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Differences in Students' Mathematical Communication Ability through the Application of Batak Culture-Oriented Learning on Problem-Based Learning and Guided Discovery

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Abstract

This study aims to determine: (1) The differences in students' mathematical communication abilities by implementing Batak culture-oriented learning on problem-based learning (PBM-B3) and guided discovery (PT-B3) and (2) the interaction between learning models and students' gender towards students' mathematical communication abilities. This research is quasi-experimental. The population of this study was first-grade students of SMP Swasta Putri Cahaya 2018/2019 with a sample taken from class VII-1 treated with the PBM-B3 learning model and class VII-2 treated with PT-B3 learning model. Each class consists of 14 male students and 14 female students. The research instrument used was a test of students' mathematical communication abilities. Data analysis was performed using covariance analysis (ANACOVA). Based on the research conducted, the results showed that: (1) There were differences in the students' mathematical communication abilities who were treated with the PBM-B3 and PT-B3 learning model after controlling the initial abilities of students. The interaction patterns of Dalihan Na Tolu found in the two learning models showed a positive effect on students' mathematical communication abilities because this interaction pattern is inherent in students which resulted in higher self-confidence in communicating ideas during problem-solving. (2) There was an interaction between the learning model and the gender of students on their mathematical communication abilities after controlling the initial abilities of students.

Keywords: *Mathematical Communication; Problem Based Learning; Guided Discovery; Batak Culture*

Introduction

Mathematics is a science field that needs to be taught to students to equip them with various kinds of thinking skills such as logical, analytical, systematic, critical, and creative thinking. Also, mathematics can form attitudes required by students to assist them to act intellectually in their environment. Attitudes that can be cultivated through learning mathematics include meticulousness, carefulness, criticalness, efficiency, persistence, and consistency. Therefore, through learning mathematics, students are expected to be able to manage various things in the world in the very best way.

This is in line with what was conveyed by the Ministry of Education and Culture, stating that through mathematics learning in schools, students are expected to have the ability to: 1) use reasoning on patterns and characters, perform mathematical manipulation in generalizing, compile evidence, or explain ideas and mathematical statements, 2) solve problems including the ability to understand problems, design mathematical models, solve models, and interpret the solutions obtained, 3) communicate ideas with symbols, tables, diagrams, or other media to clarify the situation or problem, 4) respect the advantage of mathematics in daily life. (Hasratuddin, 2015).

National Council of Teachers of Mathematics (NCTM) (2000) has set several standard processes that must be master by students in learning mathematics, including: (1) learn to do mathematical problem solving; (2) learning to do mathematical communication; (3) learn to do mathematical reasoning; (4) learn to do mathematical connection; and (5) learn to make mathematical representation.

Based on the aspects standards mentioned by the Ministry of Education and Culture and NCTM above, one of the abilities that students are expected to master in learning mathematics is mathematical communication abilities. Syarah (2013) states that "through mathematical communication abilities, students can organize and consolidate their mathematical thinking, spoken and written, which in turn can lead students to a deep understanding of the mathematical concepts they have learned". Besides, mathematical communication abilities will also support other mathematical abilities, such as problem-solving abilities. Students with good mathematical communication abilities will be able to represent a problem correctly so that it will facilitate problem-solving. Shortly saying, good mathematical communication abilities are a prerequisite to solving problems well.

The practice shows that the results of learning mathematics in Indonesia in mathematical communication aspects are still low. As affirmed by Izzati (Prayitno, 2013) that the overview of students' poor communication abilities is because mathematics learning has not focused on the development of this very ability. To support, Kadir also found that the mathematical communication abilities of junior high school students in coastal areas were still low, both in terms of academic achievements and learning models.

In general, communication occurring in mathematics learning activities in the classroom is linear only, which means a one-way communication, with the teacher as the information provider and students as the information recipient. Otherwise, the communication should be convergent, which is two-way communication so that learning activities can take place dynamically and develop towards a sustainable collective understanding. This is supported by Ansari (Purba & Surya, 2019) Sitompul, Syahputra, dan Fauzi (Trianto, 2010) states that the cause of low capability of student mathematic communication skill is the students are not capable in communicating the mean of question given. It because the previous learning only explains the steps of counting without help students to express idea in written and spoken form.

The explanation above shows that in learning mathematics, knowledge should be built by students, by allowing them to communicate their ideas through problems related to real life, the teacher only needs to guide students to reach a higher stage of understanding. One of the learning alternatives that can foster mathematical communication abilities is problem-based learning. According to Arends (Sanjaya, 2008), problem-based teaching is a learning approach in which students work on authentic problems to compile their own knowledge, develop inquiry and higher-order thinking skills, develop independence, and self-confidence.

In addition to the problem-based learning model, another learning model in accordance with constructivism theory is guided discovery learning. In guided discovery, the teacher encourages students to make guesswork, intuition, and experiment. Through guesswork, intuition, and experiment, students are expected to not only accept the concepts, principles, or procedures that have been predetermined in mathematics teaching and learning activities, but students also focus more on finding and discovering mathematical concepts, principles, or procedures. To create a discovery, students must be able to connect the mathematical ideas they acknowledge. To connect these ideas, they can communicate through pictures, graphics, symbols, or words so that it becomes simpler and easier to understand. Accustoming students with learning discovery will also simultaneously accustom them to represent information, data, or knowledge to produce findings (Bishop, 1988).

Concerning the above description, it is also important for teachers to design problems related to students' daily lives. In this research, problems related to student backgrounds will be further studied. This is supported by Bishop's statement that mathematics is a cultural phenomenon. In this case, mathematics is considered as a product of a culture that develops as a result of various human activities (Sinaga, 2016). The goal of mathematics learning through cultural background is to make mathematics more relevant to students as they will be provided with various examples that take advantage of students' experiences and events common to their cultural environment (Rosa & Orey, 2011). This is supported by Rosa and Orey (Kadir, 2015) that mathematics learning uses cultural experiences as a tool to create a more meaningful mathematics learning and to provide students with insights into mathematical knowledge embedded in their social and cultural en.vironment.

Given the cultural background of the majority of students at the research site, the researchers took problems related to Batak culture. The form of culture in this study is a form of concrete cultural objects as well as *Dalihan Na Tolu* cultural system. Social interaction pattern within *Dalihan Na Tolu* was applied in group discussion into a problem-based learning model known as problem-based learning with Batak culture (PBM-B3) and guided discovery with Batak culture (PT-B3).

Method

This research was conducted on the even semester 2018/2019. This research is a quasi-experiment. The sampling technique used is cluster sampling and one class was treated with problem-based learning with Batak-oriented culture (PBM-B3) and the other class was treated with guided discovery learning with Batak-oriented culture (PT-B3). Each class consists of 14 male students and 14 female students. The research instrument used is a test of mathematical communication abilities. Mathematical communication abilities tests were administered after performing the PBM-B3 learning model in class VII-1 and the PT-B3 learning model in class VII-2. The research flow is summarized in Figure 1 below:

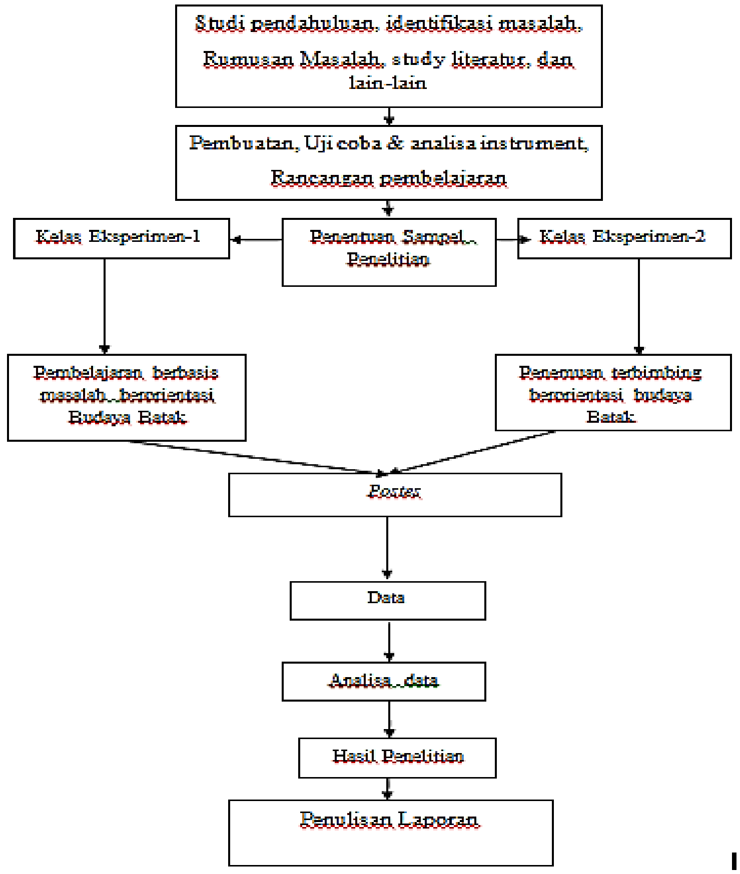

Figure 1. Research Flow

Results

A post-test of students' mathematical communication abilities was administered after learning Batak Toba culture-oriented problem-based learning in the PBM-B3 class and after learning Batak Toba culture-oriented guided discovery learning in the PT-B3 class. From the results of data processing, it was found that the average post-test score of students in the PBM-B3 class was 72.33, while the PT-B3 class was 76.43. The post-test results are shown in Table 1 below:

Table 1. Post-Test Results of Students' Mathematical Communication Ability

Class	N	Max	Min	Mean ($\bar{X}$)	Standard Deviation
PBM B3	28	90	62	72,33	6,64
PT B3	28	95	50	76,43	12,20

Furthermore, the normality test was carried out as an ANACOVA prerequisite test to see whether the data on students' mathematical communication ability in the two classes are normally distributed or not. This normality test was conducted using the Kolmogorov-Smirnov statistical test on both data classes with the following hypotheses testing:

H_0: Post-test data of students' mathematical communication ability are normally distributed.
H_1: Post-test data on students' mathematical communication ability are not normally distributed.

The H_0 criterion test is accepted if the probability (sig.) obtained is greater than 0.05 and is rejected in other cases. To test this hypothesis, the Kolmogorov-Smirnov test was utilized. The summary of the post-test normality results is displayed in the following Table 2:

Table 2. Post-test Normality Test of Mathematical Communication

	LEARNING MODEL	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
KAM	PBM B3	.137	28	.194	.945	28	.148
	PT B3	.098	28	.200*	.968	28	.523
a. Lilliefors Significance Correction							

Based on Table 2, it shows that the significance value of the Kolmogorov-Smirnov in the PBM-B3 class is 0.194 and 0.200 in the PT-B3 class. The two significance values in each learning class are greater than the significance level of 0.05, thus, given the criterion test, H0 is accepted and the other hypothesis is rejected, which implies that the post-test data of students' mathematical communication abilities are normally distributed.

Furthermore, post-test variance in both classes was tested to examine whether it is homogeneous or not. The test instrument used for the homogeneity test is the Levene test. The hypotheses tested to determine the homogeneity of the student's mathematical communication abilities are as follows:

H0: ${\sigma_1}^2 = {\sigma_2}^2$ (post-test data on students' mathematical communication abilities comes from a population with homogeneous variances)

H1: ${\sigma_1}^2 \neq {\sigma_2}^2$ (post-test data of students' mathematical communication abilities comes from a population with non-homogeneous variances)

The test criteria are if the value of $F_{count} < F_{table}$ and sig. > 0.05 with $\alpha = 0.05$, then H_0 is accepted and H_1 is rejected. The following are the results of the test for homogeneity of variance of students' mathematical communication ability post-test presented in Table 3 below:

Table 3. Post-test Homogeneity Test of Mathematical Communication

Dependent Variable: COMMUNICATION ABILITY			
F	df1	df2	Sig.
1.324	3	52	.277

Based on table 3, it exhibits that the value of F_{count} = 1.324 while the value of F_{table} (0.05; 3; 52)) = 2.7826. Besides, it also obtained a significance of 0.277, which is greater than the significance level of 0.05. It shows that $F_{count} = 1.324 < F_{table} = 2.7826$ and the sig. = 0.277> 0.05. Thus, H_0 stating the variance in each group is equal can be accepted. In other words, both classes have homogeneous data variance.

Furthermore, the linearity test was conducted to determine the relationship between the covariate variable (KAM) and the dependent variable (students' mathematical communication ability). To test the linearity of the regression model, the following hypotheses are formulated:

H0: $\gamma_1 = 0$ (the regression model is linear)

H1: $\gamma_1 \neq 0$ (the regression model is non-linear)

The test criteria are if the value of F_{count} <F_{table} and sig. > 0.05 with α = 0.05, then H_0 is accepted while H_1 is rejected. The results of the regression linearity test can be seen from the ANOVA table on the SPSS output in Table 5 below:

Table 4. Linearity Test of Regression Equations

COMMUNICATION ABILITY* KAM			Sum of Squares	Df	Mean Square	F	Sig.
COMMUNICATION ABILITY * KAM	Between Groups	(Combined)	4873.658	26	187.448	9.414	.000
		Linearity	4178.428	1	4178.428	209.838	.000
		Deviation from Linearity	695.230	25	27.809	1.397	.193
	Within Groups		577.467	29	19.913		

The linearity regression was obtained from the Deviation from Linearity. In Table 4 above, it is known that F_{hit} = 1.397 while the value of $F_{(tab\ (0.05,25,29))}$ = 1,891. It means that the value of F_{hit} = 1.397 <$F_{(tab\ (0.05,25,29))}$ = 1,891. Furthermore, it also obtained sig. = 0.193> 0.05. Based on the test criteria F_{count} <F_{table} and sig. > 0.05, then H0 is accepted while H_1 is rejected. All things considered, the regression of Y on X is linear or forms a linear line.

The final prerequisite test for ANACOVA is the linear test used to study the difference in the linear effect of initial mathematics abilities (X) on students' mathematical communication abilities (Y) between the four groups of students grouped by the learning model factor (A) and gender (B)

Statistical hypotheses examined are:

H_0: $(AB)_{ij}X = 0$ (the four regression coefficients are equal or linear)

H_1: Not H_0 (there is a non-linear regression coefficient)

Given the test criteria the value of F_{count} <F_{table} and sig. > 0.05 with α = 0.05, then H_0 is accepted while H_1 is rejected. The test results are displayed in Table 5:

Table 5. Analysis Table of Linear Regression Test

Dependent Variable: COMMUNICATION ABILITY					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4943.483[a]	7	706.212	40.099	.000
Intercept	2411.547	1	2411.547	136.929	.000
A * B	79.617	3	26.539	1.507	.225
X	2867.895	1	2867.895	162.841	.000
A * B * X	61.544	3	20.515	1.165	.333
Error	845.357	48	17.612		
Total	346961.000	56			
Corrected Total	5788.839	55			
a. R Squared = .854 (Adjusted R Squared = .833)					

Based on table 5 above, it obtained that F_{count} = 1.165 while the value of $F_{(tab\ (0.05,3,48))}$ = 2,798. In Table 5, a significance value of 0.333 was also obtained, which means that the value is greater than 0.05. It shows that the value of F_{count} = 1.165 <$F_{(tab\ (0,05,3,48))}$= 2,798 and sig. = 0.333> 0.05, which means that based on the test criteria, H_0 is accepted. Hence, the regression coefficient (slope) of the four groups is homogeneous. Thus, the ANACOVA model can be applied.

Hypothesis Testing

First Hypothesis

The hypothesis proposed is that there are differences in the mathematical communication abilities of students who are treated with Batak culture-oriented learning model in problem-based learning and guided discovery model. The statistical hypotheses tested are:

$H_0: \mu_1 = \mu_2$ (there is no difference in the mathematical communication abilities of students who are treated with Batak culture-oriented learning model in problem-based learning and guided discovery model)

$H_a: \mu_1 \neq \mu_2$ (there are differences in the mathematical communication abilities of students who are treated with Batak culture-oriented learning model in problem-based learning and guided discovery model)

The full ANACOVA test results are shown in table 6:

Table 6. ANACOVA Results of Students' Mathematical Communication Ability

Dependent Variable: COMMUNICATION ABILITY

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4656.137[a]	4	1164.034	74.675	.000
Intercept	1222.549	1	1222.549	78.429	.000
KAM	4326.798	1	4326.798	277.573	.000
Learning Model	360.936	1	360.936	23.155	.000
Gender	44.236	1	44.236	2.838	.098
Learning Model * Gender	73.041	1	73.041	4.686	.035
Error	794.988	51	15.588		
Total	315223.000	56			
Corrected Total	5451.125	55			

a. R Squared = .854 (Adjusted R Squared = .843)

Based on Table 6, the learning model factor obtained F_{count}= 23.155 while $F_{(table\ (1.51))}$ = 4.03, which means F_{hitung}> $F_{(table)}$ and p-value = 0.000 <0.05, it means H_0 is rejected. Hence, there are differences in the mathematical communication abilities of students treated with Batak culture-oriented learning model in problem-based learning and guided discovery model after controlling the initial abilities of students.

Second Hypothesis

The hypothesis proposed is that there is an interaction between the learning model and the gender of students on students' mathematical communication abilities. The statistical hypotheses tested are:

H0: $(\propto \beta)_{ij} = 0$, i = 1,2; j = 1,2 (there is no interaction between the learning model and the gender of students on students' mathematical communication abilities)

Ha: $(\propto \beta)_{ij} \neq 0$, i = 1,2; j = 1,2 (there is an interaction between the learning model and the gender of students on students' mathematical communication abilities)

Information:
α: Learning model
β: Gender of Student

The full ANACOVA test results can be seen in Table 6 above. Based on Table 6, it obtained that F_{count} factor of the learning model gender is 4.686 while $F_{(table\ (1.51))} = 4.03$, which means that $F_{count} > F_{(table)}$ and the p-value is 0.035, meaning that it is smaller than 0.05, so H_0 is rejected. As a conclusion, there is an interaction between the learning model and the gender of students on students 'mathematical communication abilities after controlling the initial abilities of students. In a graphic, this interaction is depicted in Figure 2:

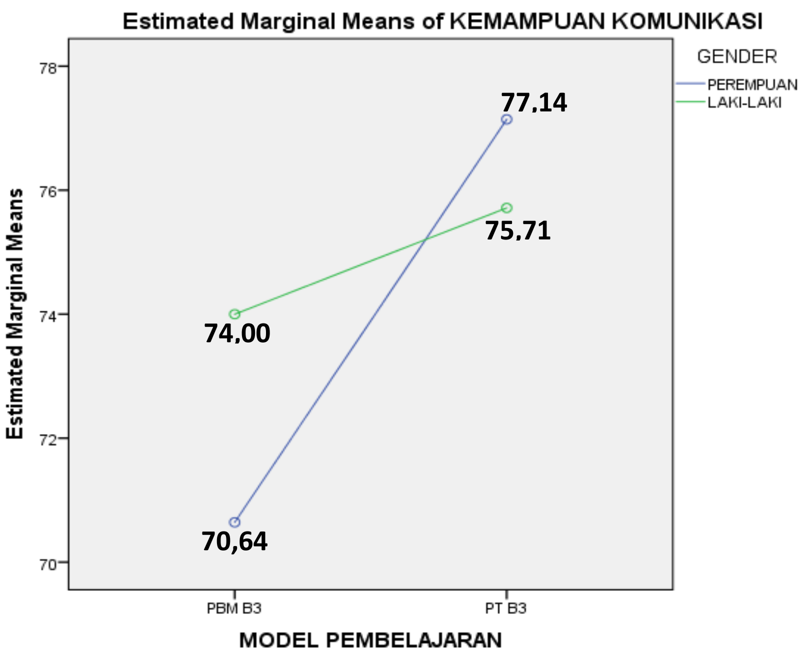

Figure 2. The Interaction of Learning Model and Gender on Students' Mathematical Communication Ability

From the results, it was found that there were differences in students' mathematical communication abilities in the PBM-B3 and PT-B3 classes. This is consistent with the conclusion made by Hijjah & Minarni (2017) there were differences in the improvement of students' mathematical communication abilities treated with problem-based learning and guided discovery. Amalia, dkk (2017) state that the problem-solving ability of students treated with problem-based learning was better than the problem-solving abilities of students treated with conventional learning. Previous researchers also presented their research results regarding the relationship between gender differences and students' mathematics abilities. The research results Rafli, dkk (2018) concludes that the completeness of mathematical communication of female students was better than that of male students, but the accuracy of male students' mathematical communication was better than that of female students.

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