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MULTIPLE REGRESSION ANALYSIS: EFFECTS OF MATH ANXIETY AND SELF-REGULATED LEARNING ON LEARNING OUTCOMES

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ABSTRAK

Hasil belajar siswa tidak hanya dipengaruhi oleh faktor kognitif, tetapi juga faktor afektif. Studi ini menggunakan desain penelitian untuk menyelidiki pengaruh kecemasan matematika dan kemandirian pada hasil belajar siswa. Populasi penelitian ini adalah semua sekolah menengah di Yogyakarta. Sampel yang digunakan terdiri dari 187 siswa perempuan dan 127 siswa laki-laki di kelas X, XI, dan XII. Data diperoleh melalui hasil belajar siswa dan distribusi skala afektif kepada siswa untuk mendapatkan data kecemasan matematika dan kemandirian belajar. Analisis yang dilakukan mendapatkan kesimpulan bahwa kecemasan matematika dan kemandirian belajar memiliki pengaruh terhadap hasil belajar siswa. Pengaruh dari kecemasan matematika dan kemandirian belajar pada siswa perempuan sebesar 86,7% dan pada siswa laki-sebesar 15,8%. Terdapat model untuk menghitung pengaruh yang diperoleh berdasarkan analisis, yaitu $\hat{Y}$ = -9,077 + 0,455 X_1 + 0,826 X_2 untuk siswa perempuan dan $\hat{Y}$ = 0,815 X_1+ 0,480 X_2 untuk siswa laki-laki.
Kata Kunci: Hasil Belajar, Kecemasan Matematika, Kemandirian Belajar

ABSTRACT

Student learning outcomes are not only influenced by cognitive factors but also affective factors. This study used a research design to investigate the influence of math anxiety and self-regulated learning on student learning outcomes. The population of this study was all secondary schools in Yogyakarta. The sample used consisted of 187 female students and 127 male students in grades X, XI, and XII. Data were obtained through student learning outcomes and the distribution of affective scales to students to obtain data on math anxiety and self-regulated learning. The analysis concluded that math anxiety and self-regulated learning influence student learning outcomes. The effect of math anxiety and self-regulated learning on female students is 86.7% and on male students is 15.8%. There is a model to calculate the effect obtained based on the analysis, namely $\hat{Y}$ = -9,077 + 0,455 X_1 + 0,826 X_2 for female students and $\hat{Y}$ = 0,815 X_1+ 0,480 X_2 for male students.
Keywords: Learning Outcomes, Math Anxiety, Self-Regulated Learning

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INTRODUCTION

Education is crucial in preparing students for 21st-century challenges by developing knowledge, attitudes, and skills. It not only pursues values but also provides direction for students to behave and act correctly, fostering a scientific spirit (Hidayat & Sutirna, 2020). What cannot be separated from education is learning activities. Learning is a crucial factor in achieving success. Factors that influence a person's achievement process come from external factors and internal factors (Hastuti & Yoenanto, 2019). Internal factors refer to the factors that originate within an individual. Internal factors can take the form of attitudes and traits inherent in a person. Meanwhile, external factors are factors that come from outside a person. External factors can be in the form of family, school, and community circumstances mathematics anxiety is an internal factor that can significantly impact learning achievement.

Anxiety is the emergence of worry or fear of certain conditions that can trigger anxiety due to the uncertainty of the future and the fear that something bad will happen (Warohmah, 2023). Students who have anxiety about learning math tend to avoid the subject and have difficulty concentrating on learning activities (Putri et al., 2023). Richardson and Suin's research reveals that math anxiety, characterized by feelings of tension and anxiety, significantly impacts real-life and academic problem-solving (Syafri, 2017).

Shishigu (2018) states that mathematics anxiety refers to negative emotions that hinder problem-solving in mathematics. Higher anxiety levels lead to lower learning achievement, while lower anxiety levels result in higher achievement. This is in line with research conducted by Hastuti and Yoenanto (2019) which states that a student's math learning achievement is low due to math anxiety. However, according to Masruroh and Reza (2015), anxiety can be positive or negative. Anxiety will be positive if it has an intensity that is not so strong or mild so that it will be a positive motivation. However, if the anxiety is very strong, it will be negative, which will cause psychological and physical disturbances (Permana et al., 2016). With the existence of student anxiety in mathematics, the researcher assumes that anxiety does not rule out the possibility of affecting math learning outcomes, meaning that with anxiety in mathematics, math learning outcomes can get better or vice versa.

In addition to math anxiety, an internal factor that can affect math learning achievement is self-regulated learning. Self-regulated learning is one of the factors that influence the success of a student to achieve more optimal achievement (Pratiwi & Laksmiwati, 2016). Students require self-regulated learning to construct the concepts and principles they learn (Hastuti, 2020). Higher education levels often lead to greater self-regulated learning (Ranti et al., 2017). Self-regulated learning trains students to be more responsible and not always depend on others. Independence owned by students can also foster self-confidence and can more quickly accept and understand the subject matter. According to Zimmerman and Schunk (1989), self-regulated learning is the systematic direction of behavior and cognition by individuals taking responsibility for tasks, interpreting knowledge, repeating information to improve and develop learning abilities, and anticipating learning outcomes. Self-regulated learning is a crucial skill for a student to have so that the math learning achievement obtained by students will be maximum and satisfying (Hidayat & Sutirna, 2020). According to Woi and Prihatni (2019), the indicators of self-regulated learning are not always dependent on others, progressive, resilient, having the initiative to learn, self-control, being able to make decisions, taking responsibility, and self-

establishment. Based on the above background, the study investigates the impact of self-regulated learning and students' math anxiety on their learning outcomes.

METHODS

This type of research is non-experimental research and the method used in this research is a survey method with multiple regression analysis to determine the influence between variables X1 and X2 on variable Y. This research was conducted at MAN 1 Sleman and MAN 2 Bantul. The study population was all XII-grade students at MAN 1 Sleman and XI-grade students at MAN 2 Bantul. The total sample of female students was 187 and male students was 127. Data were collected using tests and questionnaires. The instruments used are mathematics learning achievement tests in the form of odd semester UTS results, self-regulated learning questionnaires, and mathematics anxiety questionnaires that have been validated and reliable. The variables investigated in this study are self-regulated learning and math anxiety. Multiple regression analysis was used in this study to investigate the impact of math anxiety and self-regulated learning on their learning outcomes.

RESULT AND DISCUSSION

The collection of research results contains three variables, namely Math Anxiety (X_1), Self-Regulated Learning (X_2), and student math learning outcomes (Y). Math Anxiety and Self-Regulated Learning data were obtained through the Math Anxiety test scale and Self-Regulated Learning test scale. The variable of students' mathematics learning outcomes is in the form of data on the value of the Midterm Assessment in the 2023/2024 school year. The value of the Midterm Assessment is said to be valid because the questions have been validated by the teacher and taking the Midterm Assessment value is carried out offline.

Multiple regression calculations between Math Anxiety and Self-Regulated Learning on student math learning outcomes with the help of the SPSS 25 program can be obtained from the results of the normality assumption test with the basis for decision-making in the Lilliefors normality test, namely, if the sig value. > 0.05 then H_0 is accepted which indicates that random errors are normally distributed. From the output above, it can be seen that the value of the Lilliefors test statistic on female student data is 0.4. If the significance level is chosen α = 0.05 then since Sig. (p-value) = 0.200 > 0.05, it can be concluded that H_0 is accepting or the random errors of female students are normally distributed. The same applies to male students' data. Looking at the output above, it can be seen that the value of the Lilliefors test statistic on the female data is 0.4. If the significance level is chosen α = 0.05, then since Sig. (p-value) = 0.078 > 0.05, it can be concluded that H_0 is accepted or random errors in male student data are normally distributed.

The multicollinearity test is required as an assumption test in addition to the normality test. The multicollinearity test is carried out in two ways, namely using the Variance Inflation Factor (VIF) and the Learner method. The basis for decision-making in the multicollinearity test using the Variance Inflation Factor (VIF), namely if the tolerance value> 0.10 and VIF. Therefore, data on female students is still categorized as no multicollinearity because VIF < 10, namely 3.440. Tolerance for Self-Regulated Learning and Math Anxiety variables is 0.291. Likewise, in male student data with VIF = 1.064 that data on male students is still categorized as no

multicollinearity. In contrast to VIF, when using the Learner Method, the basis for decision-making using the learner method, namely if the c_2 value is far from 0 with a range of 0 to 1, then the data can be said to be weak multicollineary. In the female student data obtained, as follows:

$$c_2 = (1 - R^2) = (1 - 0{,}868)^{\frac{1}{2}} = (0{,}132)^{\frac{1}{2}} = \ 0{,}363$$

The number is not too close to 0, so multicollinearity is considered weak. The same thing happened to the male data with the following calculations:

$$c_2 = (1 - R^2) = (1 - 0{,}061)^{\frac{1}{2}} = (0{,}939)^{\frac{1}{2}} = \ 0{,}969$$

Based on these two results, the two data can be said to be weak multicollinearity.

The last prerequisite examination that must be conducted prior to doing the effect test is the heteroscedasticity test. Heteroscedasticity testing use a scatterplot for analysis. Heteroscedasticity is absent when there is no discernible and dots pattern spread above and below the zero point on the Y axis. Conversely, heteroscedasticity is present when there is a consistent pattern in the data.

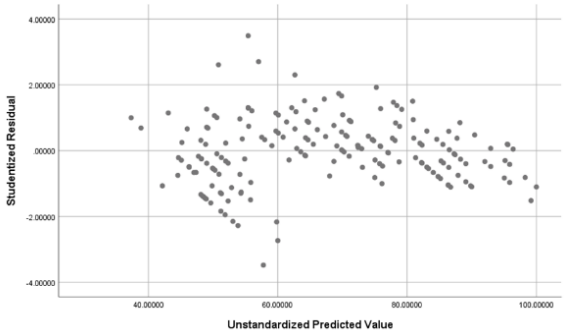

Figure 1. Heteroscedasticity Test for Female Students

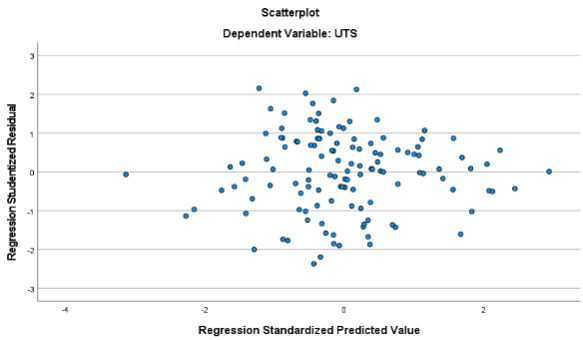

Figure 2. Heteroscedasticity Test for Male Students

The scatterplot analysis of both female and male data reveals a lack of discernible pattern, with data points dispersed both above and below the zero point on the Y axis. Therefore, it may be inferred that there is no presence of heteroscedasticity in any of the datasets. According to the conducted assumption test, data from both female and male students may be used as a

sample to examine the impact of Math Anxiety and Self-Regulated Learning on student learning results. The effect test that can be done after the assumption test is the individual effect test, joint effect test, and the confidence interval. The individual effect test conducted using SPSS 25 produces the following Table 1 and Table 2.

Table 1. Test of Individual Effect on Female Students

Coefficients[a]							
	Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B	
Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1 (Constant)	-9.077	2.266		-4.006	.000	-13.547	-4.607
Self-Regulated Learning	.455	.068	.330	6.667	.000	.320	.589
Math Anxiety	.826	.064	.636	12.851	.000	.699	.953

a. Dependent Variable: Learning Outcomes

The estimators b_0, b_1, and b_2 can be seen in the Coefficients[a] Table 1, namely $b_0 = -9.077$, $b_1 = 0.455$, and $b_2 = 0.826$. The estimator value $s_2 = 37.414$ can be seen directly in the ANOVA output section (in the Mean Square column, Residual row). If the significance level is set $\alpha = 0.05$, then the conclusion that can be drawn, namely H_0: $\beta_0 = 0$ is rejected because in the Constant line Sig. = 0.000 <0.05, H_0: $\beta_1 = 0$ is rejected so that there is a significant effect of Self-Regulated Learning on student learning outcomes if Math Anxiety is included in the model (the effect of motivation is taken into account) because in the Self-Regulated Learning row Sig. = 0.000 < 0.05, and H_0: $\beta_2 = 0$ is accepted so that there is a significant effect of motivation on student learning outcomes if Self-Regulated Learning is included in the model because in the Math Anxiety row Sig. = 0.000 < 0,05.

Based on the results obtained, with the model in general form, namely $\hat{Y} = b_0 + b_1 X_1 + b_2 X_2$, the model for female student data is $\hat{Y} = -9.077 + 0.455 X_1 + 0.826 X_2$. All b values remain in the model because they comply with H_1. The effect test that has been conducted in Table 1 also produces a confidence interval. Based on the confidence intervals in the Lower Bound and Upper Bound of the female student data in Table 1, it can be inferred that the hypothesis tests conducted on the corresponding female student data, specifically the 95% confidence interval (which employs a significance level of 0.05) for β_0, H_0: $\beta_0 = 0$ result in the rejection of H_0 because the confidence interval does not encompass 0. The similar phenomenon occurs with β_1 and β_2 since the confidence interval does not include the value of 0.

The values of the estimators b_0, b_1, and b_2 are provided in the Coefficients[a] Table 2. Specifically, $b_0 = 1.161$, $b_1 = 0.815$ and $b_2 = 0.480$. The estimator value $s_2 = 283.471$ may be seen immediately in the ANOVA output section, namely in the Mean Square column and Residual row. If the significance level is set $\alpha = 0.05$, then the conclusion that the null hypothesis H0: $\beta_0 = 0$ is accepted because in the Constant line Sig. = 0.938 > 0.05, H_0: $\beta_1 = 0$ is rejected so that there is a significant effect of Self-Regulated Learning on student learning outcomes if Math Anxiety is

included in the model (the effect of motivation is taken into account) because in the Self-Regulated Learning row Sig. = 0.000 < 0.05, and H_0: $\beta_2 = 0$ is accepted so that there is a significant effect of motivation on student learning outcomes if Self-Regulated Learning is included in the model because in the Math Anxiety row Sig. = 0.039 < 0,05.

Table 2. Test of Individual Effect on Male Students

Coefficients[a]								
		Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	1.161	14.996		.077	.938	-28.522	30.845
	Self-Regulated Learning	.815	.164	.420	4.963	.000	.024	.936
	Math Anxiety	.480	.230	.176	2.082	.039	.490	1.140

a. Dependent Variable: Learning Outcomes

According to these results, the model for male student data is $\hat{Y} = 0.815\ X_1 + 0.480\ X_2$. The value of b in constant is not included because it does not comply with H_1. Thus, the best model for male student data is without constant. Moreover, the results of the effect tests conducted also resulted in confidence intervals in the Lower Bound and Upper Bound of the male student data in Table 2. It can be concluded from the related hypothesis tests that H_0: $\beta_0 = 0$ is accepted because the confidence interval contains 0. This result is different from β_1 and β_2 because the confidence interval does not contain 0 at H_0: $\beta_1 = 0$ and H_0: $\beta_2 = 0$ are rejected.

After conducting the individual effect test and checking the confidence interval of each data, the joint effect test will be conducted next. In the joint effect test, two outputs are analyzed to check the model reliability test or F-test and to determine the coefficient of determination. The model reliability test (F-test) conducted on female student data obtained the output as in Table 3.

Table 3. Reliability Test (F-test) on Female Students

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45550.078	2	22775.039	608.726	.000[b]
	Residual	6921.639	185	37.414		
	Total	52471.717	187			

a. Dependent Variable: Learning Outcomes

b. Predictors: (Constant), Math Anxiety, Self-Regulated Learning

The ANOVA Table 3 indicates that the $F_{count} = 608.726 > F_{table} = 3,04$. The value of 0.000 is seen in the last column (Significance column). If this number is compared to the predetermined level of significance α the recommendation is to reject the null hypothesis (H_0) if Sig < α. At a

significance level of 0.05, the null hypothesis (H_0) is rejected, indicating a substantial impact of Self-Regulated Learning and Math Anxiety on the learning results of female students.

Table 4. Reliability Test (F-test) on Male Students

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6059.729	2	3029.865	12.705	.000[b]
	Residual	29331.932	123	238.471		
	Total	35391.661	125			

a. Dependent Variable: Learning Outcomes

b. Predictors: (Constant), Math Anxiety, Self-Regulated Learning

This also occurs in male student data which can be seen in Table 4 with the value of F_{count} = 12.705> F_{table} = 3,07. In the last column (Sig. column) the number 0.000 is seen. If this number is compared with the level of significance α that has been set, the provision is to reject H_0 if Sig < α. With α = 0.05, H_0 is rejected so the conclusion is that there is a significant effect of Self-Regulated Learning and Math Anxiety on male students' learning outcomes. The next stage of the joint effect test is to analyze the coefficient of determination. The output for the coefficient of determination of male student data is in Table 5.

Table 5. Test of the Coefficient of Determination for Female Students

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.932[a]	.868	.867	6.11672

a. Predictors: (Constant), Math Anxiety, Self-Regulated Learning

b. Dependent Variable: Learning Outcomes

The Adjusted R Square value for the female data is 0.867. The data indicates that Math Anxiety and Self-Regulated Learning together account for 86.7% of the impact on students' math learning results. The researcher did not analyze any factors that account for the remaining 13.3% (100% - 86.7%) of the effect. Researchers also consider external influences as additional variables that influence pupils.

Table 6. Test of the Coefficient of Determination for Male Students

Model Summary[b]				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.414[a]	.171	.158	15.44251

a. Predictors: (Constant), Math Anxiety, Self-Regulated Learning

b. Dependent Variable: Learning Outcomes

This is in contrast to the information on the Adjusted R Square value on male data listed in Table 6, which is 0.158. This shows that the proportion of the influence of Math Anxiety and Self-Regulated Learning is 15.8% on student math learning outcomes. While the remaining 84.2% (100% - 15.8%) is influenced by other variables not examined by the researcher. Researchers also consider external influences as additional variables that impact students. These two findings indicate that female students are more susceptible to the effects of Math Anxiety and Self-regulated Learning variables than male students.

The results of the analysis calculation with multiple regression analysis using SPSS 25 resulted in the conclusion that in the data of female and male students, Math Anxiety and Self-Regulated Learning positively affect learning outcomes. This can be seen in Tables 5 and Table 6 where the Math Anxiety and Self-Regulated Learning variables have a sig value <0.05 and t_{count}> table. Although each of the two variables affects the learning outcomes of female and male students, there are differences in the model when the two are combined. The model formed based on female student data is $\hat{Y} = -9.077 + 0.455\ X_1 + 0.826\ X_2$, while on male student data is $\hat{Y} = 0.815\ X_1 + 0.480\ X_2$. The difference in the model is due to the value of 0 in the interval of each variable including the constant. In male student data, the constant has a value of 0 in the interval, so the model will be better if the constant is removed.

Based on the model, several analyses can be done. The model for female students has an initial score that can be said to be the initial ability of students, which is -9.077. Meanwhile, male students do not need to pay attention to their initial ability to consider the effect of Math Anxiety and Self-regulated Learning on male students' learning outcomes. The magnitude of the influence of each variable can also be seen from the model that has been formed. Based on the model, for female students, because X_1 is Self-Regulated Learning and X_2 is Math Anxiety, Math Anxiety has more influence on the learning outcomes of female students. The same thing also happens to male students because X_1 is Math Anxiety and X_2 is Self-Regulated Learning, Math Anxiety has more influence on male students' learning outcomes. Both analyses resulted in a conclusion that Math Anxiety is more influential than Self-Regulated Learning on student learning outcomes.

This study concluded that Math Anxiety has a positive effect on student learning outcomes. This can be seen from the models for female and male students on Math Anxiety, which are 0.455 and 0.815 which are positive. However, it is not uncommon to find research results that Math Anxiety has a negative effect on student math learning outcomes, such as research conducted by Juliyanti & Pujiastuti (2020), Prasetyo & Dasari (2023), dan Putri et al. (2023). Math anxiety is defined as the fear or worry experienced by someone when doing or even thinking about mathematics-related activities (Prasetyo & Juandi, 2023). Therefore, Math Anxiety can have positive and negative effects depending on the management of this anxiety. When students have high Math Anxiety, they will feel worried about the math learning that will be carried out so that these students will prepare themselves for the learning that will be carried out properly. Based on research, external factors that can help Math Anxiety be positive are teachers who play an important role in it (Nofrialdi et al., 2018). Teachers can convince students that every mistake in the work can be corrected, convince students of their abilities, and others.

The difference in models is not the only difference in the calculation of the two data for female and male students, but there is a difference in the percentage of joint influence of the

two data. Female students have a much higher percentage of influence by Math Anxiety and Self-Regulated Learning factors than males. In female students, there is a percentage of 86.7%, while in male students it is 15.8%. This is in line with the research of Asari et al. (2023) which states that female students have much higher anxiety than male students. This is due to the stimulus to what is thought about something that has not happened or even not happened. Female students' self-regulated learning is much more influential on learning outcomes than male students. This is supported by the research of Alghamdi et al. (2020) which states that self-regulated learning owned by female students is much higher and results in better academic performance

CONCLUSION

Based on the results and discussion, it is found that there is a positive influence between Math Anxiety and Self-Regulated Learning on learning outcomes in female and male students. Female students have a greater percentage of the influence of Math Anxiety and Self-Regulated Learning on learning outcomes, that is 86.7%. Meanwhile, male students have a percentage of the influence of Math Anxiety and Self-Regulated Learning on learning outcomes of 15.8%. Based on these results, it can be concluded that the learning outcomes of female students are more easily influenced by Math Anxiety and Self-Regulated Learning than men. The calculation of the effect can use the model determined by the model for female students, namely $\hat{Y} = -9.077 + 0.455\ X_1 + 0.826\ X_2$ while the model for male students is $\hat{Y} = 0.815\ X_1 + 0.480\ X_2$. In the model used on female students, there is a model that uses all b values because the significance value is less than 0.05. However, the male students' model does not use a constant because the significance value of the constant is more than 0.05. Based on the explanation, such a large effect shows that Math Anxiety and Self-Regulated Learning can be used as predictors of student math learning outcomes.

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