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DETERMINATION OF VERBAL, NUMERIC SKILL AND MATHEMATIC COMMUNICATION TO STUDENTS' CRITICAL THINKING

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ABSTRACT

This study aims to determination of verbal, numerical skill, and mathematical communication to students' critical thinking skills in the Calculus Course. This research uses ex-post facto design. In this study, the technique used to determine the research sample was a saturated sampling technique with 26 students. The data in this study were collected using tests and analyzed using multiple regression techniques. The results showed that; (1) There is a partially significant contribution between the variables of verbal ability, numerical ability, and mathematical communication on students' critical thinking skills in calculus learning. The contribution of the verbal ability variable to students' critical thinking skills in calculus learning is 65.3%. The contribution of the numerical ability variable to students' critical thinking skills in calculus learning is 80.4%. The contribution of the numerical ability variable to students' critical thinking skills in calculus learning is 73.33%; (2) There is a simultaneous significant contribution between verbal ability, numerical ability, and mathematical communication on students' critical thinking skills in calculus learning. The simultaneous contribution between the variables of verbal ability, numerical ability, and mathematical communication with students' critical thinking skills is 90.30% and the remaining 9.70% is influenced by other variables.

Keywords: *verbal ability; numerical ability, mathematical communication; critical thinking skills*

1. Introduction

Mathematics has contributed to everyday life ranging from simple things such as basic calculations to complex and abstract things such as the application of numerical analysis in engineering and so on. One branch of mathematics is Calculus. Calculus has the goals of understanding concepts, reasoning abilities, communicating ideas, solving problems, and appreciating the use of mathematics in life. Many factors affect the quality of learning calculus, one of which is the academic potential of students. The academic potential has many similarities with intelligence when viewed from its constituent components. The constituent components of intelligence are six basic mental abilities consisting of verbal ability, number, spatial, word fluency, memory, mathematics, and reasoning. The constituent components of academic potential are four basic abilities consisting: verbal, numeric, logical, and spatial abilities (Lupita, 2020). In the process of learning mathematics, especially calculus, thought processes occur. Whether or not everyone thinks depends on their intelligence or intellectuality so, a person's intelligence can be described from the extent to which his or critical thinking ability responds to various problems.

Based on the results of preliminary observations in the even semester calculus course in 2021/2022 at ITB STIKOM Bali Jimbaran Campus related to students' critical thinking ability, it is known that the low results of learning calculus are caused by several factors are; (1) weak student ability to understand case studies given by lecturers. Students tend to be fixated on the stages democratized by the lecturer, so students are less able to compile hypotheses, categorize, and classify what they are facing by compiling patterns or ideas in their minds without

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help from friends or lecturers. (2) Suboptimal ability to construct numbers logically. (3) Nature solves the problem of many students who simply look for numbers and then operate them but cannot explain, confused in clear answers with correct mathematical language; are embarrassed to ask if there are difficulties; are not used to solving problems in their language because they are fixated with procedures; difficulty solving problems that are not similar to examples, lack of understanding how to be a good listener in the discussion; and tends to accept explanations from lecturers without commenting much.

The discussion in the previous study in 2020 related to the effectiveness of project-based authentic assessments in the online learning system on the quality of student learning outcomes in terms of critical thinking ability also showed that the factors that affect students' critical thinking ability are student characteristics . The characteristics of students internally can be divided into several parts, namely; problem-solving ability, numerical ability, verbal ability, mathematical communication ability, and numerical ability (Hari, Dewi and Pramartha, 2021). The results of previous studies show that the most important factors in determining students' critical thinking ability are verbal ability, numerical ability, and mathematical communication, therefore it needs to be studied the magnitude of the contribution of these variables to students' critical thinking ability (Irawan and Kencanawaty, 2017).

Verbal skills will help students in understanding meaning and make mathematical models to solve these mathematical problems. If the student's verbal skills are not good, then students will also find it difficult to solve math problems which will indirectly have an impact on students' critical thinking ability (Kinay and Bagceci, 2016). Therefore, this verbal ability is very closely related to the results of learning calculus. Research by Olatoye & Aderogba (2011) suggests that for students to achieve good learning achievements, they must have good verbal abilities and numerical abilities (Ajeng Daniyati, 2015). This is in line with research conducted by Awofala, Balogun, & Olagunju (2010, p.15). From the study, Awofala, Balogun, & Olagunju found that "students with high verbal ability gained more in mathematical word problems achievement than students with low verbal ability" (Ajeng Daniyati, 2015). Students with good verbal skills showed better learning achievement than students with poor verbal skills (Irawan and Kencanawaty, 2017) In addition to verbal skills, other abilities can affect students' critical thinking skills, namely numerical ability and mathematical communication skills.

Numerical ability is intended as the ability to think and organize information to solve problems related to numbers (Dedy Setiawan *et al.*, 2014). Numerical abilities include the ability to calculate in terms of addition, the ability to calculate in terms of subtraction, the ability to calculate in terms of multiplication, and the ability to calculate in terms of (Irawan and Kencanawaty, 2017). Students who have dominant numerical intelligence will have high critical thinking skills compared to students who have less dominant numerical intelligence. This is because students with high numerical intelligence tend to enjoy analyzing and studying the causes and effects of something happening independently (Lupita, 2020).

Based on the analysis of the situation and the importance of student characteristics in learning calculus, research was carried out related to the contribution of verbal ability, numerical ability, and mathematical communication and students' critical thinking ability in the Calculus Course.

2. Research Methods

This research uses Ex-Post Facto design. Determination of the sample using a saturated sampling technique with a sample of 26 students. Based on the subject matter studied in this study, the independent variable Consists of verbal ability, numerical ability, mathematical ability, and dependent variable is critical thinking ability The relationship of the free variable to the bound variable is described as follows.

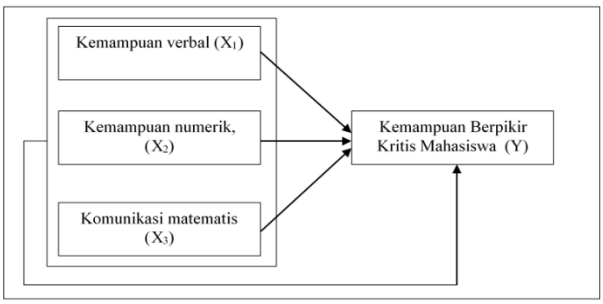

Figure 1. Constellation Of Variables

Data were collected using tests, namely (1) verbal ability tests, (2) numerical abilities, (3) mathematical communication, and (4)

students' critical thinking skills were disseminated to ITB STIKOM Bali students Jimbaran Campus even semester 2021/2022 which has a total of 26 students. The test is designed based on the indicator on the instrument grid. This study, used simple regression analysis and multiple regression. Therefore, the test requirements for regression analysis include (1) normality test of data distribution, (2) linearity test and significance of regression direction, (3) Multicollinearity test, (4) Heteroskedasticity test, and (5) autocorrelation test. The equation of multiple regression models is: $\hat{Y} = a + b_1X + b_2X_2 + b_3X_3$. The purposes of analysis used the program SPSS 20 for Windows.

3. Results and Discussion

Based on the results of data analysis, it is known that out of 26 students, students' verbal abilities are in the rendang sufficient by 57.5% and 32% in the good category. For students' numerical ability, it is known that in the calculus course, students' numerical ability of 38.24% is in a good category, and 51.76% is in the medium category. and 10% in the less category. Furthermore, for the variable mathematical communication ability of students, 21.5% are in a good category, 66% are in the sufficient category and 12.5% are in the less category. Based on the results of tests and observations, students' critical thinking ability shows that 49.5% of students have good critical thinking skills while 50.5% of students show ability moderate critical thinking.

The analysis test consists of testing the normality of data distribution, multicollinearity, linearity, and autocorrelation. (1) Based on normality tests, it is known that the significance value of Kolmogorov-Smirnov > 0.05 so that the null hypothesis is accepted, meaning that the distribution of data on the variable score of verbal ability, numerical ability, mathematical communication ability and ability critical thinking of students is normally distributed. The data obtained by the sample is classified as statistical data to be processed using parametric statistics whose results will be generalized to the population level, therefore it is necessary to be convinced that the statistical data is scattered according to the normal curve. (2) The linearity test showed all variables F deviation from the linearity of its significance > 0.05 and F The linearity of its significance < 0.05; meaning the correlation between the verbal ability score (X1), numerical ability (X2), mathematical communication ability (X3) and the student's critical thinking ability (Y) has a linear line of relationships. (3) The calculation of the Multicollinearity Test with VIF shows that Nilai tolerant > 0.1 and VIF (Variance Inflation Factor) value < 10 then all variables of verbal ability (X1), numerical ability (X2), mathematical communication ability (X3) meet the criteria of being free from multicollinearity. (4) Based on the results of the autocorrelation test analysis, a Dw value was obtained using a 5% degree of confidence in the number of samples 26 and the number of free variables 3 and one bound variable Y, the value of d greater than (du) 1,681 and smaller than (4-du) 2,319, it can be concluded that in the research data there was no autocorrelation. (5) Based on the SPSS output on the heteroskedasticity test using the Glejser test, it shows a signification value (Sig.) of > 0.05 for each variable, thus according to the test criteria, it can be concluded that there are no symptoms of heteroskedasticity in the regression model.

In this study, the data analysis technique used was multiple regression. This analytical technique is used to determine the contribution of verbal ability, numerical ability, mathematical communication ability to students' critical thinking ability with normal distribution. There are two hypotheses analyzed in this study, namely (1) there is a partial significant contribution between the variables of verbal ability, numerical ability and mathematical communication with critical thinking ability students; (2) there is a significant simultaneous contribution between verbal ability, numerical ability and mathematical communication with students' critical thinking skills. The results of the regression analysis can be presented as follows.

Table 1. Summary of Data Analysis Results of Correlations Between Variables

Variable Relationships	Determination (R^2)	F	Sig-F Change
X1 dengan Y	65,1%	345,673	0,000
X2 dengan Y	80,4%	758,297	0,000
X3 dengan Y	73,33%	509,893	0,000
X1, X2, X3, dengan Y	90%	334,459	0,000

To elaborate on answering the first hypothesis, it is necessary to describe the contribution of variables X1, X2, and X3 to variable Y. The result of the calculation of regression of verbal performance to the critical thinking ability of students shows that the

regression equation is $\hat{Y} = 11.945 + 1.151$ X1 with a calculated value of 10.866 and the significance of < 0.05. The calculation of the Significance and Linearity Test of Regression of verbal ability on students' critical thinking ability showed that F-count (regression) = 345.673 with a significance value of 0.00. The significance value of> 0.05, so the null hypothesis (H0) is rejected and an alternative hypothesis is accepted (H1) which means that the regression coefficient is meaningful (meaningful) and significant. Thus, it can be categorized as an increase in the score of verbal ability followed by an increase in the score of students' critical thinking ability. The correlation between verbal ability and students' critical thinking ability is calculated by product moment correlation known to the value of the correlation of the verbal ability and critical thinking ability value of 0.808 with a significance level of 0.00 which can be categorized as a strong relationship. Thus the alternative hypothesis (H1) "there is a significant contribution between the verbal ability variable (X1) and the student's critical thinking ability (Y)" is accepted and the null hypothesis (Ho) is rejected. The value of R2 expresses a positive linear relationship. This result shows that Verbal skills will help students in understanding meaning and make mathematical models to solve these mathematical problems. If the student's verbal skills are not good, then students will also find it difficult to solve math problems which will indirectly have an impact on students' critical thinking ability (Kinay and Bagceci, 2016). The magnitude of the determination of the variable dimensions of verbal appearance explains that the variable of students' critical thinking ability in learning calculus is 65.3%. This is in line with research conducted by Awofala, Balogun, & Olagunju (2010, p.15). From the study, Awofala, Balogun, & Olagunju found that "students with high verbal ability gained more in mathematical word problems achievement than students with low verbal ability" (Ajeng Daniyati, 2015). Students with good verbal skills showed better learning achievement than students with poor verbal skills (Irawan and Kencanawaty, 2017) In addition to verbal skills, other abilities can affect students' critical thinking skills, namely numerical ability and mathematical communication skills.

The calculation of the Significance and Linearity Test of Regression of numerical ability variables on students' critical thinking ability showed that F-counting (regression) = 758.297 with a significance value of 0.00. The significance value of> 0.05, so the null hypothesis (H0) is rejected and an alternative hypothesis is accepted (H1) which means that the regression coefficient is meaningful (meaningful) and significant. Thus, it can be categorized as an increase in the score of the numerical ability variable followed by an increase in the student's critical thinking ability score. The correlation between numerical ability and students' critical thinking ability is calculated by product moment correlation known to the value of correlation variables numerical ability (X2) and critical thinking ability a value of 0.897 with a significance level of 0.00 which can be categorized as having a strong relationship. Thus the alternative hypothesis "there is a significant contribution between the variable numerical ability and the student's critical thinking ability (Y)" is accepted and the null hypothesis (Ho) is rejected. . The magnitude of the determination of the numerical dimension variable explains that the variable of students' critical thinking ability in learning calculus is 80.4%. Numerical ability is intended as the ability to think and organize information to solve problems related to numbers (Dedy Setiawan *et al.*, 2014). Numerical abilities include the ability to calculate in terms of addition, the ability to calculate in terms of subtraction, the ability to calculate in terms of multiplication, and the ability to calculate in terms of (Irawan and Kencanawaty, 2017). Students who have dominant numerical intelligence will have high critical thinking skills compared to students who have less dominant numerical intelligence. This is because students with high numerical intelligence tend to enjoy analyzing and studying the causes and effects of something happening independently (Lupita, 2020). The ability to think critically is not only illustrated in a person's numerical and verbal abilities but also mathematical communication skills (Husnah, 2017).

Calculation of the Significance and Linearity Test of Regression of mathematical ability on students' critical thinking ability showed that F-counting (regression) = 509.893 with a significance value of 0.00. The significance value of> 0.05, so the null hypothesis (H0) is rejected and an alternative hypothesis is accepted (H1) which means that the regression coefficient is meaningful (meaningful) and significant. Thus, it can be categorized as an increase in the score of mathematical variables followed by an increase in the score of students' critical thinking ability. The correlation between mathematical ability and

students' critical thinking ability is calculated by product moment correlation known to the value of correlation variables mathematical ability and ability to think the critical value of 0.857 with a significance level of 0.00 which can be categorized as having a strong relationship. Thus the alternative hypothesis (H3) "there is a significant contribution between the mathematical ability and the student's critical thinking ability" is accepted and the null hypothesis (Ho) is rejected. The magnitude of the determination of the mathematical ability explained that the variable of students' critical thinking ability in learning calculus was 73.33%. Communication skills in mathematics include the ability to interpret and explain mathematical terms and notations both orally and in writing in expressing ideas through writing but also the ability of students to speak, read, discuss and study, and discourse (Rosa, Halini and Hamdani, 2021)

The fourth hypothesis states that there is a significant simultaneous contribution between verbal ability, numerical ability, and mathematical communication with students' critical thinking ability in learning calculus. This hypothesis was analyzed using multiple regression techniques and partial correlation. The calculation results show that the regression equation between X1, X2, and X3, against Y, is $\hat{Y} = 0.950 + 0.173X1 + 0.736X2 + 0.388X3$ The calculation of the contribution of verbal ability, numerical ability, and mathematical communication with students' critical thinking ability shows that the F-calculated price shows a value of 334.459 with a < 0.05 significance value at a significance level of 5% so that the null hypothesis is rejected and the alternative hypothesis, is accepted. This means that the double regression coefficient obtained is significantly meaningful/meaningful. So simultaneously verbal ability, numerical ability, and mathematical communication with the critical thinking ability of students in learning calculus. It is also known that the magnitude of the contribution value together (simultaneously) between the variables of verbal ability, numerical ability, and mathematical communication with the student's critical thinking ability is 90.30% and the remaining 9.70% is influenced by other variables that are not researched in this study

4. Conclusions

Based on the stages of research that have been carried out, the following results are obtained (1) There is a partial significant contribution between the variables of verbal appearance, numerical ability, and mathematical communication to students' critical thinking ability in learning calculus. The magnitude of the determination of the variable dimensions of verbal appearance explains that the variable of students' critical thinking ability in learning calculus is 65.3%. The magnitude of the determination of the numerical dimension variable explains that the variable of students' critical thinking ability in learning calculus is 80.4%. The magnitude of the determination of the numerical dimension variable explained that the variable of students' critical thinking ability in learning calculus was 73.33%. (2) There is a significant simultaneous contribution between verbal ability, numerical ability, and mathematical communication to students' critical thinking ability in learning calculus. the joint (simultaneous) contribution between the variables of verbal ability, numerical ability, and mathematical communication with the critical thinking ability of students was 90.30% and the remaining 9.70% was influenced by other variables that were not studied in this research.

Based on the stages that have been carried out in this study, suggestions that can be recommended in order to optimize the research objectives are as follows; (1) In order to optimize students' critical thinking skills, it is necessary to pay attention to various aspects such as the characteristics of student abilities, especially in calculus courses. (2) It is necessary to design and develop a learning approach that can improve verbal skills, numerical abilities, mathematical communication so that they can train students' critical thinking skills in calculus courses.

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