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The influence of problem solving ability, emotional intelligence and formative tests on learning outcomes of mathematics

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Abstract. This study aimed to examine the influence of problem solving ability, emotional intelligence, and formative tests on learning outcomes of students mathematics. This research was a cross sectional survey method study with a qualitative descriptive approach . The population in this study was all students of the eighth graders at junior high school in Kulon Progo with the number of samples taken was 255 people by using Krejcie & Morgan. Data collection used test and questionnaire as instruments. The results showed that (1) the fulfillment of all assumptions of the regression model, (2) there was a significant effect between problem-solving ability, emotional intelligence, students formative tests on students mathematics learning outcomes , (3) there was no interaction between variables either problem solving ability and emotional intelligence, problem solving ability and formative student test as well as emotional intelligence and formative student tests.

1. Introduction

Mathematics courses need to be given to all learners starting from elementary school to equip learners with logical, analytical, systematic, critical and creative thinking skills, as well as the ability to work together [1]. Mathematics is a subject that has an important role in the aspect and development of the human life [2], especially for the students, as it serves to develop communication skills by using symbols and using the sharpness of reasoning to solve problems that occur in everyday life . [3] argued that mathematics is an important tool used to solve problems both science and everyday life and help us to think creatively and critically, besides math can also initiate the idea to think logically and systematically [4]. However, the most common complaint in learning math is many middle-aged students have difficulty in understanding math problems. This is because mathematics is a subject that only deals with numbers and it distracts learners to learn and is a tedious subject [5], and becomes a subject that children do not like so that it decreases interest and students spirit in learning mathematics which will certainly affect the results of students' mathematics learning outcomes [6].

Problem solving promotes students' conceptual understanding, develops students' thinking skills, enables students to communicate mathematically and foster their interest and curiosity [7]. According to [8] the mathematics teacher recommends the use of problem solving in the teaching of mathematics in order to improve students cognitive and curiosity.

There are other factors that affect students' mathematics learning outcomes, one of them is students' psychological factors. There are three factors that affect student achievement and learning

outcomes, among others: 1) internal factors (factors in students, 2) external factors (factors from outside students), , and 3) factors on approach to learning (approach to learning), namely the type of student learning efforts that include strategies and methods used by students to conduct learning activities lesson materials [9]. The three factors are very important for the students to achieve the learning objectives, which one of them is the result of student learning. As [10] in his research findings that one of the internal factors that affect the learning process is emotional intelligence or commonly called emotional quotient (EQ). According to [11] every human being has two potential thoughts, namely the rational mind and the emotional mind. Rational thought is driven by intellectual ability or popular with the term "intelligence quotient" (IQ), while the emotional mind is driven by emotion. Experts argue that to obtain optimal learning results, one must not only have the intellectual intelligence (IQ) alone, but also related to emotional intelligence EQ).

The usual problem is that some people think that to achieve maximum learning results, the students must have high intellectual intelligence (IQ), because it will facilitate them in learning to achieve maximum learning outcomes. Binet [12] expressed that intelligence is an ability to define and maintain a goal, to make adjustments in order to achieve that goal, and to assess the critical and objective state of the self. However, in the implementation of teaching and learning process there are some students who can not achieve learning outcomes equivalent to the ability of intelligence, there are students who have high intelligence capabilities but obtain low learning outcomes, vice versa. Therefore the ability of intelligence (IQ) is not the most important factor to support the increase of student learning outcomes. In line with that [11] who thinks that intellectual intelligence (IQ) only contributes 20% to success, while 80% is a contribution to other factors of virtue, in this case emotional intelligence (EQ). Nevertheless, EQ works in synergy with intellectual intelligence IQ, a person will have high achievement if they have both intelligence. However, a person with a minimum emotional intelligence will affect his or her intellectual intelligence [13]. Emotional intelligence as the ability to recognize the feelings of oneself and the feelings of others, the ability to self-motivate and the ability to manage emotions well to oneself and in relation to other people [14].

Apart from the cognitive and affective domains, there are other factors that influence the learning outcomes of mathematics. [15] stated that one of the factors affecting students' learning outcomes is the frequent tests and repetitions given to the students. This is due to the frequent repetition of the skills and knowledge, so the students can master the lesson deeply. However, without practice and repetition, the experience he has had can be reduced even to a loss. Therefore, with the exercise and repetition, the students can increase their motivation and willingness to learn in order to improve the quality of the students' learning outcomes. As [16] stated that the greater interest and motivation to learn the better the results of learning.

In improving mathematics learning outcomes, the teachers competence; ability to teach in which includes the ability to provide innovative formative tests, must be acquired [17]. Furthermore, [17] stated that teachers should be creative and do various innovations of formative test that can improve the quality of mathematics learning outcomes. [18] explained that with formative evaluation, the teacher will get information on which parts of the concepts and materials that students have not understood, and less effective learning programs. In addition [19] stated that frequently conducted formative tests can form students' habits to learn continuously which is also intended to overcome the mistakes that students often do to accumulate the subject matter until the time of the test or test is approaching.

2. Method

The type of research used in this study was by approach of qualitative descriptive with multiple linear analysis techniques. The research method used in this study was cross sectional survey. The population in this research was all students of the eight graders of Junior High School in Kulon Progo with a sample 255 students by using Krejcie & Morgan. Then, the instruments used to collect data were test and questionnaire. The test instrument was used to measure problem-solving skills and formative tests of students on mathematics learning whereas questionnaire was used to see the level of students' emotional intelligence in learning mathematics. Data analysis used was qualitative and quantitative data analysis technique. The qualitative analysis used descriptive statistical analysis

techniques and quantitative data analysis techniques used multiple regression model equation $\hat{Y} = a + b1X1 + b2X2 + b3X3$.

3. Result and Discussion

3.1. Descriptive Data of Variables

The data collected in this study covered four variables; data on problem solving abilities (X1), emotional intelligence (X2), formative test (X3), and mathematics learning outcomes (Y). Description of dependent and independent variables can be seen in the following table:

Table 1. Description of Dependent and Independent Variables

Description	Variables			
	Y	X1	X2	X3
Average	86.03	84	87.73	93.33
Std. Dev	3.079	5.504	4.78	3.55
Max Score	91	100	98	90
Min Score	80	82	80	77
Criteria	Good	Good	Good	Good

The average of students' mathematics learning outcomes (Y) was 86.03; problem solving abilities (X1) = 84, emotional intelligence (X2) = 87.73, and formative tests (X3) = 93.33 . This suggested that emotional intelligence, problem-solving skills, formative student tests, and mathematics learning outcomes fell into good category.

In a regression model the assumptions of the regression model should be met first [20,21]. Description of regression assumption can be seen in the following table:

Table 2. Description of regression assumptions

Assumption	Score			
Normality	Skewness	Error	Kurtosis	Error
	-0.160	0.427	-0.934	0.833
Multicolinearity	X1	Tolerance	0.96	
		VIF	1.034	
	X2	Tolerance	0.986	
		VIF	1.014	
	X3	Tolerance		
		VIF		
Heteroscedastisity	X1	X2	X3	
	0.329	0.252	0.937	
Linearity		Durbin Watson		2.450

Based on table 2, the normality assumption analysis showed skewness -0.160 with error 0.427 and kurtosis -0.934 with error 0.8333. From these results, the researcher obtained a ratio of skewness and a ratio of kurtosis respectively -0.374 and -1.121. Therefore, the assumption of normality was fulfilled because it was in the range of - 2 to +2. As [22] the data could be said to be normal distribution if the ratio of skewness and rational kurtosis is in the range -2 to +2. Further, in multicolinearity analysis, to know the existence of multicolinearity that is by looking Tolerance value and Variance Infaction Factor (VIF). If the tolerance value ≤ 0.10 with the VIF value ≥ then the model can be said to contain multicollinearity [22]. The analysis of the multicolinearity assumption showed that the VIF value for all variables X1, X2, and X3 less than 10, for that purpose, regression model was independent of the

multicolinearity problem. Then for heteroscedasticity assumption test showed significant value = 0.329 X1, X2 = 0.252 and X3 = 0.937. Since all variables had a significance value greater than 5%. As [23] stated a regression model does not contain heteroscedasticity when the value of sig > 0.05 so this model was assumed to have no heteroscedasticity problem. Furthermore, a model does not contain linearity when the DW (Durbin Watson) value obtained is greater than DW tabel [23]. In this case, the DW value of the table with t=255, k=3 is 1.772, so that the regression model does not countain linearity because DW value greather than DW table or 2.450 > 1.772. Because all regression assumptions are met, it can be continued to look for the relationship of each variable.

3.2. The Result of Regression Model Analysis

To analyze the correlation between variables problem solving ability, emotional intelligence and formative test simultaneously to student's mathematics learning result. While analysis results of regression model can be seen in the following table:

Table 3. Description of regression model analysis results

Model	Unstandarized Coeficients		ANAVA					Model		
	B	Sig	Model	df	Mean Square	F	Sig	R	R Square	Adj. R Square
Constant	61.666	0.00	Reg.	3	60.706	16.999	0.00	0.814[a]	0.662	0.623
X1	-0.301	0.329	Res.	252	3.571					
X2	0.173	0.252	Tot.	255						
X3	0.444	0.937								

To know the correlation between problem solving ability (X1), emotional intelligence(X2), and formative test (X3) simultaneously to student's mathematics learning result, multiple regression analysis of three independent variables (X1,X2,X3) with one dependent variable (Y) was conducted. In pursuance of [21,23] multiple regression can be used for analyzing data when there are multiple independent variables. The results of this analysis showed all the independent variables included in the model had a mutual influence on the dependent variable for the regression model where the constant value (b_0) was 61,666, X1 (b_1) was -0.301, X2 (b_2) was 0.173, X3 (b_3) was 0.444. Thus the multiple regression equation between these three variables was $\hat{Y} = 61.666 - 0.301X_1 + 0.173\ X_2 + 0.444X_3$.

The results of the analysis could figure out the significance of the regression model used is by comparing the significance of *p value* on F *test* with $a = 5\%$, if *p value* less than $a = 5\%$, then regression model can be used to predict the independent variable against the dependent variable [22,23]. Based on the results of ANAVA in table 3are obtained F *test* = 16.999 with a significance value or *p value* 0.000. Since the value of *p value* was less than a = 5%, this regression model could be used to predict the problem solving (X1) variable, emotional intelligence (X2), formative test (X3) together was explanatory which was significant to the result of learning mathematics (Y). This result showed that any increase or drop in the unit of the problem solving abilities variable (X1) was followed by an increase or decrease of -0301 to the learning outcomes of mathematics, any increase or drop in one unit of emotional intelligence unit (X2) was followed by an increase or decrease of 0. 173 on the mathematics learning outcomes, and any increase or decrease in the unit of student formative test variable unit (X3) was followed by an increase or a decrease of 0.444 against the results of students' mathematics learning. So it could be predicted that the better the students 'problem solving abilities, emotional intelligence, and formative tests of students, the better the students' mathematics learning outcomes. The results are in accordance with the statement [9] that one of the factors that affect learning outcomes is the intelligence of both intellectual intelligence and emotional intelligence.

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These result are also in correspond with the statement [11,14] that to obtain optimal learning outcomes, a person not only have intellectual intelligence, but also related to emotional intelligence.

Based on the above table also showed the calculation results of *R value* is 0.623 with value F *test* of 16.999 and the significance of 0.000. To see whether there is a relationship between independent variables with the dependent variable simultaneously that is by comparing the results *p value* with *a*= 5%, if *p value* less than 5% then the two variables affect each other [22,23]. Thus it could be concluded that there was a significant relationship between problem solving abilities, emotional intelligence, and formative tests of students on student learning outcomes mathematics and these three variables accounted for 62.3% of mathematics learning outcomes. This result is in accordance with the finding [24] that the problem solving ability affects the mathematics achievement of student and the use of problem solving in the teaching of mathematics can improve students' cognitive and curiosity skills [8]. These results are in accordance with statement [13] that emotional intelligence affects the intellectual intelligence in this case the result of learning mathematics and this results also consistent with the finding [25] that the provision of formative tests contributes well to mathematics learning achievement.

3.3. Variable Interaction

To know the results Interaction between independent variables. The analysis results of interaction variable are presented in the following table:

Table 4. Statistic of Variable Interaction

Control Variables		Control Variables		
		X1	X2	X3
X1	Correlation	1.000	0.116	-0.141
	Sig. (2 Tailed)	-	0.541	0.457
	df	0	253	253
X2	Correlation	0.116	1.000	-0.16
	Sig. (2 Tailed)	0.541	-	0.932
	df	253	0	0
X3	Correlation	-0.141	-0.16	1.000
	Sig. (2 Tailed)	0.457	0.932	-
	df	253	253	253

Based on the table 4 above, the results of the analysis showed p value of 0. 541 for (X1*X2), 0.457 for (X1*X3), and 0.932 for (X2*X3). The result showed that the value of *p value* of all variables greater than *a*= 5%, so it could be concluded that there was no interaction between variables, either problem solving ability (X1) to emotional intelligence (X2), problem solving ability (X2) to formative student test (X3), and emotional intelligence (X2) on formative student tests (X3). As [22,23] stated interaction between independent variables should not occur in multiple regression equations or significance values greater than *a* = 5%.

4. Conclusion

Based on the results of data analysis and discussion, it was concluded the assumptions on the regression model was the assumption of nomality, assumption of multicollinearity, and assumption of heterosdexatity were all met The regression model formed was $\hat{Y} = 61.666 - 0.301X_1 + 0.173X_2 + 0.444X_3$. In addition, it also was concluded that a significant effect between problem-solving ability (X1), emotional intelligence (X2) formative tests student (X3) on the mathematics learning outcomes (Y).Furthermore, the analysis showed that there was no interaction between variables, either problem

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solving skills (X1) or emotional intelligence (X2), solving abilities and formative tests student (X3) and emotional intelligence (X2) and formative tests students (X3).

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