when needed. According to Rusman, the independent learning process can improve students' understanding so that they do not always depend on teachers or other parties. According to Zimmerman (2000), students who have high self-regulated learning tend to actively seek information, set learning targets, control the learning process, and evaluate the learning outcomes obtained. In contrast, students with low self-regulated learning tend to be passive, give up easily, and rely on the help of others when facing learning difficulties. In mathematics learning, self-regulated learning has a very important role because mathematics requires the ability to think systematically and sustainably. Students who are able to manage the learning process independently will find it easier to understand abstract mathematical concepts. They are also better prepared to face challenges and difficulties in solving math problems.

Several previous studies have shown that Self-Regulated Learning has a positive contribution to students' mathematical abilities. Research conducted by Agung Pratikno (2022) shows that Self-Regulated Learning has an effect on students' understanding of mathematical concepts. Then research conducted by Amalia and Purwaningsi (2020) also found that Self-Regulated Learning has a positive influence on the ability to understand mathematical concepts.

Self-Regulated Learning (SRL) is a learning approach that positions students as the primary managers of their own learning process. In this approach, students not only receive information from the teacher but also actively plan, monitor, control, and evaluate their learning activities to achieve predetermined learning goals. Although various studies have examined Self-Regulated Learning in mathematics learning, most studies have focused more on the relationship between Self-Regulated Learning and learning outcomes, problem-solving skills, or mathematical creative thinking skills. Research that specifically examines the influence of the Self-Regulate Learning approach on students' ability to understand mathematical concepts in integer materials at the junior high school level, especially through quasi-experimental designs, is still relatively limited. Therefore, this study was conducted to provide empirical

evidence regarding the influence of the Self-Regulated Learning approach on students' understanding of mathematical concepts.

The novelty in this study lies in the application of the Self-Regulated Learning approach to improve students' understanding of mathematical concepts in integer materials through the Pretest-Posttet Control Group Design at the junior high school level. This study not only measures student learning outcomes, but also analyzes the influence of the Self-Regulated Learning approach on the ability to understand mathematical concepts based on a comparison between the experimental class and the control class.

Based on this description, a learning approach is needed that is able to develop cognitive abilities while increasing student learning independence, research. Therefore, to evaluate the influence of learning independence on the understanding of mathematical concepts when compared to other teaching, this study selected two groups. One group uses the Self-Regulated Learning approach, and the other group applies conventional learning. The main objective of this study is to study whether the Self-Regulated Learning approach has an influence on students' understanding of mathematical concepts to assess these achievements, the researcher analyzes student learning outcomes through pre-tests and post-tests.

METHOD

This study uses a Quasi-Experimental method with the design used is Pretest-Posttest Control Group Design. In this design, both groups of samples are given a pre-test before treatment and a post-test after treatment. The experimental class received learning with a Self-Regulated Learning approach, while the control class received conventional learning.

Table 2. Pretest Control Group Design

Classes	Pretest	Treatment	Posttest
Experiments	O_1	X_1	O_2
Controls	O_3	X_2	O_4

Description:

O_1 = Pretest experimental group

O_2 = Posttest experimental group

O_3 = Pretest control group

O_4 = Posttest control group

X_1 = Treatment by implementing Self-Regulated Learning-based learning

X_2 = Treatment by applying conventional learning

The research was carried out at SMP Negeri 1 Suwawa, Bone Bolango Regency, Gorontalo Province in the even semester of the 2025/2026 school year. Based on the opinion of Sugiyono (2020:130), population can be interpreted as a general scope that includes: entities or objects that have certain characteristics and quantities that are determined by researchers to be further analyzed and then conclusions are drawn. In this case, the population used includes all grade VII students of SMP Negeri 1 Suwawa which consists of two classes with a total of 52 students.

The instruments used in this study include: (1) Teaching Modules, (2) Student Worksheets (LKPD) and (3) Mathematical concept comprehension tests in the form of essays which refer to five indicators of concept understanding in integer material. Data collected

Through three techniques, namely: (1) pretest conducted before treatment to find out the student's initial ability; (2) posttest carried out after treatment to measure the improvement of learning outcomes; and (3) observation using observation sheets to monitor the implementation of learning. In this study, The data analysis included comparing students' pretest and posttest scores between the experimental and control groups using descriptive statistics. Furthermore, prerequisite tests consisting of the normality test and homogeneity test were conducted to ensure that the data met the assumptions for parametric analysis. The effectiveness of the treatment was also measured using the N-Gain test to determine the improvement in students' mathematical concept understanding. Finally, hypothesis testing was performed using an independent samples t-test to examine the significant differences between the two groups.

RESULTS AND DISCUSSION

Results

The initial tests conducted on the control group and the experimental group aimed to evaluate the basic skills of students from these two groups. The initial exam was conducted before the learning process began or before the treatment was applied to both groups observed. After the implementation of the pre-test of the two classes, the initial ability of students from both classes is known. During the learning activities in the control class, students recorded the data submitted by the researcher. The teaching methods used in the control classroom present problems that students have to overcome, but during the learning session, students seem to participate less actively and are more likely to play, so No. one asks them things they don't understand. On the other hand, in the experimental class, it was seen that students were more enthusiastic and appeared active during the learning process.

Data on the ability to understand mathematical concepts was obtained from the results of the pretest and posttest in both classes. A summary of the pre-test and post-test results can be seen in the data description table in Table 3 below:

Table 3. Descriptive Analysis Results

Data	Classes	N	Min	Max	Red	Median	Mode	SD	Variance
Pretest	Experiments	26	7	18	11,88	11,50	10	2,80	7,87
	Controls	26	6	16	11,12	10,00	10	2,69	7,23
Posttest	Experiments	26	14	24	20,85	22,00	22	2,45	5,98
	Controls	26	13	22	18,39	18,50	18	2,12	4,49

Based on the information in the table, it can be seen that the average score achieved by students in the pre-test in the two classes is not the same, with the control class obtaining, with the average of the experimental class being 11.88 and the control class being 11.12. Furthermore, if we pay attention to the maximum value of both classes, the control class shows the number 16 while the experimental class is also 18. For the minimum values of both groups, namely control class 7 and for experimental class 6. After being given treatment, the average posttest of the experimental class increased to 20.85, while the control class increased to 18.39. This shows that the increase in the experimental class is higher than in the control class. Furthermore, when considered from the highest and lowest values, the control class showed a number of 22 while the experimental class was also 24. For the minimum values of both groups, namely control class 13 and for experimental class 14.

Table 4. Descriptive Analysis Results

Classes	N	Pretest	Posttest	N-Gain	Category
Experiments	26	11,88	20,85	0,74	Tinggi
Controls	26	11,12	18,39	0,56	Sedang

Based on the N-Gain analysis presented in Table X, it can be seen that the improvement in students' mathematical concept understanding differs between the experimental class and the control class. The experimental class obtained an average N-Gain score of 0.74, while the control class obtained an average N-Gain score of 0.56. Based on the N-Gain classification criteria, the experimental class falls into the high category, whereas the control class falls into the medium category.

Before hypothesis testing, normality tests and homogeneity tests were carried out as a prerequisite for parametric statistical analysis. The normality test is an important step that must be carried out before starting parametric statistical analysis. The normality test uses the Liliefors test with the following criteria: for the test it is stated that if the Lcal < Ltable at $\alpha = 0.05$ is below a certain limit, then the data can be accepted as containing a normal distribution or H0. .accepted. On the other hand, if the Lcal > Ltable at $\alpha = 0.05$ is above this limit, then the data does not show a normal distribution. The results of the normality test analysis obtained can be found in the following table

Table 5. Data Normality Test Results

Data Groups	N	Count	Table	Conclusion
Experimental Class Pretest	26	0,050	0,1738	Normal
Control Class Pretest	26	0,050	0,1738	Normal
Posttest	26	0,1262	0,1738	Normal
Experiment Class Control Class Posttest	26	0,0721	0,1738	Normal

Based on the test parameters, if the Lcount < Ltable at $\alpha = 0.05$ is below a certain limit, then the data can be accepted as containing a normal distribution (accepting H0). In the Liliefors test, all pretest and posttest data in both classes have a Lcal value of < Ltable, so that H_0 is accepted and it is concluded that all data is normally distributed. With both data sets spread normally, the next stage is to perform homogeneity testing.

The purpose of uniformity testing is to find out if there are similarities between the experimental group and the control group. The test process is carried out with the help of Excel software where the test results are considered valid if the results are Fcal < Ftable. The results of the homogeneity test are presented in Table 6 below.

Table 6. Variance Homogeneity Test Results

Data	Classes	Variance	Calculation	Ftable	Conclusion
Pretest	Experiments Controls	7,8662 7,2262	1,0886	1,9554	Homogeneous
Posttest	Experiments Controls	5,9754 4,4862	1,3320	1,9554	Homogeneous

The results in Table 5 show that the Fcal < Ftable in the pretest data recorded a significant number of 1.0886. This shows that the significant value is lower than the Ftabel (1.0886 < 1.9554) which indicates that the preliminary data (pre-test) also shows homogeneity. This is also the same as the posttest value which recorded a significant value of 1.3320 which shows that the significant value is lower than the Ftable (1.332 < 1.9554), which indicates that the final data (post-test) also shows homogeneity or H₀ is accepted. Therefore, it can be concluded that the variance of the two groups is homogeneous. With the fulfillment of the conditions of normality and homogeneity, hypothesis testing can be continued.

After undergoing normality and homogeneity tests as initial requirements for both class groups, then an influence test was carried out with an independent sample t-test with the following stages.

- Determining the Hypothesis

H_0 = There was no significant influence on student learning outcomes between those who used the Self-Regulated Learning approach and those who were taught through the Conventional approach.

H_a = There is a prominent influence in learning outcomes between students who are taught through the Self-Regulated Learning approach and students who are taught through the Conventional approach.

- Determining the Level of Significance

  In the t-test analysis, an independent sample t-test was used with a significance level of 5% or 0.05. α =

- Determining Values t_{tabel}

  To find the value, it is done by looking for dk with a significance value of 0.05. So, if you use the significance level of 0.05, it is obtained = 1.675$t_{tabel} dk = n_1 + n_2 - 2 = 26 + 26 - 2 = 50 t_{tabel} t_{tabel}$

- Data Analysis

  The results of data analysis using the t-test can be shown in the following table.

Table 7 Independent Sample t-Test Results

Groups	Average	Variance	dk	Stuttgart	Table	Conclusion
Experiments	20,85	5,98	50	3,881	1,675	H₀ is rejected and Hα is accepted
Controls	18,39	4,49				

Based on Table 4, the value of tcal = 3.881 is greater than ttable = 1.675 at the significance level of α = 0.05 with the degree of freedom dk = 50. Thus H₀ is rejected and H is accepted, which means that there is a significant influence of the Self-Regulated Learning approach on students' understanding of mathematical concepts. Through the analysis of the t-test, the researchers concluded that there was a difference in the academic achievement of students between the experimental group and the control group. To identify which differences affect learning outcomes, analysis can be carried out by calculating the average learning achievement of each class.α

Discussions

The findings of this study are in line with the theory of Zimmerman (2000) which states that self-regulated learning is the ability of individuals to manage cognitive, motivational, and behavioral aspects in the learning process so that learning goals can be achieved optimally. Students who have good self-regulated learning tend to be more active, disciplined, and responsible for their learning process.

The results of this study are also supported by a study conducted by Agung Pratikno (2022) involving 111 students who concluded that the mathematical problem-solving ability of students taught using the SRL approach is higher than conventional learning. This is evidenced by the score obtained which is 0.424 or 42.4% and is evidenced by the significance value = 0.00 < 0.05. The influence of self-regulated learning on concept understanding is 42.4%. In addition, research conducted by Yunita Lesmanawati, Wardani Rahayu, Kadir, and Vina Iasha (2020) which stated that the results show that the role of mathematical creative thinking skills has an influence on Self Regulated Learning. The results of this study are expected to provide insight to teachers regarding the development of five basic mathematical competencies of students, so that they become a reference in expanding knowledge and popularizing teachers in providing mathematical tests to students.

In addition, this research is also in line with the research of Sofri Rizka Amalia and Dian Purwaningsih (2020) with the title The Influence of Self Regulated Learning and Google Classroom-Assisted Web Courses, Whatsapp Group on Concept Understanding. The results of this study are that there is a positive influence between the application of e-learning assisted by google classroom and whatsapp group on the ability to understand concepts, there is a positive influence between self-regulated learning on the ability to understand concepts, and there is a positive influence between the application of e-learning assisted by google classroom and whatsapp group on the ability to understand concepts. Research by Lu'luilmaknun et al. (2022) also shows that the higher the level of student learning independence, the better their ability to understand mathematical concepts.

The results of this study are consistent with the research of Winata, Friantini, and Sukirno (2021) which concluded that independent learning contributes to improving the understanding of mathematical concepts in technology-based learning. This research also aligns with research conducted by Bungsu et al. (2018), which also showed that independent learning has a positive relationship with mathematics learning outcomes. These findings support the results of this study, which showed an increase in the ability to understand mathematical concepts after implementing the SRL approach.

SRL-based learning has also been proven to increase students' confidence in solving problems independently, reduce dependence on teachers, and encourage higher learning initiatives. These factors contribute directly to the improvement of understanding of mathematical concepts, as students who have a high level of learning independence tend to be more effective at processing and integrating mathematical information (Zimmerman in Agung, 2022).

The results of the study prove that the Self-Regulated Learning approach has a significant effect on the understanding of mathematical concepts of grade VII students of SMP Negeri 1 Suwawa on integer material. The advantages of the experimental class can be explained through the characteristics of the SRL approach which emphasizes direct observation and active involvement of students during the learning process. The improvement in the ability to understand mathematical concepts in the experimental class occurs because during the learning process students are given the opportunity to manage and control their own learning process. Through the Self-Regulated Learning approach, students are trained to set learning goals, plan learning strategies, monitor learning progress, and evaluate the results obtained. These activities

make students more active in building their understanding of the mathematical concepts learned.

The implementation of experimental classroom learning with the treatment of self-regulated learning showed that the learning process carried out 4 meetings in each class showed a diverse increase. The increase in the control class from an average of 11.12 to 18.39 also showed that conventional learning still made a positive contribution, but it was not equivalent to the increase achieved by the experimental class (from 11.88 to 20.85). This difference confirms that the SRL approach is better able to encourage students to develop their cognitive abilities because they are more active in organizing and monitoring their own learning process. In the normality test for the experimental class, the value $L_{hitung} = 0{,}1262$, for the real level with n = 26, and thus Because, it is accepted. Thus, the mathematics learning outcomes for the experimental class are distributed normally. Data normality testing was also carried out on the data on the mathematics learning outcomes of students in the control class. From the students' mathematics learning outcomes, a score = 0.0721 was obtained while for the real level with n = 26 was obtained = 0.1738, because , thus the learning outcomes of the control class were also distributed normally.$\alpha = 0{,}05 L_{tabel} = 0{,}1738 L_{hitung} < L_{tabel}$. $L_{hitung} < L_{tabel} H_0 \, L_{hitung} \alpha = 0{,}05 L_{tabel} L_{hitung} < L_{tabel}$.

After the data normality test was carried out, a homogeneity test was carried out on the data obtained from students' mathematics learning outcomes. To carry out homogeneity testing, it is carried out with the F test (large variance test divided by small variance). Based on the results of the calculation in the appendix obtained = 1.332 seserta . Because it can be concluded that the variance of the data comes from a homogeneous population.$F_{hitung} F_{tabel} \; adalah \; 1{,}9554 F_{hitung} < F_{tabel}$.

Since both samples are normal distributions, statistical tests can be proceeded to hypothesis testing to assess how much of an influence self-regulated learning has on this study. For hypothesis testing in this study, a t-test (one-sided) was used, with a level and dk = . The hypothesis to be tested is to accept if with the degree of freedom (dk) = $\alpha = 0{,}05 n_1 + n_2 - 2 = 26 + 26 - 2 = 50 H_0 t_{hitung} > t_{tebel} \, n_1 + n_2 - 2$. Based on the findings of the independent t-test sample analyzed using Excel software, the value of tcal = 3.881 is greater than the significance of 0.05, it is obtained ttable = 1.675. Which shows that the tcount is > ttable or 3.881 > 1.675 thus H_0 is rejected and H is accepted.

Based on the results of the research that has been carried out on the t-test, the researcher can conclude that there is an influence on student learning outcomes between those who apply self-regulated learning and those who use conventional. It was found that the mathematics learning outcomes of students who were taught using Self-Regulated Learning were higher than the mathematics learning outcomes taught using conventional learning. Therefore, learning using self-regulated learning has a significant influence on the mathematics learning outcomes of grade VII students at SMP Negeri 1 Suwawa.

CONCLUSION

Based on the results of the research, data analysis, and discussions that have been carried out, it can be stated that the learning of the two groups in each test shows different variations. This difference is due to the increase in students' understanding after teaching. From the results of the study, it can be seen that before the learning activities began, the researcher carried out a pre-test on the experimental group and the control group aimed to evaluate the initial ability of each group. The results of the initial tests carried out by the researchers showed a difference in the average score between the two groups, where the experimental group obtained an average score of 11.88, while the control group recorded an average of 11.12. After the learning process

with different treatments was held, there was a significant difference in the post-test, where the control group received an average score of 18.39, while the experimental group achieved an average of 20.85. After the learning process with different treatments was held, there was a significant difference in the post-test, where the control group obtained an average score of 18.39, while the experimental group achieved an average of 20.85. In addition, the experimental class demonstrated a higher improvement in learning outcomes, indicating that the Self-Regulated Learning approach was more effective than conventional learning in enhancing students' understanding of mathematical concepts. The hypothesis testing results also confirmed a significant difference between the two groups, with tcal = 3.881 > ttable = 1.675 at a significance level of 0.05.

These findings answer the research question by demonstrating that the Self-Regulated Learning approach positively influences students' mathematical concept understanding. For future research, it is recommended to investigate the implementation of Self-Regulated Learning in different mathematical topics and educational levels with larger sample sizes. Future studies may also explore its impact on other mathematical abilities, such as problem-solving, reasoning, and mathematical communication skills.

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