The effectiveness of problem based learning assisted by cabri 3D on student’s mathematical communication writing and drawing skills

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Abstract. This study aims to describe: (1) the effectiveness of the Problem Based Learning (PBL) model assisted by Cabri 3D on student’s mathematical communication writing skills and student’s mathematical communication drawing skills; and (2) comparison of effectiveness between PBL models assisted by Cabri 3D and conventional learning on student’s mathematical communication writing skills and student’s mathematical communication drawing skills. This research is a quasi experiment. The data was collected through tests of student’s mathematical communication writing skills and student’s mathematical communication drawing skills. The data was analyzed descriptively and statistically. The data is displayed based on average and standard deviation as a descriptively. The statistical test is used to the proportion’s test of one population and the proportion’s test of two populations. The results of the study is the 5% significance level, it can be concluded that (1) PBL models assisted by Cabri 3D effective on student’s mathematical communication writing skills and student’s mathematical communication drawing skills; and (2) PBL models assisted by Cabri 3D are more effective than conventional learning models on student’s mathematical communication writing skills and student’s mathematical communication drawing skills.

1. Introduction
In general, the success of learning mathematics at the school, district, and provincial levels can be seen in the 2018 National Examination (UN) Exhibition issued by the Ministry of Education and Culture of the Republic of Indonesia. In 2018 Rembang district was ranked 22nd out of 35 regencies in Central Java Province, with an average UN score of 45.17.

The percentage mastery of the national exam mathematics questions for junior high school in 2018 in Table 1 shows that the percentage of material mastery in the material to build flat-side spaces is still quite low. this is indicated by the average value of student’s abilities for several indicators tested in the national exam for the lower Rembang Regency. Moreover, if we pay attention to the indicators tested on the national exam, it does not cover all the indicators that exist in the material to build flat-side spaces which can cause students to have difficulty in learning the other indicators in the material to build flat-side space. This means that students will still find it difficult to understand and solve problems in the material to build flat-side spaces.
Table 1. The percentage mastery of the national exam mathematics in 2018

| Serial Number | Tested Ability                                                                 | Student’s right |   |   |
|--------------|-------------------------------------------------------------------------------|-----------------|---|---|
|              | Material coverage: 3-Geometry and Measurements                                 | Districts       | Province | National |
| 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 indicates low achievement

From the data above shows the low learning achievement of student’s in the State Middle School in Rembang, related to this the researchers tried to find information about the problems that exist in schools by conducting observations in several schools namely 1 Lasem Junior High School, 2 Lasem Junior High School, 1 Rembang Junior High School and 1 Sluke Junior High School. Based on the results of interviews with teachers and students, information was obtained that student’s were still having difficulty learning and resolving problems regarding the material to construct flat side spaces. Some of the difficulties of the students include the following: (1) Students have difficulty drawing, seeing pictures, and imagining building a flat side space. (2) Students have difficulty determining and calculating diagonal length of field and diagonal of space. (3) Student’s difficult in understanding what is known and asked, for example students have difficulty determining ribs if known volume and surface area. (4) Student’s difficult to understand the sentence in the story problem and then write a mathematical model and represent their ideas to solve the problem in the matter of the story.

Furthermore, the researcher then gave problems of mathematical communication skills, then asked several students in several Junior High Schools to work on the problem. From the results of the student’s work, it can be seen that there are still many students who have difficulty writing mathematical models, drawing or illustrating the building of flat side spaces according to the problem, and solving problems. This shows that mathematical communication skills are still low.

Based on definitions and indicators of the mathematical communication skills revealed by previous researchers [1], [2], [3], [4] and [5], than, in this study mathematical communication skills are divided into two, namely: (1) mathematical communication writing skills, that is student’s ability to convey information and mathematical problems, and convey ideas, strategies, and mathematical problem solving solutions using mathematical models, mathematical sentences or mathematical symbols; and (2) mathematical communication drawing skills, that is student’s ability to convey information and mathematical problems, as well as convey ideas, strategies, and solutions to mathematical problem solving using tables, graphs, images, or diagrams.

The results of interviews with teachers and teachers of several junior high schools in the Rembang Regency stating that learning in most classes still uses conventional learning or direct learning models. It shows that one of the factors that is suspected to affect the student’s mathematical communication ability is the learning model. Learning models whose activities are still dominated by teachers and students that passively make student’s less active in conveying their thoughts and student’s are just waiting for explanations from the teacher so that the impact on student’s mathematical communication skills is still low, and will make student’s bored with learning activities. Teacher-centered learning makes student’s passive in learning, so student’s only receive knowledge delivered by the teacher and student’s are not given the opportunity to build mathematical knowledge based on student ideas [6].

In addition, learning should be more varied and can make student’s become active so that student’s mathematical communication skills, and will make student’s become interested and enthusiastic about learning activities. This is in accordance with Permendikbud 2016 number 22 attachment where the learning process in education units should be held interactively.
Problem Based Learning (PBL) model is one of the learning models that presents real problems as the basic foundation in the learning process so students will be able to improve their mathematical communication skills by understanding real problems and then conveying solutions to real problems according with students own ideas [7]. 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 [8]. Thus student’s are expected to be able to improve their mathematical communication skills by understanding real problems and solving these problems in accordance with the student’s own ideas.

In addition to implementing a learning model that can make student’s active, the material to build a flat side space will be easier for student’s to understand if learning is assisted by a media that can present a 3-dimensional space so that students will easily see the location of elements or elements a building space, with the hope that student’s do not have difficulty in imagining the location of parts or elements of a building space, later students will easily understand and solve problems related, so students will be easier in communicating mathematical problems that served. One of the softwares that can help present a building in 3 dimensions, so that students will easily see the location of parts or elements of a building space is a Software Cabri 3D. Cabri 3D is a learning media that can be used to assist teachers in providing geometry learning, and also helps student’s learn geometry, because Cabri 3D makes it easy for students to understand mathematical problems in building space [9]. Cabri 3D can facilitating understanding of geometry with visualization so that it is useful for learning and teaching geometry [10]. With the help of the Cabri 3D program, students can visualize 3-dimensional shapes to assist students in solving problems [11]. Cabri 3D can make students more enthusiastic in learning and make students easier to understand about lines and angles [12].

Based on the arguments above, the formulation of the problem from this study is as follows: (a) Is the PBL assisted by Cabri 3D effective for student’s mathematical communication writing skills and student’s mathematical communication drawing skills?; and (b) Compared to conventional learning, is the PBL model assisted by Cabri 3D effective on student’s mathematical communication writing skills and student’s mathematical communication drawing skills?

2. Method
This research is a quasi experiment. The study was conducted at 1 Rembang Junior High School in March 2019 until May 2019. The population in this study were all eighth grade student’s of 1 Rembang Junior High School. Determination of samples in this study using random sampling techniques. Student’s of class VIII-J were given learning using PBL assisted by Cabri 3D and VIII-D were given learning using conventional learning.

The research design in the study are as follows.

![Figure 1. The research design](image-url)
The data in this study were collected through the pretest and posttest of student’s mathematical communication writing skills and student’s mathematical communication drawing skills. The instruments used in this study were pretest questions of student’s mathematical communication writing and drawing skills with phytagoras theorem material each consist of 4 items and posttest questions of student’s mathematical communication writing and drawing with material to build flat side space each consist of 4 items.

In terms of content validity by mathematicians, the student’s mathematical communication writing and drawing skills test instruments were eligible to be used for this study. Calculation of reliability of pretest mathematical communication writing skills of student’s obtained $r_{11} = 0.227$ which means $r_{11} \geq 0.7$ so that it can be said that the question instrument pretest mathematical communication writing skills of student’s is reliable. Calculation of reliability pretest of mathematical communication drawing skills of student’s obtained $r_{11} = 0.7194$ which means $r_{11} \geq 0.7$ so it can be said that the instrument pretest mathematical communication drawing skills of student’s was reliable. Calculation of posttest reliability of mathematical communication writing skills of student’s obtained $r_{11} = 0.725$ which means $r_{11} \geq 0.7$ so that it can be said that the post-test instrument of student’s mathematical communication writing skills is reliable. Calculation of posttest reliability of mathematical communication drawing skills of students obtained $r_{11} = 0.7179$ which means $r_{11} \geq 0.7$ so that it can be said that the posttest instrument student’s mathematical communication drawing skills are reliable.

The data analysis technique consists of descriptive analysis and statistical analysis. Descriptively, data is displayed based on average and standard deviation. Statistical analysis uses a proportion of one population test and a proportion of two population tests. The data used in the statistical analysis of the data are the results of the posttest of student’s mathematical communication writing and drawing skills. Tests on the proportion of one population were used to analyze whether PBL assisted by Cabri 3D was effective on student’s mathematical communication writing and drawing skills. The hypotheses to be tested are as follows.

1. $H_{01}: p \geq p_0$
   $H_{11}: p < p_0$
2. $H_{02}: p \geq p_0$
   $H_{12}: p < p_0$

With,

$H_{ij}$: Hypothesis as students’ mathematical communication writing skills

$H_{ij}$: Hypothesis as students’ mathematical communication drawing skills

The formula used in the proportion test is:

$$z = \frac{x - np_0}{\sqrt{np_0(1-np_0)}}$$

With,

$X$ : number of student successes

$p_0$ : hypothesis value

$n$ : number of students

$H_{0j}$ ($j = 1,2$) is rejected if $z$ is in the critical area $z < z_{1-\alpha}$ [13].

The two population proportion test was used to compare the effectiveness of PBL assisted by Cabri 3D and conventional learning models on student’s mathematical communication writing skills and student’s mathematical communication drawing skills. The hypotheses to be tested are as follows.

1. $H_{01}: p_1 \leq p_2$
   $H_{11}: p_1 > p_2$
2. $H_{02}: p_1 \leq p_2$
   $H_{12}: p_1 > p_2$

With,

$H_{ij}$: Hypothesis for student’s mathematical communication writing skills

$H_{ij}$: Hypothesis for student’s mathematical communication drawing skills
\( p_1 \): Proportion of the success of PBL model assisted by Cabri 3D class student’s
\( p_2 \): Proportion of the success of conventional class student’s

The formula used in the proportion test is

\[
z = \frac{X_1 - X_2}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}
\]  

(2)

With,
\( X_1 \): the number of success of PBL model assisted by Cabri 3D class student’s
\( X_2 \): the number of success of conventional class student model’s
\( n_1 \): the number of PBL model assisted by Cabri 3D class student’s
\( n_2 \): the number of conventional class student’s
\( \hat{p} = \frac{X_1 + X_2}{n_1 + n_2} \)

\( H_0j \) \((j = 1, 2)\) is rejected if \( z \) is in the critical area \( z > z_\alpha \) [13].

3. Result and Discussion

3.1. The effectiveness of the PBL model assisted by Cabri 3D on student’s mathematical communication writing skills and student’s mathematical communication drawing skills

Test data of student’s mathematical communication writing skills before and after being given treatment are presented in Table 2 below.

**Table 2. Data on student’s mathematical communication writing skills**

| Value             | Eksperimen Grup | Control Grup |
|-------------------|-----------------|--------------|
|                   | Pretest         | Posttest     | Pretest | Posttest |
| Average           | 67.5            | 78.06        | 66.41   | 70.57    |
| Standard Deviation| 14.07           | 9.68         | 13.47   | 14.35    |

From Table 2 above, it is known that the average value of student’s mathematical writing skills before being given treatment in the experimental and control classes is relatively the same. Standard deviation before being given treatment in both classes is also relatively the same. The increase in the average student’s mathematical communication writing skills before and after treatment in the experimental class is 10.56. After being given treatment, the average value of student’s mathematical communication writing skills of the experimental class was 7.49 higher than the control class.

The proportion of students success in student’s mathematical communication writing skills before and after being given treatment is presented in Table 3 below.

**Table 3. Proportion of Student’s Success in Mathematical Communication Writing Skills**

| Proportion | Eksperimen Grup | Control Grup |
|------------|-----------------|--------------|
|            | Pretest         | Posttest     | Pretest | Posttest |
| Success    | 57%             | 87%          | 44%     | 66%      |
| Failure    | 43%             | 13%          | 56%     | 34%      |

Table 3 above shows that after being given treatment, the proportion of student’s success from the experimental group increased by 30%. In addition, the proportion of student success in the posttest in the experimental group, which reached 87%, showed that the value fulfilled the criteria set by the researcher, which was more than 75%.

The results of the hypothesis test obtained a value of \( z = 1.476 \) which is greater than the value of \( z_{1-\alpha} = z_{0.95} = -1.645 \) so that \( H_0 \) is not rejected. Therefore, at a 5% significance level it can be said that PBL assisted by Cabri 3D is effective against mathematical communication writing skills.
Test data for drawing mathematical communication drawing skills of student’s before and after being given treatment are presented in Table 4 below.

**Table 4. Data on student’s mathematical communication drawing skills**

| Value      | Eksperimen Grup | Control Grup |
|------------|-----------------|--------------|
|            | Pretest | Posttest | Pretest | Posttest |
| Average    | 70,28   | 80       | 69,53   | 71,61    |
| Standard Deviation | 10,87   | 10,17    | 11,13   | 15,39    |

From Table 4 above, it is known that the average value of student’s mathematical communication drawing skills before being given treatment in the experimental and control classes is relatively the same. Standard deviation before being given treatment in both classes is also relatively the same. The average increase in mathematical communication drawing skills of student’s before and after being given treatment in the experimental class is 9,72. After being given treatment, the average value of students mathematical communication drawing skills of the experimental class was 8,39 higher than the control class.

The results show that the improvement of student’s mathematical writing and drawing communication skills above is in accordance with research [14] which states that there is an increase in student’s mathematical communication abilities after using PBL model. PBL models have a significant influence on student’s mathematical communication skills and also indicated that the average pretest ability of student’s mathematical communication abilities is lower than average posttest of student’s mathematical communication skills [15].

The proportion of students' success in drawing mathematical communication drawing skills of student’s before and after being given treatment is presented in Table 5 below.

**Table 5. Proportion of student’s success in mathematical communication drawing skills**

| Proportion | Eksperimen Grup | Control Grup |
|------------|-----------------|--------------|
|            | Pretest | Posttest | Pretest | Posttest |
| Success    | 67%     | 90%      | 44%     | 63%      |
| Failure    | 33%     | 10%      | 56%     | 37%      |

Table 5 above shows that after being given treatment the proportion of student success from the experimental class increased by 23%. In addition, the proportion of students' success in the posttest in the experimental group, which reached 90% showed that the values met the criteria set by the researcher, which was more than 75%.

The results of the hypothesis test obtained the value of \( z = 1,897 \) which is greater than the value of \( z_{1-a} = z_{0.95} = -1,645 \) so that \( H_0 \) is not rejected. Therefore, at the 5% significance level it can be said that PBL assisted by Cabri 3D effective against student’s mathematical communication drawing skills.

The results that show the effectiveness of PBL assisted by Cabri 3D on the students mathematical communication writing and drawing skills above are in accordance with research [16] which states that PBL is effective in terms of student’s mathematical communication writing skills. The PBL model assisted by manipulative tools is effective for mathematical communication skills [17]. PBL developed meets valid, practical, and effective criteria to improve mathematical communication skills [18].

### 3.2. Comparison of effectiveness between PBL models assisted by Cabri 3D and conventional learning models on student’s mathematical communication writing skills and student’s mathematical communication drawing skills

Hypothesis test results on student’s mathematical communication writing skills obtained values of \( z = 1,933 \) which is greater than the value of \( z_{a} = z_{0.05} = 1,645 \) so that \( H_0 \) is rejected. Therefore, at the 5% significance level it can be said that PBL assisted by3D Cabri is more effective than conventional learning on student’s mathematical communication writing skills. On the other hand, in
Table 2 it can be seen that the increase in the average mathematical communication writing skills of student’s writing in PBL assisted by Cabri 3D is higher than the class with conventional learning. This is in accordance with the results of the study of [19] which states that an increase in mathematical communication skills of student’s who get PBL is better than using conventional learning. In addition, according to [20] states that student’s mathematical communication skills subject to the PBL are better than those with conventional.

With PBL, students are confronted with real problems and then students can explain the situation or the information obtained on the problem into symbols and mathematical models. In addition, students also use the help of Cabri 3D to observe the problem of building flat side spaces. Then students write the ideas they find to solve the problem in symbols and mathematical models. So that PBL assisted by Cabri 3D effective to improve student’s mathematical communication writing skills.

Hypothesis test results on mathematical communication drawing skills of student’s obtained a value of \( z = 2.527 \) which is greater than the value of \( z_\alpha = 1.645 \) so that \( H_0 \) is rejected. Therefore, at the 5% significance level it can be said that PBL model assisted with Cabri 3D is more effective than conventional learning model in student’s mathematical communication drawing skills.

On the other hand, in Table 4 it can be seen that the increase in the average mathematical communication drawing skills of student’s in PBL model assisted by Cabri 3D is higher than the class with conventional learning models. This is in accordance with the results of [21] which states that the improvement of student’s mathematical communication skills in indicators presents mathematical statements and ideas into tables and diagrams in student’s who have PBL higher than student’s who get conventional learning.

With PBL, students are confronted with real problems and then students can explain the situation or the information contained on the problem in tables, graphs, and pictures. In addition, students also use the help of Cabri 3D to observe the problem of building flat side spaces and assist students in writing information, situations, and problem solving ideas into drawing shapes of flat side space. Then students draw the ideas that they found to solve the problem into tables, graphs, and pictures. So that PBL assisted by Cabri 3D effective to improve student’s mathematical communication drawing skills.

4. Conclusions and Suggestions

4.1. Conclusion the results of this study are
a. PBL model assisted by Cabri 3D is effective on student’s mathematical communication writing skills and student’s mathematical communication drawing skills.
b. PBL assisted by 3D Cabri are more effective than conventional learning on student’s mathematical communication writing skills and student’s mathematical communication drawing skills.

4.2. Suggestions that can be conveyed are
For teachers or researchers who want to improve the student’s mathematical communication writing skills and student’s mathematical communication drawing skills in the flat side space building material can apply the PBL model assisted by Cabri 3D.

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