

The Influence of Formative Assessment Methods on Learning Outcomes of Plane Geometry by Controlling Critical Thinking Skills

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ABSTRACT

To improve the quality of student learning outcomes in plane geometry, aside from improving the quality of learning, it can also be done through improving the quality of the assessment. Therefore, the application of appropriate assessment methods in learning plane geometry is very important. This study aims to determine the effect of formative assessment methods (performance assessment and conventional assessment) on student learning outcomes in plane geometry by controlling critical thinking skills. This research is a quasi-experimental research involving 40 students majoring in Mathematics Education, FMIPA Undiksha as a sample. Data analysis was performed using one-way covariance analysis. By controlling critical thinking skills, the results of the study show that the learning outcomes of plane geometry of students who are given a performance assessment are higher than students who are given a conventional assessment.

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1. INTRODUCTION

Based on the results of the evaluation of plane geometry lectures in 2020 in the Mathematics Education Department, FMIPA, Ganesha Education University, it was revealed that the learning outcomes achieved by students were not as expected. This is indicated by the low learning outcomes of students' plane geometry as stated in the quote list of student scores. In the even semester of the 2020/2021 academic year, out of 89 students who programmed plane geometry, the average UTS and UAS scores only reached 58.23. The low learning outcomes of plane geometry achieved by students will certainly have an impact on the student's cumulative achievement index (GPA). In fact, nowadays, student GPA is an important aspect for: measuring the quality of student learning outcomes, continuing their studies, as well as competing for job opportunities. This condition cannot be allowed to continue. There must be an effort to improve student learning outcomes. As stated by (Sarjono et al., 2018), to improve the quality of education (learning outcomes) besides being able to be achieved through improving the quality of learning, it can also be done through improving the quality of the assessment.

Regarding the influence of critical thinking skills on learning outcomes, states that classroom teachers at all levels should consider critical thinking which offers real promise for increasing the achievement of all students in the core subject areas studied. (Quitadamo et al., 2008) state that critical thinking and problem solving skills are abilities that directly contribute to academic and professional success. Osarenren and Asiedu as quoted by (Chukwuyenum, 2013) state that critical thinking is an important concept needed to improve performance in every subject, especially in mathematics. (Haseli & Rezaii, 2013) state, critical thinking is considered a basic epistemic process that increases students' abilities in reducing anxiety, problem solving, decision making in social conditions, educational achievement, and the like. (Firdaus et al., 2015) stated that many studies have shown that developing critical thinking skills can improve mathematics learning outcomes.

Some empirical data also shows that critical thinking skills affect learning outcomes. The results of Scott and Markert's research as quoted by (Chukwuyenum, 2013) show that there is a 33% positive correlation between critical thinking skills and academic success in students in the first two years of health school. They concluded that students' critical thinking skills are a determining factor for students' academic success. Furthermore, (Chukwuyenum, 2013) recommends that critical thinking skills be something that is very meaningful to improve students' understanding of mathematical concepts. Meanwhile, from the results of his research (Wicaksono, 2014) it was revealed that critical thinking contributed 41.99% to student learning outcomes. Findings from research conducted by (Aditya et al., 2013) show that critical thinking skills have a positive effect on students' mathematics learning outcomes. Another finding from the research results of (Wulandari et al., 2011) shows that students' critical thinking skills contribute positively to their learning outcomes.

Considering the results of theoretical studies and empirical evidence that critical thinking skills affect learning outcomes, it is very important to control aspects of critical thinking skills so that the influence of the use of formative assessment methods (conventional and performance) on student learning outcomes can be studied more clearly

2. METHODS

In this study, the learning process in both groups used a general learning syntax through the stages of exploration, elaboration and confirmation because this study did not see the effect of using a learning model. The difference in treatment only occurs in the type of assessment method used, namely group A1 using the performance assessment method and group A2 using the conventional assessment method. The performance assessment method given as treatment in the experimental group refers to the performance assessment method that has been developed by (Ariawan & Ardana, 2021). The performance assessment method used in it contains the tasks that must be completed, the design of the activities carried out in completing the task, and a rubric for assessing the tasks that must be completed to assess the process.

The population in this study were 92 students majoring in Mathematics Education, FMIPA Undiksha who programmed the plane geometry course in the odd semester 2021/2022 spread over 4 parallel classes, namely Class A = 23 people, Class B = 23 people, class C = 24 people. and class D = 22 people. Regarding the number of samples required in experimental research using the experimental group and the control group, (Sekaran & Bougie, 2016) states, the number of sample members in each group that can be taken ranges from 10 to 20 samples. Therefore, the research sample used in this study was 40 students who were divided into 2 selected classes which were determined using random sampling technique. From the results of the draw, Class D was obtained as the experimental group and class B as the control group. For data analysis, 20 students were taken randomly in each class. The learning outcomes referred to in this study are only related to the cognitive domain which is only taken based on the results of students' UTS scores.

The instrument used to measure critical thinking skills in this study was a critical thinking skills test which was developed by adapting the California Critical Thinking Skills Test (CCTST) Form A which was translated by Prof. Dr. A. A. Ngurah Marhaeni, MA. This instrument has been tested and

used by (Ariawan, 2016). The test kit consists of 30 multiple choice questions covering 6 indicators of critical thinking skills, namely: interpretation, analysis, evaluation, inference, explanation, and self-management. The critical thinking skills test tool used has a reliability coefficient of 30 valid critical thinking skills test items of 0.845. Based on the normative criteria according to Guilford, this critical thinking skill test kit has a very high level of reliability.

Before the data was analyzed further, the research data was tested for analytical prerequisites, namely: normality test, homogeneity test, and linearity test, regression direction significance test, and regression line alignment test.

The normality test for the distribution of data in this study uses the Lilliefors test statistic with the test criteria that the data has a normal distribution if $L_0 < L_t$ at a significance level of 5% and in other cases the data is not normally distributed.

To test the homogeneity of variance between groups, the IBM SPSS Statistics for Windows version 20 tool was used through Levene's test. Regression linearity test was conducted to find out the equation of the regression line between the variables of critical thinking ability and the variable of student learning outcomes of geometry. The test criteria is if $F_{count} < F_{table}$ then the regression form is linear, at a significance level of 5% and in other cases it is not linear. In testing the significance of the regression direction, testing the null hypothesis is carried out with the F statistical test. The test criteria is if $F_{count} > F_{table}$ at a significance level of 5% ($\alpha = 0.05$), then the F_{count} (regression) price is significant, which means that the regression coefficient is significant. (meaning).

The regression line alignment test was carried out using the IBM SPSS Statistics for Windows version 20 program. The test procedure was carried out using univariate GLM (General Linear Model) statistics using the SPSS program syntax, with the following criteria: at the significance level = 0.05 H_0 is accepted if value $F_{count} < F_{table}$ which means that the regression lines in all cells are parallel; and reject H_0 if the value of $F_{count} > F_{table}$, which means that there is a regression line that is not parallel. Because in this study, the effect of the independent variables on the use of performance assessment methods and conventional assessment methods on learning outcomes of plane geometry was investigated, the hypothesis testing was carried out using One Path Covariance Analysis (one covariable). The test criteria are: at the significance level, reject H_0 if $F^*A > F_{(\alpha, dbA, dbD)}$.

3. FINDINGS AND DISCUSSION

The plane geometry learning outcome test consists of 10 questions from 10 predetermined indicators, so that each indicator will be represented by one item. The test was piloted on 50 student respondents who had completed lectures (got the material) plane geometry as listed on the item grid. From the analysis of the test results, it was found that the 10 items tested were all in the valid category. reliability coefficient of 0.832. Based on the normative criteria according to Guilford, the learning outcome test device for plane geometry has a very high level of reliability so that it can be used as a relatively standardized test kit.

Analysis Prerequisite Test Results

Based on the Liliefors test, the following results were obtained.

Table 1. Liliefors Test Results

Group	N	L_0	L_t	Relation	Distribution
A1	20	0,112	0,192	$L_0 < L_t$	Normal
A2	20	0,115	0,192	$L_0 < L_t$	Normal

From the Liliefors test as shown in Table 1, it was obtained that L_0 for group A1 = 0.112 and L_0 for group A2 = 0.115. Meanwhile, for the significance level = 0.05 which is used for $N = 20$, it is obtained $L_t = 0.192$. Thus, the L_0 values for each data group are all smaller than the L_t values. Thus, it

can be concluded that all data on student learning outcomes of plane geometry (Y) are sourced from populations that are normally distributed.

Based on the Levene test using IBM SPSS Statistics for Windows version 20, the following results were obtained.

Table 2. Levene Test Results Using IBM SPSS Statistics for Windows Version 20

Levene's Test of Equality of Error Variances ^a			
Dependent Variable: Learning outcomes			
F	df1	df2	Sig.
,057	1	38	,813

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Critical Thinking + Group

From the calculation results of Levene's test using SPSS as stated in Table 2, the Sig value is obtained = 0.809 > = 0.05. Thus, it can be concluded that the variance of the data on the results of studying Geometry between groups A1 and A2 is homogeneous.

For the Linearity Test, based on the calculation results, the following results are obtained.

Table 3. Summary of Linearity Test Results

Group	F_{Count}	F_{table}	Sig.	Conclusion	
A1	1,177	$F_{(0.05;6;12)} = 2,996$	0,380	Accepted H_0	Linear
A2	1,326	$F_{(0.05;7;11)} = 3,012$	0,324	Accepted H_0	Linear

In Table 3 above, it can be seen that the Fcount value of each sample group is smaller than the Ftable value. This means that students' critical thinking skills are linearly related to students' learning outcomes of plane geometry. Significance test of the relationship between Critical Thinking Skills (X) and Learning Outcomes of Plane Geometry (Y) using a simple linear regression model. The results of this test are presented in the following table.

Table 4. Summary of Significance Test Results Relationship of Critical Thinking Skills (X) with Learning Outcomes of Plane Geometry (Y).

Group	F_{hitung}	F_{tabel}	Sig.	Conclusion	
A1	18,349	$F_{(0.05;1;12)} = 4,747$	0,001	Reject H_0	Mean
A2	21,773	$F_{(0.05;1;11)} = 4,844$	0,001	Reject H_0	Mean

Based on Table 4 above, all Fcount values are greater than Ftable values. Thus, it can be concluded that critical thinking skills (X) have a significant relationship with learning outcomes of plane geometry (Y) for both groups of data.

The calculation results for the regression line parallelism test are contained in the following table.

Table 5. Results of the Parallelization Test of Regression Lines

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	687,197 ^a	3	229,066	19,036	,000
Intercept	927,012	1	927,012	77,036	,000
X	436,823	1	436,823	36,301	,000
FS	,066	1	,066	,005	,942

FS * X	2,624	1	2,624	,218	,643
Error	433,203	36	12,033		
Total	212532,000	40			
Corrected Total	1120,400	39			
a. R Squared = ,613 (Adjusted R Squared = ,581)					

Based on the results of the calculations in Table 5, it is found that Fcount for FS*X = 0.218 is smaller than Ftable = 4.113 or the value of Sig. = 0.643 > 0.05 so that H0 is accepted. It is concluded that there is no difference in the slope of the regression line (slopes) for cells formed by learning using a performance assessment (A1) and cells formed by learning using a conventional assessment (A2) or all regression lines are parallel.

Hypothesis testing

The statistical hypotheses tested are as follows.

$$H_0 : \mu^*A_1 \leq \mu^*A_2$$

$$H_1 : \mu^*A_1 > \mu^*A_2$$

For $i = 1, 2$, μ^*A_i represents the corrected mean for variable Y with the assumption that the linear effect of X on Y is the same for groups A1 and A2. The calculation results are presented in the following table.

Table 6. Hypothesis Test Calculation Results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	684,573 ^a	2	342,286	29,059	,000
Intercept	937,965	1	937,965	79,629	,000
Critical thinking	434,573	1	434,573	36,893	,000
Group	143,121	1	143,121	12,150	,001
Error	435,827	37	11,779		
Total	212532,000	40			
Corrected Total	1120,400	39			
R Squared = ,611 (Adjusted R Squared = ,590) ^a					

Table 7. Dependent Variable: Learning Outcomes

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Performance	74,621 ^a	,773	73,054	76,188
Conventional	70,779 ^a	,773	69,212	72,346

a. Covariates appearing in the model are evaluated at the following values: Critical Thinking = 20.25.

Based on the calculation results, in Table 6 it turns out that in the group row, the Fcount = 12.150, and Ftable = 4.105. Because Fcount > Ftable or Sig < 0.05, H0 is rejected. This means that there are differences in learning outcomes of plane geometry between students who are given a performance assessment and those who are given a conventional assessment, after controlling for students' critical thinking skills.

Meanwhile, the results of the calculation of the corrected Means obtained that the average corrected learning outcomes of Plane geometry for students who were given a performance assessment was 74.621 and the average corrected for plane geometry learning outcomes for students who were given a conventional assessment was 70.779.

Thus, it is concluded that the learning outcomes of plane geometry of students who were given a performance assessment were higher than the learning outcomes of plane geometry of students who were given a conventional assessment, after controlling for students' critical thinking skills.

The results of testing the research hypothesis which states that the learning outcomes of plane geometry in the group of students who are given a performance assessment are higher than the group of students who are given a conventional assessment, after controlling for students' critical thinking skills can be accepted. Thus, it can be concluded that in the plane geometry learning at the Mathematics Education Department, Ganesha University of Education, the achievement of student learning outcomes who were given a performance assessment was higher than the group of students who were given a conventional assessment, after controlling for students' critical thinking skills.

In plane geometry learning, the assessment that is applied is expected to have an impact on the quality of student learning. The formative assessment method that can be applied is a performance assessment. The use of performance assessment in learning is based on the consideration of the advantages of the assessment method compared to conventional assessment methods. According to (Mustamin, 2010), some of the advantages of the performance assessment method are: (1) learning can be more effective because performance assessment is integrated in the learning process, (2) helps students to communicate ideas, both to friends, teachers and to the class, (3) more complete and valid in assessing students' abilities, (4) developing students' knowledge and skills because they not only provide answers but also their reasons, and (5) answers are open because there are no right or wrong answers.

The plane geometry course is a subject that requires a lot of mathematical proof. According to (Salsabila et al., 2020), the use of the performance assessment method is very suitable for use in subjects that are full of mathematical proof. Thus, the use of the performance assessment method will be very synergistic and coherent with the learning of plane geometry.

Although the plane geometry learning process is carried out online, the performance assessment method can still be done. In fact, through this performance assessment method, 4 basic 21st century skills (communication, collaboration, critical thinking, and innovative-creative thinking skills) can still be measured in online discussion forums (Maryuningsih et al., 2020).

The application of the performance assessment method in plane geometry learning requires students to always be actively involved in completing performance tasks because student involvement in groups to complete performance tasks will receive an assessment. This is in accordance with (Mustamin, 2010) which states, performance assessment requires students to be active because what is assessed is not only the product but more importantly the skills they have. In addition, the application of performance assessment in plane geometry learning will be able to familiarize students to show their performance in all things, whether to solve problems, express opinions, discuss, or give reasons for the answers given (Sa'dijah, 2009). Even the application of performance assessments will be able to improve students' creative thinking skills (Sari et al., 2020). In general, the application of performance assessments can improve the quality of teaching and learning (Salma & Prastikawati, 2021).

Meanwhile, the application of conventional assessment methods in plane geometry learning pays less attention to the process, and places more emphasis on the product or the results of the answers given by each group. Thus, the involvement of each group member in solving problems received less attention when students were solving problems. This tends to cause students to be less actively involved in finding solutions to the problems given and only rely on answers from other group members. This can be the cause of the less than optimal learning outcomes achieved by students.

The results in this study are in line with the results of other studies related to the comparison of effectiveness between performance assessments and conventional assessments. From the results of his research, (Mulana et al., 2021) it was revealed that the mathematics learning outcomes of students who studied mathematics with performance appraisals were higher than the mathematics learning

outcomes of students who studied mathematics with conventional assessments after controlling for mathematical logic intelligence. From the results of (Dungus, 2013) it was found that the average student learning outcomes in Physics II subjects who were given a performance assessment were higher than the average student learning outcomes who were given a written assessment. From the results of their research by (Widiani et al., 2014) it was found that the Indonesian writing skills achieved by students who took learning with performance assessments were better than students who took lessons with conventional assessments. Meanwhile, from the results of research by (Adnyana et al., 2014) it was revealed that the average score of mathematics learning outcomes that followed the performance assessment model was higher than students who followed the conventional learning model.

4. CONCLUSION

Based on the results of hypothesis testing with Ananova followed by a difference test, it can be concluded that the learning outcomes of plane geometry in the group of students who were given the performance assessment method were higher than the group of students who were given the assessment method, after controlling for students' critical thinking skills. Based on these findings, it is believed that efforts can be made to improve the quality of the student's plane geometry learning process and outcomes by using a performance assessment in the plane geometry learning process

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