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The Relation between Curiosity, Self-efficacy and Student' Mathematical Reasoning Ability

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Abstract. This study aims to describe correlation among curiosity, self-efficacy and the mathematical reasoning ability of senior high school student. This research was classified as an ex post facto study. The population comprised all tenth grade student of senior high school in Brebes District. The technique of taking sample using stratified proportional random sampling techniques. The data were collected through a test and Likert scale questionnaires. The data were analyzed using the multiple linear regression analysis. The result of this study show that curiosity and self-efficacy as an aggregate correlate with the mathematical reasoning ability of senior high school student, with a contribution of 26,4% obtained by the regression model $Y = 1{,}033 + 0{,}428\ X_1 + 0{,}365\ X_2$.

INTRODUCTION

Mathematical reasoning ability is an important skill to learn mathematics. Recognizing the importance of mathematical reasoning ability, Indonesia makes reasoning as one of the important competencies that must be possessed by students. This is stated in Permendikbud Tahun 2016 No 21 tentang Standar Isi Pendidikan Dasar dan Menengah [1], which explains that one of the students' skills is developed through the activities of reasoning. The importance of mathematical reasoning abilities for students is reinforced by National Council Teacher of Mathematics which states that in school mathematics has standards that must be possessed by students that is the content and process standards [2]. Standard processes include problem solving, reasoning and proof, connection, communication, and representation. NCTM [2] also states that the procedural fluency of students in solving mathematical problems and conceptual understanding can be developed through reasoning. It means that the better the reasoning ability possessed by students, then the procedural ability and the students' understanding of the concept of mathematics is better. Ontario also have same opinion that reasoning process supports understanding in learning of mathematics [3]. Ball and Bass also stated that reasoning is basic skill of mathematics and is necessary for a number of purposes- to understand mathematical concepts, to use mathematical ideas and procedures flexibility, and to reconstruct once understood, but forgotten mathematical knowledge [4]. Furthermore, Bieda, Ji, Drwencke, and Picard stated that each of these practices entails mathematical reasoning, which is the process of making sense of and understanding mathematical ideas and concepts inherent to procedures [5]. Mathematical reasoning ability assist students in generating a sense to understand the ideas and concepts that exist in the procedure, which means that when students make the process of mathematical reasoning, students not only memorize the formula and procedures to do but also try to understand the ideas and concepts used. So it can be concluded that reasoning is important.

In fact, although reasoning ability are important, students in Indonesia still have low reasoning ability. This is shown from the results of the *Programme for International Student Assessment* (PISA) study which focuses on research on the ability of mathematical literacy. OECD defines mathematical literacy as an individual capacity in formulating, using and interpreting mathematics in various contexts, including mathematical reasoning [6]. PISA divides the level of expertise in mathematics into six levels. Levels are ranked based on scores obtained by

a country on tests conducted by PISA. Students are said to have had the ability to reason if the score is in the level of three to six. Pisa study result show that from year 2003, 2006, 2009, 2012, and 2015, Indonesia achieved scores 360, 391, 371, 375, and 386 that shows Indonesia is at level one [7]. That is, Indonesian students can be said not to have good reasoning ability.

Experts have almost identical definitions of mathematical reasoning ability. Mathematical reasoning is essentially about the development, justification and use of mathematical generalizations [8]. MOE stated that mathematical reasoning refers to the ability to analyse mathematical situations and construct logical argument [9]. Furthermore, Goos, Stillman& Vale stated that mathematical reasoning involves creating, investigating and evaluating conjectures, and developing mathematical arguments to convince oneself and others that the conjectures are true [10]. Students who have a good ability to be trying to convince him to make a conjecture of a series of conjectures-conjectures that exist to investigate and evaluate whether the conjecture that he has made a correct conjecture.

The students' mathematical reasoning abilities are closely related to their affective abilities. Among affective abilities that have an influence and are closely related to students 'mathematical reasoning abilities are students' curiosity towards mathematics. According to Witt opinion [11] that stated there is a symbiotic relationship between curiosity and reasoning. Curiosity is an essential starting-point for enticing children into engaging in mathematics which goes beyond the application of learned procedures and therefore engages them in reasoning [11].

Curiosity is the desire to learn and learn something to get new information or knowledge [12]. Curiosity also encourages students to do exploration activities. This is in accordance with the opinion that stated curiosity is broadly defined as a desire for acquiring new knowledge and new sensory experience that motivates exploratory behavior [13]. In addition to exploration activities, students 'curiosity towards mathematics can also be demonstrated by asking students' activities on matters relating to mathematics. It can be concluded that mathematical curiosity is the desire to understand and study math more deeply to gain new knowledge shown through exploration activities and liveliness in asking.

Other affective abilities that have an influence on students' math reasoning ability are self-efficacy because it is one of the important factors in the success of learning. Self-efficacy is closely related to one's beliefs about his / her abilities. Ormrod stated self-efficacy is the judgment of a person about ability of a person to perform certain behaviors or achieve certain goals [14]. Students who have self-efficacy will have control over their lives so that they can succeed in achieving the goals set [15].

McCoach, Gable and Madura [16] stated that Self-efficacy can affect student activity, where if students have low self-efficacy in learning they will avoid the task. But those who judge themselves to have sufficient self-efficacy will be more eager to participate. Hackett and Betz [17] also have the same opinion about that. He defined mathematics self-efficacy as an individual's confidence in her or his ability to successfully perform or accomplish a mathematics task. Self-efficacy can also affect the amount of work done by students, perseverance and learning. Students who have self-efficacy in learning generally provide greater and longer-lasting effort than students who doubt their capabilities especially when they encounter difficulties [18].

Based on the above exposure, it can be concluded that curiosity, self-efficacy and the ability of mathematical reasoning is important. In addition there are indications of a relationship between curiosity and self-efficacy with the ability of mathematical reasoning. This research is important to know how much curiosity, self-efficacy and mathematics reasoning ability of all tenth grade senior high school students in Brebes district. It is important to know how big the ability is owned by students, so that can be used as evaluation for improvement of student's mathematical ability. This research is important to identify the relationship between independent variable with dependent variable that is curiosity, self-efficacy and mathematical reasoning ability so this study can be used as refection for education policy holders especially for Brebes district.

METHOD

This research is ex post facto study with quantitative approach. This study was classified as ex post facto study that is research conducted by studying variable that have occurred [19]. In this study, researchers wanted information about curiosity, self-efficacy and mathematical reasoning ability and the relationship between curiosity, self-efficacy and mathematical reasoning ability of all tenth grade senior high school students in Brebes district. The population of this research is all senior high school students in the tenth grade in Brebes district which come from 15 private senior high school and 17 public senior high school. Samples from this study taken using stratified proportional random sampling techniques. The sample size of this study was 362 student of tenth grade senior high school that come from 12 selected class from 32 senior high school in Brebes district.

Instrument that used in this study are test and non-test. The essay test instrument is used to measure students' mathematical reasoning abilities. The problem consists of three items that each item contains a mathematical

question appropriate for measuring the ability of mathematical reasoning instrument non test in the form of a questionnaire with Likertscala used for to measure curiosity and self-efficacy. Each questionnaire contains 30 items of suitable statements for measuring curiosity and self-efficacy. The question of mathematical reasoning ability has been validated by expert judgment. Curiosity and self-efficacy questionnaires have been validated using expert judgment and factor analysis. Instrument reliability tested by Alpha Cronbach. The data obtained from the sample were analyzed using multiple regression analysis to determine the relationship between curiosity, self-efficacy and mathematical reasoning ability.

RESULT AND DISCUSSION

The data collected in this study include three variables there are curiosity data (X1), self-efficacy (X2), and mathematical reasoning (Y). Description of data conducted on research variables, both independent variables and dependent variables. Trends in each variable use the five categories proposed by Azwar there are very high, high, medium, low, and very low [20].

Student's Curiosity

Based on data obtained from a questionnaire consisting of 30 statements with five alternative answers. The following Table 1 shows the curiosity tendency obtained from the research sample.

TABLE 1. The tendency of curiosity variable

Interval	Criteria	Freq	Percentage (%)
120 < X	very high	19	5.25%
Self e100< X ≤ 120	high	100	27.62%
80< X ≤ 100	medium	203	56.08%
60< X ≤ 80	low	38	10.50%
X ≤ 60	very low	2	0.55%
TOTAL		362	100%

The data in Table 1 can be presented in graphical form as follows.

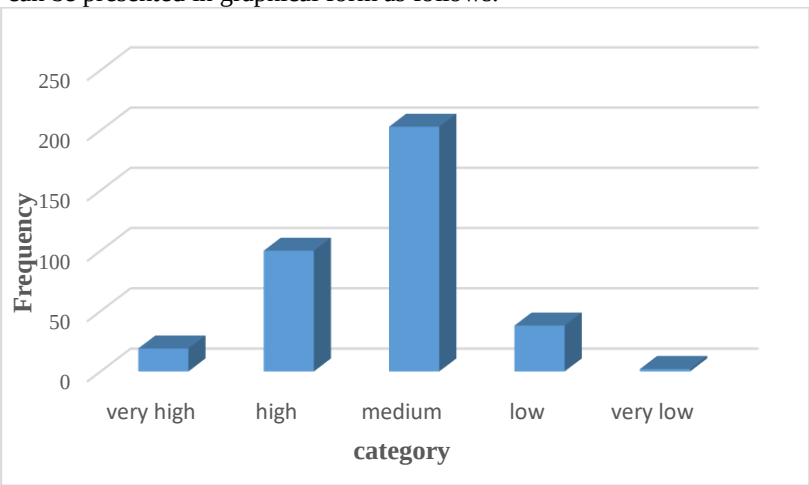

FIGURE 1.Graph of curiosity variable tendency

Based on Table 1 above can be seen 5,25% student who has a very high curiosity category, 27,62% high category, 56,08% medium category, 10,5% low category and 0,55% very low category. In general, Curiosity of tenth grade high school students including in medium category that shown by the largest percentage of score acquisition is 56,08%.

Student's Self-efficacy

Based on data obtained from a self-efficacy questionnaire consisting of 30 statements with five alternative answers. The following Table 2 shows the self-efficacy tendency obtained from the research sample.

TABLE 2. The tendency of self-efficacy variable

Interval	Criteria	Freq	Percentage (%)
120 < X	very high	8	2.21%
100< X ≤ 120	high	53	14.64%
80< X ≤ 100	medium	217	59.94%
60< X ≤ 80	low	80	22.10%
X ≤ 60	very low	4	1.10%
TOTAL		362	100%

The data in Table 2 can be presented in graphical form as follows

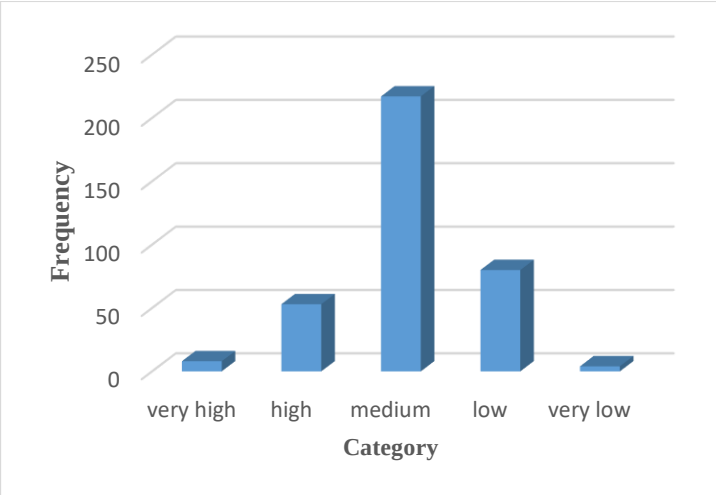

FIGURE 2. Graph of self-efficacy variable tendency

Based on Table 2 above can be seen 2,21% student who has a very high self-efficacy category, 14,64% high category, 59,94% medium category, 22.10% low category and 1.10% very low category. In general, the self-efficacy of tenth grade high school students including in medium category that shown by the largest percentage of score acquisition is 59,94%.

Student's Mathematical Reasoning Ability

Based on data obtained from essay question consisting of 3 mathematical problem. The following Table 3 shows the mathematical reasoning ability tendency obtained from the research sample.

TABLE 3. The tendency of Mathematical reasoning ability variable

Interval	Criteria	Freq	Percentage (%)
22.5< X	very high	35	9.67%
17.5< X ≤ 22.5	high	142	39.23%
12.5< X ≤ 17.5	medium	154	42.54%
7.5< X ≤ 12.5	low	31	8.56%
X ≤ 7.5	very low	0	0.00%
TOTAL		362	100%

The data in Table 3 can be presented in graphical form as follows

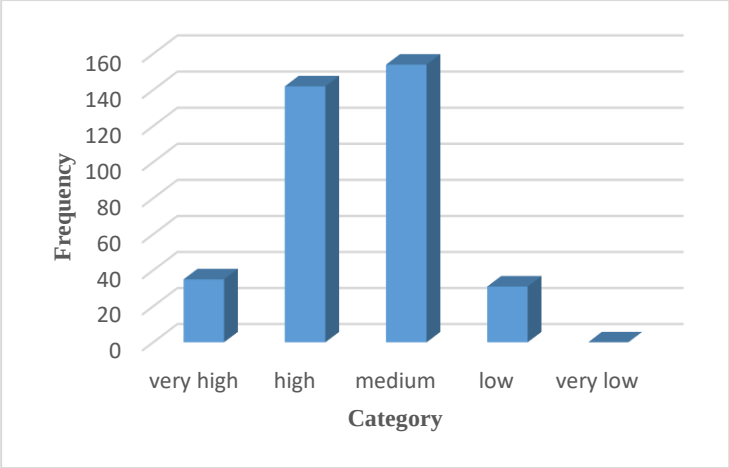

FIGURE 3. Graph of mathematical reasoning ability variable tendency

Based on Table 3 above can be seen 9.67% student who has a very high mathematical reasoning ability category, 39,23% high category, 42,54 % medium category and 8,56% low category. There is not student in very low category. In general, the mathematical reasoning ability of tenth grade high school students including in medium category that shown by the largest percentage of score acquisition is 42,54%.

Analysis of the relationship between curiosity and self-efficacy and mathematical reasoning ability simultaneously

This study aims to determine whether or not the relationship between independent variables consisting of curiosity (X_1), and self-efficacy (X_2) with the dependent variable is mathematical reasoning ability (Y). Hypothesis testing is done by using multiple linear regression analysis assisted by SPSS for windows 17.0. The results of the analysis will show the relationship between independent variables with dependent variables. The result of relationship analysis is shown by Figure 4 below.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.518[a]	.268	.264	1.08887

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	156.125	2	78.062	65.841	.000[a]
	Residual	425.641	359	1.186		
	Total	581.766	361			

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	1.033	.433		2.384	.018		
	Curiosity	.428	.089	.307	4.808	.000	.498	2.007
	Self Efficacy	.365	.092	.253	3.950	.000	.498	2.007

FIGURE 4. Regression Analysis Result between Curiosity, Self-efficacy and Mathematical Reasoning Ability

From Figure 4, it can be seen that the multiple correlation coefficient (R) = 0,518 value that indicates that relationship between curiosity, self-efficacy and mathematical reasoning ability including in the strong category. The value of R^2 obtained is 0.268. R^2 adjusted value obtained by 26,4% means that 26,4% of the mathematical reasoning ability of tenth grade student of senior high school in Brebes District can be explained using variable curiosity, and self-efficacy. The remaining 73,6% of students' mathematical reasoning ability is explained by other factors. The value of significance obtained is 0.000 and the value of F_{count} is greater than F_{table} [21]. So it can be concluded that there is a connection between curiosity and self-efficacy with the ability of mathematical reasoning

simultaneously. Figure 4 also show that regression coefficient a = 1,033, b_1 = 0,428, b_2 = 0,365, so estimation of the regression model as follows.

$$Y = 1{,}033 + 0{,}428\ X_1 + 0{,}365\ X_2$$

Based on the above equation, the ability of mathematical reasoning will increase by 0,428 when the value of curiosity rises 1 point and the value of self-efficacy remains, the ability of mathematical reasoning increased by 0.365 when the value of self-efficacy rose by 1 point and the value of curiosity remained. If curiosity and self-efficacy rise by 1 point, then the ability of mathematical reasoning is expected to rise 0.793. The regression equation can be used to predict the value of the dependent variable if all the independent variables are optimized [22]. From the regression equation obtained, if curiosity and self-efficacy is optimized, then the ability of mathematical reasoning to be = 8.963 or near the ideal value of mathematical reasoning that is 10. It shows because the correlation level is strong then the optimization of the suspected variables related to the ability mathematical reasoning can improve the ability of mathematical reasoning.

The results of this study also in accordance with existing research and theory. as well as research conducted by Lawson, Banks, and Logvin found that self-efficacy and reasoning ability were positively correlated. The study also explained that the reasoning itself has a basic factor that affects the self-efficacy of a person [23]. It identifies a symbiotic relationship between reasoning and self-efficacy. This symbiotic relationship also occurs between curiosity and reasoning ability. According to Witt opinion, the mindset that is developed through engaging in reasoning will encourage children to become more curious about mathematics [11]. This means students' curiosity will increase if students also improve their reasoning abilities.

CONCLUSION

The conclusion that can be draw from this research is a relation between curiosity, self-efficacy and mathematical reasoning. Based on the results of this study, the students' math reasoning ability can be improved by increasing curiosity and self-efficacy. This study is expected to add a reference for advanced research related to the same variables. This research data is taken from samples of senior high school students in Brebes district, there is a possibility of difference of research result if done in other area hence similar research can still be used in other region by adding other independent variable. Here we provide some basic advice for formatting your mathematics, but do not attempt to define detailed styles or specifications for mathematical typesetting. You should use the standard styles, symbols, and conventions for the field/discipline you are writing about.

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