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Multiple Regression Analysis: Self-Efficacy, Self-Regulated Learning, Math Learning Outcomes

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ABSTRACT

Learning outcomes are interconnected with the competencies and self-perceptions possessed by each person. This research investigates the impact of self-efficacy and self-regulated learning on the results of mathematics learning. This research included a total of 164 students from two Madrasah Aliyah (MA) located in the Bantul area. The used research methodology is quantitative in nature. The used tools included self-efficacy and self-regulated learning questionnaires, alongside the outcomes of the midterm assessments. Data analysis procedures include doing precondition tests and using multiple linear regression analysis. The prerequisite tests include normality testing, linearity tests, homogeneity tests, and multicollinearity tests. The data processing results in a regression model: $Y = 11,091 + 0{,}676X_1 + 0{,}273X_2$, This indicates that self-efficacy and self-regulated learning have a beneficial impact on mathematics learning outcomes. The acquisition of the F test indicates that a significance value of 0.00<0.05 is achieved, indicating that self-efficacy and self-regulated learning have a substantial impact on students' mathematical learning results.

Kata Kunci:
Self-efficacy,
Self-regulated learning,
Hasil Belajar Matematika

ABSTRACT

Hasil belajar saling berhubungan dengan kompetensi dan persepsi diri yang dimiliki oleh setiap orang. Penelitian ini menyelidiki dampak efikasi diri dan pembelajaran yang diatur sendiri terhadap hasil belajar matematika. Penelitian ini melibatkan total 164 siswa dari dua Madrasah Aliyah (MA) yang berada di daerah Bantul. Metodologi penelitian yang digunakan bersifat kuantitatif. Alat yang digunakan termasuk efikasi diri dan kuesioner pembelajaran yang diatur sendiri, di samping hasil penilaian tengah semester. Prosedur analisis data meliputi melakukan uji prakondisi dan menggunakan analisis regresi linier berganda. Uji prasyarat meliputi uji normalitas, uji linearitas, uji homogenitas, dan uji multikolinearitas. Hasil pengolahan data dalam model regresi: $Y = 11,091 + 0{,}676X_1 + 0{,}273X_2$*, Hal ini menunjukkan bahwa efikasi diri dan self-regulated learning memiliki dampak menguntungkan terhadap hasil belajar matematika. Perolehan uji F menunjukkan tercapainya nilai signifikansi* $0{,}00 < 0{,}05$ *yang menunjukkan bahwa efikasi diri dan self-regulated learning berdampak besar terhadap hasil belajar matematis siswa.*

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Introduction

One of the general sciences on which modern technological progress is based is mathematics (Munahefi et al., 2022). Mathematics plays a pivotal role across multiple scientific domains and enhances cognitive abilities. The swift progress in today's information and communication technology heavily relies on advancements in mathematics, encompassing number theory, algebra, analysis, probability theory, and discrete mathematics (Subarianto et al., 2019). Strong mathematical skills from

an early age are the main key to mastering and creating technology in the future. Mathematics is also the foundation for students to be able to obtain, manage, and utilize information in dynamic, uncertain, and competitive situations (Aini, 2022). Therefore, focusing on learning mathematics is very important considering how relevant mathematics is for students' future (Lestari, 2015).

On the other hand, the benchmark for educational success in Indonesia is still reviewed from student learning outcomes, especially in mathematics learning. Learning outcomes are students' self-assessments (Young et al., 2003), the term learning outcomes refers to the tangible and verifiable improvements in skills or accomplishments that students undergo as a direct consequence of their educational experiences. of learning experiences (Németh & Long, 2012). Clemons (Fasikhah & Fatimah, 2013) additionally, it contends that learning outcomes are influenced by a multifaceted interplay of factors such as individual aptitude, self-awareness, parental approach, socioeconomic standing, task evaluation, success expectations, cognitive approaches, self-control, gender, academic performance, personal attitudes towards education, and other related aspects. According to Nasution (2002), the outcome of acquiring knowledge in mathematics is the degree of proficiency in comprehending mathematical concepts. mathematical learning outcomes refer to the specific skills and knowledge that children acquire as a result of engaging in mathematical learning activities. The learning results of each learner vary among individuals (Ruliyanti, 2014). However, many viewpoints indicate that students who excel in mathematics also showcase competence in other subjects. Despite several factors potentially affecting students' math performance, like self-regulated learning, there's a perception of a link between success in math and broader academic abilities.

Self-regulated learning is key in students' academic success at the secondary school level, especially in complex subjects such as calculus and physics (Taub et al., 2022). Self-regulated learning in the learning process encompasses more than simply cognitive ability or academic aptitude. It is a systematic approach that assists people in transforming their cognitive abilities into practical skills within an academic setting (Zimmerman, 1990). Self-regulated learning theory is focused on developing three learning principles: metacognition, motivation, and essential action (Brenner, 2022; Winne & Perry, 2000; Zimmerman, 2008). The metacognitive approach in learning seeks to identify students' difficulties in self-regulated learning, while the metacognition method aims to understand obstacles in students' self-learning (Brenner, 2022). Motivating learning is one that is ready to face complex challenges. Learning through essential actions is an approach that solves problems with self-regulated learning as a mental, emotional, and strategic process that individuals create to achieve their personal goals in a planned manner (Jiang et al., 2022). This view is in line with the concept that self-regulated learning involves planning and

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monitoring thought and feeling processes in completing academic tasks (Kerlin, 1992).

Students with good self-regulation also have good control in achieving academic goals (Assakinah et al., 2022). Self-regulated learning helps students to develop the skills necessary to learn effectively, so that they can achieve their academic expertise. The ability of students to manage their own learning process has an important role in achieving optimal achievement (Rahmiyati, 2017). Success in achieving learning targets can be observed from the academic achievements obtained (Fadila et al., 2021). This implies that self-regulated learning is a significant contributor to achieving favorable learning outcomes. Self-efficacy is an equally crucial factor in learning mathematics, alongside self-regulated learning.

Self-efficacy is one of the personal elements that can improve mathematics learning outcomes. This is an important part of the affective aspect because it has a major impact on learning objectives and the achievement of learning outcomes (Safiqo, 2020). Self-efficacy is the belief in one's own competence to effectively plan and execute activities required to achieve desired outcomes (Bandura, 1995). Self-efficacy involves an individual's perception and belief in their skills as well as the ability to move themselves towards specific goals (Jatisunda, 2017; Puozzo & Audrin, 2021). In addition, self-efficacy is also a determining factor in how strongly individuals engage in activities, how long they endure obstacles, and how resilient they are to situations that may not be suitable for them (Zubaidah et al., 2021). Thus, self-efficacy is a belief in one's own talents and capacity to complete the task at hand. This belief is reflected in planning, executing, and completing tasks in accordance with the goals to be achieved.

In practice, students often do not have confidence in their ability to solve the mathematical problems faced (Nurani et al., 2021; Pangestu & Sutirna, 2021). This has an impact on students' ability to show academic achievement in accordance with their potential. When faced with complex math problems, students with low levels of self-efficacy feel discouraged and less likely to complete a given task. Conversely, students with a high level of self-efficacy when faced with a challenging math problem, will feel motivated and eager to solve it (Fitri, 2017).

Multiple studies have shown the substantial impact of self-regulated learning on learning outcomes, including study (Fadila et al., 2021; Nurfa & Quraisy, 2021; Sholiha et al., 2022). Advocates contend that students who possess a strong capacity for self-regulated learning are capable of effectively managing their own learning process, resulting in favorable academic achievements. Conversely, children without this ability may struggle to achieve desired learning results. In other studies such as (Lesmanawati et al., 2020; Ruswana & Zamnah, 2018) stated that there is a

notable correlation between self-regulated learning and pupils' capacity to comprehend and engage in innovative mathematical thinking. Research (Fitriani & Pujiastuti, 2021; Missa et al., 2022) also elucidated the findings of a substantial correlation between self-efficacy and academic achievements in mathematics. This study aims to do regression analysis to further investigate the relationship between self-regulated learning, self-efficacy, and mathematics learning outcomes, building upon previous research findings.

Method

The study used a quantitative methodology with a descriptive orientation. The objective of the research is to examine the potential impact of the variables of self-efficacy (X_1) and self-regulated learning (X_2) on mathematics learning outcomes (Y). The data was collected using a non-test method, namely a self-efficacy scale with 17 items (8 positive and 9 negative) and a self-regulated learning scale with 20 statements (11 favorable and 9 unfavorable). The non-test instruments have undergone a validation procedure and have been deemed valid and suitable for usage after modification. The data pertains to the learning outcomes in mathematics, which were obtained from the midterm exams of students in mathematical disciplines.

The research included the whole student population of two Islamic-based institutions, namely Madrasah Aliyah (MA), located in Bantul Regency, Yogyakarta. A total of 164 samples were collected from the whole population utilizing random sampling. The research used necessary tests and multiple linear regression analysis, using the Statistical Package for Social Science (SPSS) version 25 data processing tool, to conduct data analysis. The necessary tests used include the Kolmogorov-Smirnov normalcy test, homogeneity test, linearity test, and multicollinearity test. Subsequently, the data undergoes several linear regression tests to ascertain the impact of the independent variable on the dependent variable. The mathematical expression for multiple linear regression is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon$$

Information:

Y : Dependent variables
$\beta_0, \beta_1, \ldots, \beta_k$: Population parameters
$X_1, X_2, \ldots, X_k$: independent variable
ε : random error

Results and Discussion

Researchers collected various data using self-efficacy questionnaires, self-regulated learning questionnaires, and Midterm Assessment scores to conduct their study. As for the steps taken by researchers to find out whether self-efficacy and self-regulated

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learning affect learning outcomes, multiple linear regression tests will be carried out by first going through several prerequisite tests.

Test Analysis Prerequisites

The prerequisite tests used include normality tests using the Kolmogrov Smirnov normality test, homogeneity test, linearity test, and multicollinearity test.

Normality Test

The researchers computed the three data points to see whether they followed a normal distribution, based on the available data. Conducting a normality test using the One Sample Kolmogorov-Smirnov Test. This study used a significance level of $\alpha = 5\% = 0.05$. The calculation output is presented in Table 1.

Table 1. Normality Test

Komponen	Nilai
N	164
Normal Parameters (a, b)	
Mean	0.0000000
Std. Deviation	21.47658962
Most Extreme Differences	
Absolute	0.062
Positive	0.043
Negative	-0.062
Test Statistic	0.062
Asymp. Sig. (2-tailed)	0.200 c,d

a. Test distribution is Normal
b. Calculated from data
c. Lilliefors Significance Correction
d. This is a lower bound of the true significance

Table 1 show that the Asymp. Sig. (2-tailed) value of 0.200. This means that the value is greater than 0,05. Based on the collection of these values, it may be inferred that the data gathered have a normal distribution. The scatter plot displayed in Figure 1 below also provides information on the normality data.

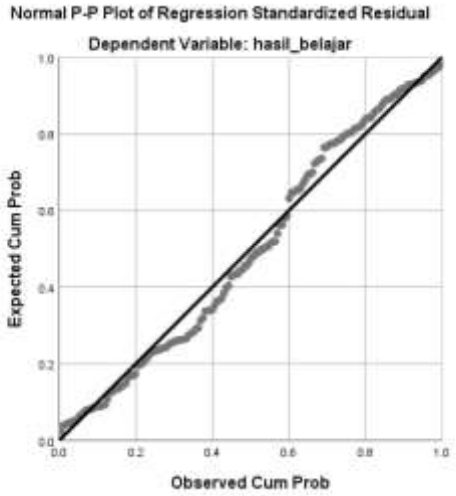

Figure 1. Normality Test Plot

The data acquired in this investigation exhibit a normal distribution, as seen in Figure 1. The conclusion was derived from the study of the scatter plot findings, which showed dispersed circles that were distributed along a linear trend.

Homogeneity Test

Based on the output in Figure 2, information is obtained that the research data is homogeneous or has the same variance. The conclusion is drawn based on a scatter plot which shows that the spheres spread randomly, both above and below the number 0 on the Y axis.

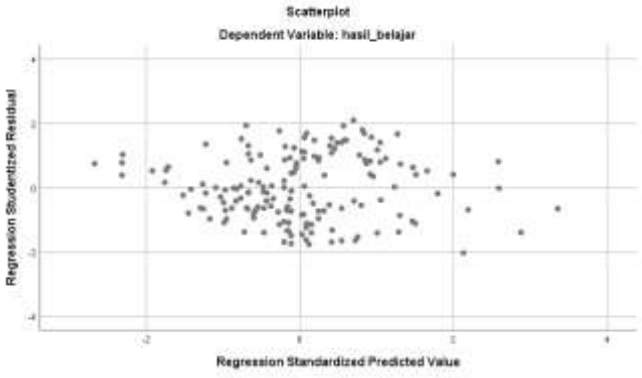

Figure 2. Homogeneity Test Plot

Figure 2 illustrates that the data collected in this investigation have a normal distribution. The conclusion was derived from the study of the scatter plot findings, which showed dispersed circles distributed along a linear trend.

Linearity Test

The linearity test is conducted on two separate occasions. Initially, a test will be conducted to examine the relationship between self-efficacy and students'

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mathematical learning results, specifically focusing on linearity. Furthermore, the study examines the relationship between self-regulated learning and student mathematical learning results using a linearity test. The results of the linearity test examining the relationship between self-efficacy and students' mathematical learning outcomes can be seen in Table 2.

Table 2. Linearity test of Self Efficacy and learning Mathematics

Sumber Variasi	Sum of Squares	df	Mean Square	F	Sig.
Between Groups (Combined)	38863.103	37	1050.354	2.681	0.000
├── Linearity	24445.533	1	24445.533	62.387	0.000
└── Deviation from Linearity	14417.570	36	400.488	1.022	0.448
Within Groups	49371.536	126	391.838	—	—
Total	88234.639	163	—	—	—

Table 2 show that a significance value in Deviation from Linearity of which means greater than $0.448 > 0.05$. With the acquisition of these values, it can be concluded that the self-efficacy variable (X_1) and the learning outcome variable (Y) have a significant linear relationship. Furthermore, the linearity test between self-regulated learning and student mathematics learning outcomes is contained in Table 3.

Table 3. Linearity test of Self Regulated Learning and Mathematics Learning Outcomes

Sumber Variasi	Sum of Squares	df	Mean Square	F	Sig.
Between Groups (Combined)	12862.125	19	676.954	1.293	0.196
├── Linearity	323.760	1	323.760	0.619	0.433
└── Deviation from Linearity	12538.364	18	696.576	1.331	0.177
Within Groups	75372.514	144	523.420	—	—
Total	88234.639	163	—	—	—

Table 3 show that a significance value in Deviation from Linearity of which 0.177 means greater than 0.05. Based on the acquisition of these values, it can be inferred that there is a substantial linear connection between the self-regulated learning variable (X_2) and the learning result variable (Y).

Multicollinearity Test

The purpose of the multicollinearity test is to assess the correlation between each variable. An ideal regression model should exhibit no connections among its independent variables. The research data underwent a multicollinearity test, the results of which are shown in Table 4.

Table 4. Multicollinearity Test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Model
1	0.529[a]	0.280	0.271	19.863	1

Predictors: (Constant), SRL, self_efficacy

Table 4 show the value of $R = 0.529$; $R^2 = 0.280$; and $R_a^2 = 0.271$. This shows that the value of R is still far from number 1, so it can be said that multicollinearity has not occurred. Because R is greater than R^2 ($R > R^2$), hence multicollinearity is considered harmful. However, if you use VIF, you get the VIF value as follows:

$$VIF = \frac{1}{1 - R^2} = \frac{1}{1 - 0.280} = 1.389$$

Because the value of $VIF = 1.389 < 10$, it is still categorized as no multicollinearity with a tolerance of $\frac{1}{1.389} = 0.72$.

Multiple Linear Regression Test

Once the precondition test confirms that the data is normally distributed, homogeneous, linear, and free from multicollinearity, it may be used for conducting influence testing. Multiple linear regression tests are conducted to assess the impact of the independent variables X_1 and X_2 on the dependent variable Y. The results of these tests are shown in Table 5.

Table 5. T Test

Variabel	B	Std. Error	Beta	t	Sig.
(Constant)	11.091	17.448	—	0.636	0.526
Self_Efficacy	0.676	0.164	0.311	4.128	0.000
SRL	0.273	0.268	0.077	1.017	0.010

Table 5 provided data for a study on the impact of each independent variable on the dependent variable. In the Constant line, a significance value of $0{,}526 > 0{,}05$ is obtained, meaning H_0: $\beta_0 = H_0$ accepted, so β_0 there is no need to put into a multiple linear regression model. Furthermore, in the self-efficacy line, a value of $Sig.\, 0{,}000 <$ 0,05 is obtained, meaning H_0: $\beta_1 = H_0$ rejected, so that there is a significant effect of self-efficacy on mathematics learning outcomes if SRL is taken into account. Finally, in the SRL line, the value of $Sig. = 0{,}010 < 0{,}05$ is obtained, meaning H_0: $\beta_2 = \beta_0$ acceptable, there is a notable impact of self-regulated learning (SRL) on mathematics learning outcomes when considering the influence of self-efficacy. In order to assess the impact of the independent variable on the dependent variable, the F test is conducted, as shown in Table 6.

Table 6. F Test

Model	Sumber	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6298,661	2	3149,330	10,027	,000[b]
	Residual	50566,283	161	314,076		
	Total	56864,944	163			

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a. Dependent Variable: *hasil_belajar*
b. Predictors: (Constant), SRL, *self_efficacy*

In Table 6 (ANOVA) above, the calculated $F\ value = 10.027$ is obtained. In the last column (column Sig.) you can see the number 0,000. Compare this number with the level of significance of the α we set. The condition is to reject H_0 if $Sig < \alpha$, with $\alpha = 0{,}05$. These results indicate that self-regulated learning and self-efficacy have a considerable impact on students' mathematics learning outcomes.

The regression equation model, $Y = 11,091 + 0{,}676X_1 + 0{,}273X_2$ demonstrates that the self-efficacy variables have a favorable impact on mathematics learning results. This means that every increase in self-efficacy, mathematics learning outcomes increase by 0,676 units at a constant of 11,091. Greater self-efficacy leads to a better level of mathematical learning achievement. Consistent with the findings of (Fitriani & Pujiastuti, 2021) research indicates that self-efficacy accounts for 65.3% of the variance in students' mathematical learning results, with the remaining portion being attributed to other factors. According to researchers' observations, various elements influence students' self-efficacy. Many students lack confidence in their abilities and perceive mathematics as a challenging subject, resulting in a lack of interest in learning it. When students possess high self-efficacy, they're motivated to persist in problem-solving. Conversely, low self-efficacy leads students to give up quickly when confronted with challenges.

Like self-efficacy, self-regulated learning also has an impact on students' mathematical learning results. Seen in the regression model $Y = 11,091 + 0{,}676X_1 + 0{,}273X_2$ shows that there is an increase in learning outcomes of 0,273 for every increase in student self-regulated learning. Other studies have also revealed that self-regulated learning affects 40% of students' mathematics learning outcomes (Arsyad et al., 2022). There are several factors that can affect self-regulated learning, namely students who tend to depend on teachers, and students tend to have difficulty in doing and developing their thinking skills. The level of student engagement in enhancing their own performance throughout the mathematics learning process directly influences the attainment of desired mathematics learning goals. This is in line with (Chaudhary, 2018) opinion that self-regulated learning is an important thing of learning and achievement where self-regulated students are much more likely to succeed in the learning process and reach higher levels. Therefore, children with a strong ability to manage their own learning will achieve high levels of mathematical learning.

The F-statistical test had a significance level of $0.000 < 0.05$, as reported by the researchers. Therefore, it can be inferred that both self-efficacy and self-regulated learning have a substantial influence on students' achievement in mathematics. The

results of the study are also relevant to what (Handayani & Sholikhah, 2021) conducted that self-efficacy and self-regulated learning affect learning outcomes so that learning achievement increases. In line with that, Maisaroh (2012) also stated in his research that partially the self-efficacy variable has a direct and significant effect on the learning achievement variable, and the self-regulated learning variable also has a direct influence on the learning achievement variable. Each student certainly has different self-regulated learning, these differences are one of the factors that affect mathematics learning outcomes. Students with high self-efficacy have sufficient confidence in their talents, enabling them to formulate plans to effectively pursue their objectives.

Conclusion

According to the conducted study, a regression model was derived, namely $Y = 11,091 + 0{,}676X_1 + 0{,}273X_2$. This indicates that there is a positive correlation between self-efficacy and self-regulated learning in relation to mathematical learning outcomes. The acquisition of the F test indicates that a significance value of $0{,}00 < 0{,}05$ is achieved, indicating that self-efficacy and self-regulated learning have a noteworthy impact on students' mathematical learning results.

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