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The Effect of Self-Regulation on Student's Mathematical Problem Solving Ability

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ABSTRACT

Math problem-solving skills are important for students to have. Because the subject of mathematics is very close to everyday life. But in reality many students can't control themselves to solve these math problems. Self-regulation is a very important ability to control individuals in acting when facing a problem, so it is indicated as a factor that has an influence on the ability to solve mathematical problems. Therefore, it is necessary to study the effect of self-regulation on students' mathematical problem solving ability. This study aims to (1) find out the picture of students' self-regulation, (2) know the picture of students' mathematical problem solving ability, (3) find out the influence of self-regulation on students' mathematical problem solving ability. The population in this study was grade V students at MI Ma'arif Kadipaten. Sampling techniques with non-probability sampling types and saturated sampling techniques. The research trial sample was class V A students totaling 25 respondents, while the research sample amounted to 22 respondents from class V B. Self-regulation data was obtained through questionnaires and mathematical problem solving skills through tests. The results of this study are (1) students' self-regulation is in the medium category, (2) mathematical problem solving ability is in the medium category, (3) there is a significant positive influence of self-regulation on mathematical problem solving ability.

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INTRODUCTION

The ability to solve problems has a very crucial role in life (Maulyda 2020). Mathematics, as one of the subjects that is closely related to daily life, is an important part of this. However, there is an irony from the early research we conducted that many students had difficulty solving math problems, even though this discipline is a fundamental element in life. The National Council Teachers of Mathematics (NCTM) emphasizes the importance of mathematics as the key to unlocking opportunities, stating that "mathematics is the key to opportunity". In addition, individuals also need to have competence, achievements, and intellectual abilities to make the most of these opportunities (Mashlihah and Hasyim 2019). The ability to solve math problems is one of the most essential skills. Problems often arise from the mismatch between expectations and reality. According to Cooney, a situation can be considered a problem if the individual is unable to resolve it in the way they normally would. Questions that seem simple can be problematic when students are not able to solve them with common methods. In this context, problem-solving skills become very important (Andi Nurlaelah, Ilyas, and Nurdin 2021).

Problem solving, according to Polya, is an effort to find solutions that can lead to the achievement of long-term goals. In the process of solving problems, students need effective methods or strategies to find solutions (Amaliah, Sutirna, and Zulkarnaen 2021). Therefore, the ability to find solutions to problems that cannot be solved in conventional ways is an important skill that students must have. Problem-solving ability is considered a cognitive ability related to evaluation, observation, and designing techniques to solve problems (Hali et al. 2022). Slovin stated that problem-solving involves using information and skills to achieve the right goals. These abilities relate to various aspects, including motivation, self-control, resilience, and cognitive abilities, among other factors (Hulaikah et al. 2020).

One indication of problem-solving ability is self-regulation, this is because problem-solving ability is related to the ability of individuals to self-control their behavior or attitude when facing something. In line with McClenland's research, self-regulation has become a key predictor of a variety of things, including academic achievement as well as long-term educational success. In his editorial, it is explained that self-regulation is an important part of advancing understanding and development (Wood et al. 2018). Inzlicht aid that self-regulation affects various areas such as job performance, health, and financial savings (Inzlicht et al. 2021). Meanwhile, in research related to self-regulated learning training, it was concluded that the training can improve academic performance and student motivation

(Bakker and de Vries 2021).

Bernard explained self-regulation regarding the mechanism by which the organism can regulate its internal state in response to internal and external stressors. For example, a child who is better able to regulate his or her behavioral responses to stressors is said to have high self-regulation (Robson, Allen, and Howard 2020). According to Reinecke, self-regulation is defined as the ability to override or alter a person's inner response, as well as to stop the tendency to behave in a way that is desirable and refrain from acting on it (Reinecke, Gilbert, and Eden 2022). Zimmerman and Martinez Pons classify the characteristics of a person who is able to regulate themselves is like a person who is able to start on his own and is persistent in learning, confident and has many ideas in dealing with problems, and is reactive to himself and his performance is good in carrying out his duties (Caron and Markusen 2016). From the explanation of the experts above, it is concluded that self-regulation is the ability of humans to control themselves in controlling behavior, emotions, and impulses in order to create effective conditions in the learning process so that the planned goals are achieved.

Based on the results of initial research related to the student's situation, it is suspected that the ability to solve mathematical problems is influenced by self-regulation. If the results of self-regulation research are proven to have a positive effect on mathematical problem-solving skills, then efforts can be made to improve mathematical problem-solving skills by exploring self-regulation indicators. In the previous research mentioned above, it was proven that self-regulation is closely related to the ability to control oneself in dealing with something. Therefore, further research is needed regarding the influence of self-regulation on students' mathematical problem-solving skills.

RESEARCH METHOD

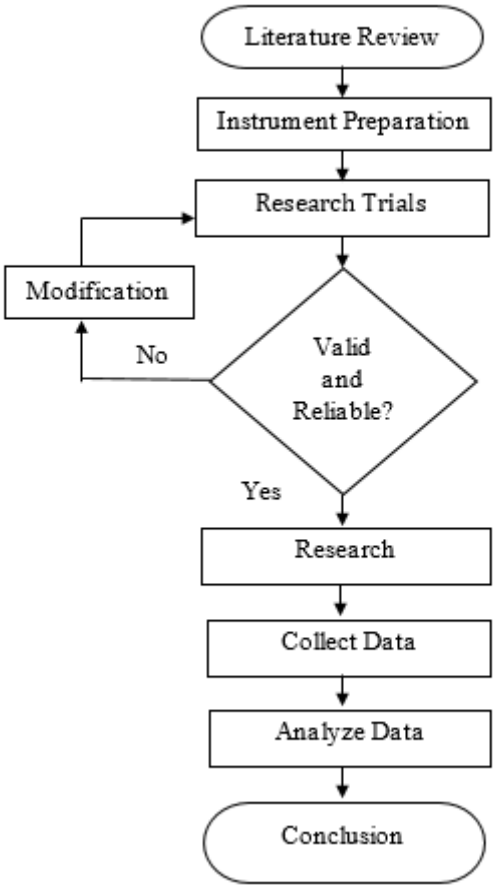

Figure 1. Research Flowchart

This type of research is a survey research in which the researcher will administer a survey on a sample or the entire population of people to describe attitudes, behaviors, opinions, or special characteristics in the population and aim to determine the influence of Self-Regulation on Students' Mathematics Problem Solving Ability (Creswell 2015).

This research was carried out at MI Ma'arif Kadipaten Ponorogo Regency. The subject of this study is students of class V A as a research trial class to find out the instruments that are declared valid and reliable, so that they can be continued in the research in class V B. In this study, the sample used was 22 people with a sampling technique with a saturated sampling model.

The data collection technique in this study was carried out with two techniques, namely test and non-test techniques. The test technique is carried out with a planned and systematic measuring instrument and arranged according to procedures to measure the ability and knowledge of students. In this study, tests are used to measure students' problem-solving

skills. While non-test techniques are a set of instruments to assess students without testing them, but with systematic observation. Non-test techniques are used to find out student self-regulation through the distribution of questionnaires whose results are known based on student responses.

According to Zimmerman, there are three aspects of self-regulation that must exist in each individual. The three aspects are metacognitive, motivational, and behavioural (Mardianti Asyhaer et al. 2023). The questionnaire instrument that is prepared must contain these three indicators.

Table 1. Indicators of Self-Regulation

Indicator	Description
Metacognitive	Matlin defines metacognition as understanding and awareness related to cognitive processes or thought processes. The three stages of metacognitive strategies are the conscious process of learning, learning planning, and monitoring or reflection (Ulum 2016).
Motivational	Motivation is a basic need that controls a person's behavior and is related to the ability in the individual. In the aspect of motivation, it is influenced by three things, namely intrinsic motivation, autonomy, and self-confidence.
Behavioral	The behavioral aspect is an effort that can regulate a person, select, and optimize the environment that supports his activities (Mardianti Asyhaer et al. 2023).

The preparation of student problem-solving ability test questions is carried out by paying attention to the stages in problem-solving skills. Polya explained the four stages of problem-solving skills, namely understanding the problem, devising a plan, carrying out the plan, and looking back (Rambe and Afri 2020).

Table 2. Stages of Problem Solving Ability

Stages of Polya	Description
Understand The Problem	Students can write down what they know and ask in the question appropriately.
Devising A Plan	Students create a problem-solving plan and write down the complete list of the problems they ask along with all the information they get
Carrying Out The Plan	Students can carry out the plan made, prepare the correct completion steps, correct procedures and calculations.
Looking Back	Students double-check answers and write down conclusions

The first research is a form of trial to determine the validity and reliability of self-

regulation questionnaire instruments and mathematical problem-solving ability tests. If the calculation ≥ the table, then it can be concluded that the questionnaire item is valid. However, if the calculation ≤ the table, it can be concluded that the questionnaire item is invalid (Wulansari 2018). With the number of subjects (N) of 25 students with a significance level of 5%, the table = 0.396 was obtained. The statement item is said to be valid if the calculation value ≥ 0.396. Based on these provisions, it was stated that 20 valid self-regulation questionnaires and 5 valid math problem-solving ability test questions. Meanwhile, the provision of a construct or variable is said to be reliable if the value of Cronbach Alpha > 0.7. Based on these provisions, self-regulation questionnaires and mathematical problem-solving ability tests are declared reliable. Questionnaire and test instruments that are declared valid and reliable can be used as research instruments, while invalid items are disqualified (Widyaningrum 2015).

After the item is declared valid and reliable, real research is carried out through questionnaires and tests. The data obtained was then analyzed, in this study two data analysis techniques were used, namely through statistical or inferential tests to explain the data, and linear regression tests to analyze inferential data assisted by the SPSS 25.0 for windows application. To find out the level of self-regulation so that it is easier to analyze student data on the ability to solve mathematical problems, it is necessary to group the self-regulation category (Arikunto 1996). The grouping criteria are as follows:

Table 3. Self-Regulation Categorization

Category	Criteria
$X \leq (Mx - 1{,}0\ SDx)$	Low
$(Mx - 1{,}0\ SDx) < X < (Mx + 1{,}0\ SDx)$	Medium
$X \geq (Mx + 1{,}0\ SDx)$	High

Information:

X = total score of the object

Mx = average score

SDx = standard deviation

Students' mathematical problem-solving skills also need to be categorized, so that later the picture of mathematical problem-solving skills with students' self-regulation based on their categories can be analyzed. The following are the criteria for categorizing students' mathematical problem-solving skills:

Table 4. Mathematical Problem Solving Ability Categorization

Category	Criteria
$X \leq (Mx - 1{,}0\ SDx)$	Low
$(Mx - 1{,}0\ SDx) < X < (Mx + 1{,}0\ SDx)$	Medium
$X \geq (Mx + 1{,}0\ SDx)$	High

Information:

X = total score of the object

Mx = average score

SDx = standard deviation

RESULT AND DISCUSSION

After obtaining the results of the research obtained from the students' responses in the questionnaire and students' answers in taking the test, then a descriptive statistical test was carried out to find out the picture of self-regulation and students' mathematical problem-solving skills. Classical assumption tests and linear regression tests were also carried out to determine the influence between self-regulation on students' mathematical problem-solving skills (Wulansari 2018).

Overview of Student Self-Regulation

The picture of student self-regulation can be known based on the results of the descriptive statistical test obtained from the answers to the 4-scale questionnaire totaling 23 questions that were distributed and responded to by students. The description of student self-regulation is presented in the following table:

Table 5. Descriptive Statistics of Student's Self Regulation

Descriptive Statistic	Value
Minimum	46
Maximum	90
Mean	78
Standar Deviation	12,482

Based on the data above, it is known that Mx = 78 and SDx 12,482. Thus, it is known that the questionnaire score with a value of more than or equal to 90 gets the high category, between 90 and 66 gets the medium category, and less than or equal to 66 gets the low category.

Table 6. The Result of Student's Self-Regulation Categorization

Value	Category	Frequency
$X \leq 66$	Low	3
$66 < X < 90$	Medium	18
$X \geq 99$	High	1

It can be seen from the table above, that the self-regulation questionnaire scores of students in the low category are 3 students, the medium category is 18 students, and the high category is 1 student. So it can be concluded that student self-regulation is in the medium category.

Overview of Students' Mathematics Problem-Solving Ability

An overview of students' mathematical problem-solving ability can be known based on the results of descriptive statistical tests obtained from test answers totaling 5 questions with a maximum score of 10 for each question. An overview of students' mathematical problem-solving skills is presented in the following table:

Table 7. Descriptive Statistics of Student's Mathematical Problem Solving Ability

Descriptive Statistic	Value
Minimum	25
Maximum	50
Mean	44
Standar Deviation	7,323

Based on the data above, it is known that Mx = 44 and SDx = 7.323. Thus, it is known that the questionnaire score with a value of more than or equal to 51.3 gets the high category, between 51.3 and 36.7 gets the medium category, and less than or equal to 36.7 gets the low category.

Table 8. The Result of Student's Mathematical Problem Solving Ability Categorization

Value	Category	Frequency
$X \leq 36,7$	Low	3
$36,7 < X < 51,3$	Medium	19
$X \geq 51,3$	High	0

It can be seen from the table above, that the scores of students' mathematical problem-solving skills in the low category were 3 students, the medium category was 19 students, and no students got a high category in mathematical problem-solving skills. So it can be concluded that students' mathematical problem-solving ability is in the medium category.

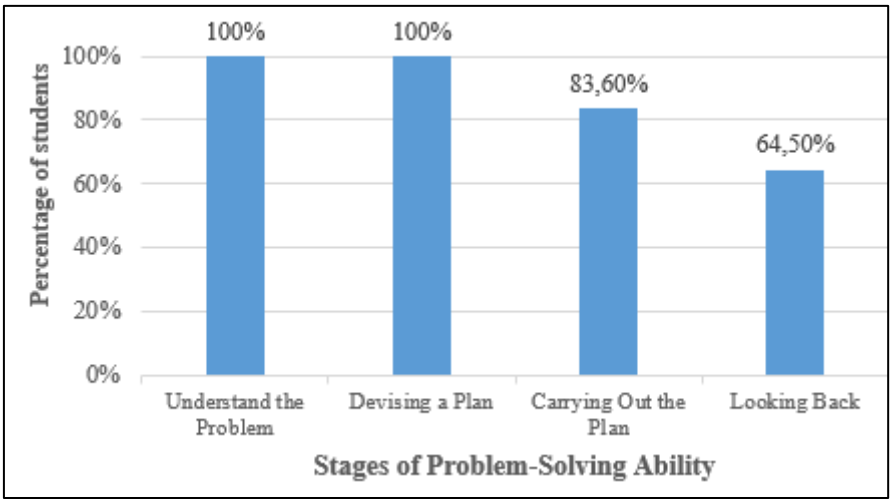

Figure 2. Results of Analysis of Students' Mathematical Problem Solving Abilities

The researcher also analyzed the achievement of each indicator of problem-solving ability in the results of the student's mathematical problem-solving ability test. Based on the results of the analysis, the results as presented in the image above were obtained that students were able to understand the problem and make a good problem-solving plan. However, out of the total number of students, only 83.6% of students were able to carry out the math problem solving plan and 64.5% of the students rechecked the results of solving math problems. Based on the findings, it can be concluded that students are easier to understand problems and make a solution plan, but only some of them can implement the solution plan and review the results of the problem solving that has been carried out. This can happen due to a lack of autonomy and motivation of students in solving math problems.

The Effect of Self-Regulation on Students' Mathematics Problem-Solving Ability

To determine the influence of self-regulation on students' mathematical problem-solving ability, a linear regression test was conducted. However, before entering the linear regression test, it is necessary to carry out a classical assumption test including the normality test, linearity test, multicollinearity test, and heteroscedasticity test (Widyaningrum 2015). The test results can be seen in the following table:

Table 9. Classical Assumption Test Results

Classical Assumption Test	Criteria	Value	Result
Normality Tests	>0,05	0,121	Normal
Linearity Tests	*Linearity* <0,05 *Deviation from linearity* >0,05	0,000 0,293	Linear
Multicollinearity Tests	*Tolerance* >0,1 VIF <10	0,728 1,374	Multicollinearity doesn't occurs
Heteroscedasticity Tests	*absolute residual* >0,05	0,488	Heteroscedasticity doesn't occurs

From the table above, it is known that the data are distributed normally, linearly, no multicollinearity, no heteroscedasticity so that it is said to have met the classical assumption test as a condition for a linear regression test. Next, a linear regression test was carried out whose results can be seen as follows:

Table 10. Linear Regression Test Results

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	6.025	5.777		1.043	.309
	Self-Regulation	.487	.073	.830	6.653	.000
a. Dependent Variable: Problem Solving Ability						

In the results of the simple linear regression above, it can be seen that constant (a) is valued at 6.025 and self-regulation (b) is valued at 0.487. So the regression equation can be written Y = 6.025 + 0.487X. From the equation, it can be concluded that the value of the constant is 6.025, meaning that if the self-regulation is 0, then the student's mathematical problem-solving ability is worth 6.025. The regression coefficient of the self-regulation variable is 0.487, meaning that if the student's self-regulation increases by one unit, then the student's mathematical problem-solving ability will increase by 0.487 units. The coefficient has a positive value meaning that there is a positive relationship between self-regulation and students' mathematical problem-solving skills. So it can be concluded that the higher the student's self-regulation, the higher the student's mathematical problem-solving ability.

Berns argues that self-regulation is one's own ability that also involves the ability of others to control behavior, impulses, and emotions at the right time, condition, and place. However, not all individuals have good self-regulation. Based on the results of the study between students with the highest problem-solving ability and the lowest, it is known that there are differences in responses related to self-regulation. Students who score the highest

in problem-solving skills can manage their study time independently without being commanded. He also believes that the test scores obtained will affect the final score, so he continues to try to improve the test score. Meanwhile, students with the lowest problem-solving ability scores do not care if the test score will affect the final score, and do not have the initiative to study independently without being commanded.

Zimmerman explained that self-regulation consists of 3 aspects, namely metacognitive, motivational, and behavioral. The researcher analyzed the influence of each indicator through the determination coefficient test, which has the greatest influence on students' mathematical problem-solving ability. The results are as follows:

Table 11. Results of Self-Regulation Indicator Analysis

Indicator	R Square
Metacognitive	69,5%
Motivational	70,7%
Behavioral	47,2%

From the results of the determination coefficient test, it is known the percentage of influence of each self-regulation indicator on mathematical problem-solving ability. Metacognitive indicators have an influence of 69.5%, motivation indicators have an influence of 70.7%, and behavioral indicators have an influence of 47.2%. Based on the results of the analysis, it can be concluded that motivation indicators have the greatest influence on students' mathematical problem-solving skills.

If discussed more deeply, motivation indicators have sub-indicators, namely intrinsic motivation, autonomy, and self-confidence. Based on the students' responses in answering the questionnaire, it is known that students do not have good self-autonomy. Most students tend to choose to ignore if they get a score below the KKM, also less concerned about the math homework given if they have other busyness.

CONCLUSION

From this study, it can be concluded that self-regulation has a significant positive influence. If the student's self-regulation is good, then the problem-solving ability is also good. It was also found that the self-regulation indicator that had the greatest influence on mathematical problem-solving ability was the motivation indicator. These indicators are related to intrinsic motivation, autonomy, and self-confidence. From the results of research in the field, it is evident that students' motivation to face problems is still low. So in this case, it is necessary to evaluate student self-regulation, especially in the motivation indicator which

has the greatest influence on problem-solving skills. To be able to improve students' problem-solving skills, teachers or learning companions must also improve student self-regulation. It is not permissible to decide that students are stupid just because they have not been able to solve problems well. Because it is proven that problem-solving ability is not only influenced by intelligence quotient (IQ) but also influenced by self-regulation. Furthermore, it is necessary to research things that can improve students' self-regulation based on their indicators, considering that this self-regulation has a great positive influence on mathematical problem-solving skills.

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