The Implementation of Problem Based Learning and Guided Inquiry Learning Assisted by Cabri 3D on Mathematical Communication Drawing

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Abstract. This study aims to determine: (1) whether there is a difference between student's mathematical communication drawing skills using Problem Based Learning (PBL) models assisted by Cabri 3D, using the Guided Inquiry Learning (GIL) model assisted by Cabri 3D, and using conventional learning; and (2) which is better between PBL model assisted by Cabri 3D, Guided Inquiry Learning model assisted by Cabri 3D, and conventional learning on student's mathematical mathematical communication drawing skills in the material to build flat side spaces. This study used a quasi experimental research method. The data was collected through test of student's mathematical communication drawing skills.Several tests were conducted at a 5% significance level in this study, namely: (1) One-way ANOVA test concluded that there was a difference between student's mathematical communication drawing skills using the PBL model assisted Cabri 3D, using Guided Inquiry Learning model assisted by Cabri 3D, and using conventional learning; and (2) Scheffe' test concluded that student's mathematical communication drawing skills using PBL models assisted by Cabri 3D and using Guided Inquiry Learning model assisted by Cabri 3D were better than using conventional learning, and it was concluded that student's mathematical communication drawing skills using Guided Inquiry Learning model assisted by Cabri 3D is better than using a PBL model assisted by Cabri 3D.

Keywords: mathematical communication drawing, Cabri 3D, PBL,GIL.

1 Introduction

The success of mathematics learning at the school, district, and provincial levels in general can be seen in the "Pamer UN" application of the National Examination Exhibition (UN) issued by the Educational and Cultural Ministry of the Republic of Indonesia. In the 2018 national exam, Rembang Regency ranked 22 out of 35 districts in Central Java Province, with an average UN score of 45.17.Then, in the following Table 1 shows that the percentage's mastery of space building material to build flat side spaces is still quite low, this is indicated by the average value of student ability for several indicators tested in the national exam for Rembang Regency in a red shading.

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Table 1. Percentage's Mastery of Mathematics Material for National Examinations in 2018

Province : 03 – Central Java (527085 student's) Districts : 26 – Rembang (9388 student's)		Exam lessons : Mathematics		
Serial Number	Tested Ability	Student's right		
		Districts	Province	National
Material coverage: 3-Geometry and Measurements		45,39	44,64	42,80
31	Determine the based of the prism if there are many ribs and n-side prism sides, a and b, respectively	45,27	45,40	42,43
32	Calculating the remaining wire makes a fourth frame get up if is known that the available wire lenght is n meters	44,51	45,71	44,51

**) red shading incates low achivement*

With the low learning achievement of State Junior High School students in Rembang Regency shown by the "Pamer UN" application, the researcher tried to find information about the problems that exist in the school by observing at Junior High School 2 Lasem on October 5, 2018 until October 27, 2018. Based on the results of interviews with teachers and students, obtained information about some of the difficulties students in learning the material to build flat side spaces, among others, as follows. (1) Students have difficulty in drawing, seeing pictures, and imagining to build flat side spaces. (2) Students have difficulty seeing, determining, and calculating the length of the diagonal of the plane and the diagonal of the space. (3) Students have difficulty in understanding what is asked in the question statement. (4) Students have difficulty in understanding the sentence in the story problem to then represent or write down their ideas to solve the problem.

The observations above show that students have difficulty in communicating mathematically, so the researcher then gives a problem of the material to build flat side spaces related to mathematical communication skills to class IX students who have studied the material to flat side spaces in Junior High School 2 Lasem. The results of student problem solving show that there are still many students who have difficulty in understanding problems, writing mathematical models, and drawing or illustrating building flat side spaces according to problems. This shows that students mathematical communication skills are still low.

It was concluded from several definitions and indicators of mathematical communication skills in research[1], [2], [3], [4], and [5] then the mathematical communication skills are devided into two namely, students ability to convey information and mathematical problems, as well as conveying ideas, strategies, and solutions to mathematical problem solving using mathematical models, mathematical sentences or mathematical symbols referred to as mathematical communication writing skills, and the ability of students to convey information and mathematical problems, as well as convey ideas, strategies, and solutions to mathematical problem solving using tables, graphs, pictures, or diagrams called mathematical communication drawing skills. But in this study researchers only limited the students mathematical communication drawing skills.

One factor that might affect students mathematical communication is the learning model. This is based on the results of interviews with the teachers of several Junior High School2 Lasem stating that most learning in the classroom still uses direct learning models.The learning model whose activities are still dominated by the teacher that can make students become passive and less active in conveying their ideas and they're only waiting for an explanation from the teacher so that later it will have an impact on students mathematical communication skills are still low, and will make students become bored with learning activities. Teacher-centered learning makes students passive in learning, so students only accept the knowledge conveyed by the teacher and students are not given the opportunity to build mathematical knowledge based on student ideas[6].In addition, in the teaching and learning process that is dominated by teachers we often find students who feel bored[7].So that I can conclude that direct learning model which is still dominated by teacher will make the potential of students not develop and eventually students will have difficulty in solving problems. It also will make students become bored due to less inviting students to be active.

To overcome these problems, mathematics learning should be varied so that not only teachers are active, but students must be active to be able to understand the subject matter and also be able to solve mathematical problems. Learning activities in the classroom should use learning models that can increase active attitudes and mathematical communication skills of students, and can optimize the potential of students. This is in accordance with Permendikbud 2016 number 22 where the learning process in educational units should be held interactively.

One of the learning model that is thought to be appropriate and can improve students mathematical communication drawing skills is Problem Based Learning (PBL) model.PBL is the learning models that presents real problems as a basic foundation in the learning process with the hope that students will be able to improve their mathematical communication skills by understanding real problems and then solving these problems according to students own ideas[8].The characteristics of PBL enable students to be involved in the learning process and students are faced with problem situations that require them to analyze, gather information, see cause and effect relationships, and find solutions and reflect on them [9].There is an increase in mathematical communication skills with PBL[10].PBL assisted manipulative aids is effective on students mathematical communication skills[11].

Another learning model that is thought to be appropriate and can improve students mathematical communication drawing skills is Guided Inquiry Learning (GIL) model. The basic skills of inquiry include the activities of making observations, making hypotheses, collecting and processing data, drawing conclusions, making conclusions and finding solutions. Whereas in Guided Inquiry Learning, students investigate questions raised by the teacher through prescribed procedures, and receive explicit step-by-step guidance at each stage, leading to predetermined results[12]. GIL is effective in teaching aspects of science and mathematics[13].GIL model can be used as an alternative learning model to develop students mathematical communication skills[14].

Moreover, the material to build a flat side space will be easier for students to understand if in learning is assisted with a media that can present a 3-dimensional building, so students will easily see the location of the parts or elements a building space, and hoping that students have no difficulty in imagining the location of the parts or elements of a building space. Cabri 3D is a learning medium that can be used to assist students in learning geometry and also to assist teachers in providing geometry learning, and to assist students to understand mathematical problems in building space[15].Cabri 3D is useful for learning and teaching geometry, as well as facilitating understanding of geometry with visualization [16]. With the help of the 3D Cabri program, students can visualize 3-dimensional shapes and solving problems[17].Cabri 3D can make students more enthusiastic and easier to understand about lines and angles [18].

Based on the arguments above, this study aims to determine: (1) whether there is a differences between students mathematical communication drawing skills using PBL assisted by Cabri 3D, using GIL assisted by Cabri 3D, and using conventional learning; and (2) Which is better between PBL assisted by Cabri 3D, GIL assisted by Cabri 3D, and conventional learning on students mathematical communication drawing skills.

2 Method

This study was a quasi-experimental study conducted in class VIII of Junior High School 2 Lasem in March 2019 to May 2019. The population in this study were all grade VIII students in Junior High School 2 Lasem. Determination of the sample in this study using random sampling techniques. VIII-A students as the first experimental class were given PBL assisted by Cabri 3D, VIII-E students as the second experimental class were given GIL assisted by Cabri 3D, and VIII-D students as the control class were given direct learning.

The research design in this study is as follows.

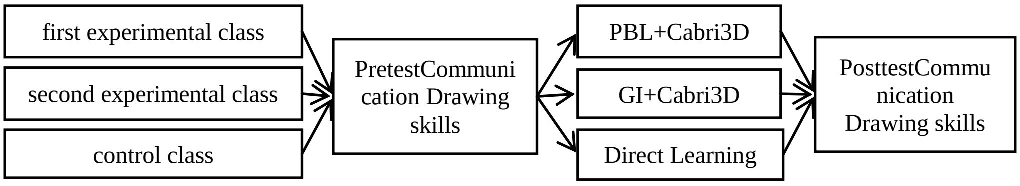

Fig. 1. The research design

The data in this study were collected through the pretest and posttest of the students mathematical communication drawing skills.The instruments used in this study were pretest questions with phytaoras theorem material and posttest questions with material to build flat side space. The pretest and posttest questions about the students mathematical communication drawing skills were validated by mathematicians and mathematics education. Furthermore, the pretest and posttest questions were tested and then calculated the level of difficulty, distinguishing power, and reliability to find out which question instruments were appropriate to use. The feasible questions are then tested on all three research classes, after which hypothesis testing is conducted to find out which learning model is better for students communication mathematical skills drawing between PBL assisted by Cabri 3D, GIL assisted by Cabri 3D and direct learning on the material to build flat side space.

The data used in statistical data analysis are the results of pretest and posttest students mathematical communication drawing skills. Data analysis techniques in this study used statistical analysis by conducting several tests conducted at a significance level of 5%.

1. Prerequisite Test
   a. The normality test uses the Lilliefors test which aims to find out the values of the dependent variable in each population that is normally distributed or not. The hypothesis to be tested is as follows.
   H_0 : Samples come from populations that are normally distributed
   H_1 : Samples do not come from populations that are normally distributed
   The formula used in the homogeneity test is as follows.

$$L = Maks|F(z_i) - S(z_i)| \quad (1)$$

   H_0 is rejected if L_{obs} is in the critical area $L_{obs} > L_{\alpha;n}$, where n is sample size [20].

   b. Homogeneity test which aims to determine the variances of a number of the same population or not then using Bartlett test. The hypothesis to be tested is as follows.
   H_0 : ${\sigma_1}^2 = {\sigma_2}^2 = {\sigma_3}^2$ (variance between groups is no different)
   H_1 : Not all variances are the same.

The formula used in the homogeneity test is as follows.

$$\chi^2 = \frac{2{,}303}{c}\left(f \log RJG - \sum f_j \log {s_j}^2\right) \quad (2)$$

H_0 is rejected if ${\chi^2}_{obs}$ is in the critical region ${\chi^2}_{obs} > {\chi^2}_{\alpha;v}$, where v is the degree of freedom $(k-1)$ [20].

2. One way anova test which aims to find out whether there is a difference between the students mathematical communication drawing skills using PBL assisted by Cabri 3D, GIL assisted by Cabri 3D, and direct learning. The hypothesis to be tested is as follows.

   $H_0\ :\ \mu_1 = \mu_2 = \mu_3$

   $H_1\ :\ \mu_1 \neq \mu_2$ or $\mu_1 \neq \mu_3$ or $\mu_2 \neq \mu_3$(there are at least two dissimilar average)

   with,

   μ_1 : meanmathematical communication drawing skills using PBL assisted by Cabri 3D

   μ_2 : meanmathematical communication drawing skills using GIL assisted by Cabri 3D

   μ_3 : mean students mathematical communication drawing skills using direct learning

   The formula used in the one way anava test with unequal cells is as follows.

$$F_{obs} = \frac{RKA}{RKG} \quad (3)$$

   $H_0$is rejected if $F_{obs}$is in the critical area $F_{obs} > F_{\alpha;k-1,N-k}$ [20].

3. Scheffe' test which aims to find out which one has better students mathematical communication drawing skills between using PBL assisted by Cabri 3D, GIL assisted by Cabri 3D, and direct learning. The hypothesis to be tested is shown in the following table.

Table 2. Comparison and Hypotheses

Comparison	H_0	H_1
μ_1 vs μ_2	$\mu_1 = \mu_2$	$\mu_1 \neq \mu_2$
μ_1 vs μ_3	$\mu_1 = \mu_3$	$\mu_1 \neq \mu_3$
μ_2 vs μ_3	$\mu_2 = \mu_3$	$\mu_2 \neq \mu_3$

   The formula used in the one way anava test with unequal cells is as follows.

$$F_{i,j} = \frac{(\overline{X_i} - \overline{X_j})^2}{RKG\left(\frac{1}{n_i} + \frac{1}{n_j}\right)} \quad (4)$$

   $H_0$is rejected if F_{obs} is in the critical area $F_{obs} > (k-1)F_{\alpha;k-1,N-k}$[19].

3Result and Discussion

3.1 Prerequisite Test

a. Normality test (Pretest Data)

Normality test using pretest data is done before the class given treatment, with the aim to find out whether the classthat will be given the treatment come from normal distribution population as a condition that the class can be given treatment.

The results of normality test calculations in first experimental class obtained $L_{obs} = 0{,}111$ smaller than the value $L_{\alpha;n} = L_{0,05;30} = 0{,}161$ so that H_0 is not rejected. Insecond experimental class obtained $L_{obs} = 0{,}094$ smaller than the value $L_{\alpha;n} = L_{0,05;30} = 0{,}161$ so that H_0 is not rejected. Incontrol class obtained $L_{obs} = 0{,}114$ smaller than value $L_{\alpha;n} = 0{,}157$ so that H_0 is not rejected. Therefore, at the 5% significance level, it can be said that first experimental class, second experimental class, and control class came from normally distributed popupation.

b. Homogeneity Test (Pretest Data)

Homogeneity test using pretest data is done before the class given treatment, with aim to find out wether variances of the three classes that will be given treatment are same (homogen) as a condition that the three classes can be given treatment.

Homogeneity test calculation results in three classes of research obtained value ${\chi^2}_{obs} = 1{,}694$ smaller than the value ${\chi^2}_{0,05;2} = 5{,}991$so that H_0 is not rejected. Therefore, at a significance level of 5% it can be said that the variances of the three populations are the same (homogen).

c. Normality test (Posttest Data)

Normality test using posttest data is done after the class given treatment, with the aim to find out whether the class that has been given the treatment come from normal distribution population as a prerequisite for being able to do the Anava test.

The results of normality test calculations in first experimental class using PBL assisted by Cabri 3D obtained $L_{obs} = 0{,}123$ smaller than the value $L_{\alpha;n} = L_{0,05;30} = 0{,}161$ so that H_0 is not rejected. In second experimental class using GIL assisted by Cabri 3D obtained $L_{obs} = 0{,}145$ smaller than the value $L_{0,05;30} = 0{,}161$ so that H_0 is not rejected. Incontrol class using direct learning obtained $L_{obs} = 0{,}128$ smaller than the value $L_{0,05;32} = 0{,}157$ so that H_0 is not rejected. Therefore, at the 5% significance level, it can be said that the first experimental class, second experimental class, and control class sample came from normally distributed popupation.

d. Homogeneity Test (Posttest Data)

Homogeneity test using posttest data is done after the class given treatment, with aim to find out wether the variances of the three classes that have been given the treatment are same (homogen) as a prerequisite for being able to do the Anava test.

Homogeneity test calculation results in three classes of research obtained value ${\chi^2}_{obs} = 3{,}966$ smaller than the value ${\chi^2}_{0,05;2} = 5{,}991$so that H_0 is not rejected. Therefore, at a significance level of 5% it can be said that the variances of the three populations are the same (homogen).

3.2One-Way Anova Test

The results of one-way anova test calculations obtained value $F_{obs} = 15{,}937$ which is greater than the value of $F_{\alpha;k-1,N-k} = F_{0,05;2;91} = 3{,}099$ so that H_0 is rejected. Therefore, at a significance level of 5% it can be said that there is a difference between students mathematical communication drawing skills using PBL assisted by Cabri 3D, using GIL assisted by Cabri 3D and using direct learning.

3.3Scheffe' Test

The results of the scheffe' test calculation between PBL assisted by Cabri 3D and GIL assisted by Cabri 3D obtained the value of $F_{obs} = 6{,}442$ greater than the value of $(k-1)F_{\alpha;k-1,N-k} = (2).F_{0,05;2;89} = 6{,}198$ so H_0 is rejected. Therefore, at the 5% significance level it can be said that there is a difference between students mathematical communication drawing skills using PBL assisted by Cabri 3D with using GIL assisted by

Cabri 3D. Because mean for students mathematical communication drawing skills using GIL assisted by Cabri 3D that value $85{,}556$ is higher than using PBL assisted by Cabri 3D that value $74{,}167$, it can be concluded that GIL assisted by Cabri 3D is better than PBL assisted by Cabri 3D on student mathematical communication drawing skills on material build flat side space.

Scheffe test calculation results between PBL assisted by Cabri 3D and direct learning obtained $F_{obs} = 9{,}330$ is greater than the value $(k-1)F_{\alpha;k-1,N-k} = (2).F_{0{,}05;2;89} = 6{,}198$ so H_0 is rejected. Therefore, at a significance level of 5% it can be said that there is a difference between mathematical communication drawing skills using PBL assisted by Cabri 3D with using direct learning. Because the mean for students mathematical communication drawing skills using PBL assisted by Cabri 3D that value $74{,}167$ is higher than using the direct learning that value $60{,}677$, it can be concluded that PBL assisted by Cabri 3D is better than direct learning on students mathematical communication drawing skills. These conclusion are depend on the research [20].

Scheffe' test calculation results between GIL assisted by Cabri 3D and direct learning obtained value of $F_{obs} = 31{,}734$ is greater than the value $(k-1)F_{\alpha;k-1,N-k} = 6{,}198$ so H_0 is rejected. Therefore, at the 5% significance level it can be said that there is a difference between students mathematical communication drawing skills using the GIL assisted by Cabri 3D with using direct learning. Because the mean for students mathematical communication drawing skills using GIL assisted by Cabri 3D that value $85{,}556$ is higher than using direct learning that value $60{,}677$, it can be concluded that GIL assisted by Cabri 3D is better than direct learning on students mathematical communication drawing skills. These conclusion are depend on the research [21].

4Conclusions

The conclusion of this research is

a. There is a difference between students mathematical communication drawing skills using PBLassisted Cabri 3D,GIL assisted Cabri 3D, and conventional learning.

b. Students mathematical communication drawing skills using PBLassisted by Cabri 3D and using GIL assisted by Cabri 3D are better than using conventional learning, and it is concluded that the students mathematical communication drawing skills using GIL assisted by Cabri 3D is better than PBL assisted by Cabri 3D.

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