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Mathematical Problem Solving Ability on Problem Based Learning Assisted by GeoGebra in Primary School

Ike Kurniawati[1]✉, Tri Joko Raharjo[2], Khumaedi Khumaedi[2]

[1.] Universitas Bengkulu, Bengkulu, Indonesia
[2.] Universitas Negeri Semarang, Semarang, Indonesia

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Abstract

Training students through problem solving in mathematics learning is expected to be able to equip them to solve existing problems easily in everyday life. This study aims to analyse the use of Problem Based Learning (PBL) model assisted by GeoGebra in improving students' mathematical problem solving abilities. The method of this study was quantitative experimental type using Pre-Test Post-Test in one group. The samples of the study were students of VA class from SDN Petompon 01 and students of VA class from SDN Sampangan 02 with a total of 64 students. The data were obtained through the question sheet of problem solving abilities. Then, the data were analysed using N-gain. After carrying out learning using PBL models assisted by GeoGebra, the final results showed that mathematical problem solving ability from both groups of students experienced an average increase of 0.55 with a medium category. Therefore, students need to get more learning and practice in solving the questions using problem solving. Because problem solving abilities will be more optimal if the students are given the opportunity to learn with the real world directly.

✉ Correspondence address:
Desa Belitar Muka, Sindang Kelingi, Rejang Lebong, Bengkulu.
E-mail: ikekurniawati561@gmail.com

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INTRODUCTION

Mathematics is a subject which should not only be a theory, it would be better if mathematics learning is made become more meaningful by applying it in society, so that the knowledge gained is not only limited to theory but has been practiced. The National Council of Teachers Mathematics (NCTM) explains the mathematical thinking process covering five main standard competencies namely problem solving ability, reasoning ability, connection ability, communication ability and representation ability (NCTM, 2000).

In Indonesia, those five mathematical thinking competencies have not yet been fully achieved. Based on the results of Trends in International Mathematics and Science Study (TIMSS) survey in 2015, Indonesian students' achievements in mathematics were ranked 44 out of 49 countries with a score of 397, which is far below the international average of 550 (Mullis, Martin, Foy, & Hooper , 2016).

The cause of the students' low mathematical grades is the weak problem-solving ability in nonroutine or high-level questions (Inayah, 2018; Pratiwi, 2019). The questions tested in PISA consist of 6 levels and the questions tested are contextual, which is taken from the real world. In Indonesia, students are only accustomed to routine questions at level 1 and level 2, so it make the mathematical problem solving ability of Indonesian students is still relatively low (Eviyanti, Surya, Syahputra, & Simbolon, 2017; Harahap, 2017).

The results of observations taken in Semarang city by giving problem solving ability questions precisely in class V SDN 1 Petompon in April 2019, obtained information that from 28 students who became observational samples, there were 46% of students got scores below 50, 39% of students got scores between 51-70 and 15% of students got score above 70. These results indicate that there are still many students who have scores below 70, which means that many students still have difficulty on their problem solving skills.

Mathematics learning in the 2013 curriculum suggests a fundamental change in the learning process that was originally teacher center turned into student center. The learning model that focuses on student center and is based on problems in daily life is called PBL learning model. PBL is a learning model based on problems and put students themselves as learning subjects, so learning process becomes more student-centered (Apriyani, Nurlaelah, & Setiawati, 2017; Fatchurrohmah, Sarwi, & Utsman, 2017). PBL can facilitate students to conduct investigations, solve problems, and absolutely are student center (Asmara, Waluya, & Rochmad, 2017; Susilo, Waluya, & Junaedi, 2012). PBL is designed by exposing students to a problem so that they can develop critical, creative, and high-level thinking as well as their problem solving skills (Susanto & Retnawati, 2016).

The application of PBL model can be applied through the assistance of technology-based learning media. The application of technology in mathematics learning can be done through the use of Geogebra. Geogebra is adapted to the learning development stages of elementary school students. Piaget (Ibda, 2015) divides the stages of children's thinking skills into four stages, namely: a) sensory stage, b) pre

operational c) concrete operational stage, and d) formal operational stage. The stage of children development shows that the age of students in elementary school starts to shift from the concrete operational stage to the formal operational stage, so that Geogebra is suitable for them whose initial learning material is presented in a concrete form, continued to the semi-concrete stage, and in the end students can think and understand mathematics in the abstract.

Geogebra serves as a learning medium that can provide visual experiences to students in learning geometrical concepts. Geogebra can help students to develop experimental processes, problem-oriented, and discovery learning on mathematical concepts (Saputro, Prayito, & Nursyahidah, 2015). Geogebra helps students to reduce learning difficulties caused by abstract objects in mathematics learning (Hohenwarter & Fuchs, 2004).

Based on the background of the problem, this study aims to analyze the use of PBL model assisted by Geogebra that can be useful in improving students' mathematical problem solving abilities in elementary schools.

METHODS

This research is an experimental quantitative research with pre-experimental design using pre-test post-test type in one group (one-group pre-test post-test design). One-group pre-test post-test design is a design that includes a group of students that is observed in the pre-test stage which is then followed by treatment and ends with a post-test.

The population in this study was fifth grade elementary school students in Gajah Mungkur sub-district in the academic year 2019/2020. The sample of this research was students of VA class from SD Negeri 1 Petompon and students of VA class from SD Negeri Sampangan 02 in the academic year 2019/2020. The sampling technique used was nonprobability sampling technique: purposive sampling. Sampling technique for choosing the elementary schools was using criteria for those that have used the 2013 curriculum, have A accreditation, belong to public schools, under the same sub-district, and have the same number of students, teachers, facilities, infrastructure and the material taught.

Learning was carried out using the PBL model assisted by Geogebra with material about geometry volume of cubes and blocks, lesson 4 sub-lesson 1, in 2nd semester 2019/2020 academic year. Data collection was done by giving a question sheet about problem solving abilities. Then, data was analyzed using the n-gain test. The formula used to calculate the increase in students' problem solving abilities is as follows.

$$N - Gain = \frac{S_{post} - S_{pre}}{SMI - S_{pre}}$$

Notes:

s_{pre} = Pretest score
s_{post} = Posttest score
SMI = The maximum score obtained if the students answer the question perfectly.

High or low N-Gain scores are determined based on criteria that can be seen in Table 1.

Table 1. The Criteria of N-Gain Scores

N-gain Scores	Criteria
N – gain ≥ 0.70	High
0.30 ≤ N – gain < 0.70	Medium
N – gain < 0.30	Low

The students problem solving ability is categorized as getting improvement if the normalized gain is classified at least as a medium criterion or 0.30 ≤ N-gain <0.70.

RESULTS AND DISCUSSION

Improvement of students' problem solving abilities on PBL assisted by Geogebra was analyzed by finding a normalized gain score or n-gain. The initial step taken to find the n-gain score was to find the gain score of each student. The gain score was obtained from the difference between the pretest and posttest score of each student. After obtaining the gain score, the n-gain score could be calculated. N-gain score was calculated by comparing the difference between the pretest and posttest score with the difference between the ideal maximum score and the pretest score.

The results of the pretest and posttest average scores of problem solving skills in VA class at SD Negeri 1 Petompon and VA class at SD Negeri Sampangan 02 are presented in table 2.

Table 2. Results of students' problem solving ability

Data Type	Pretest	Posttest
Minimum Score	33	57
Maximum Score	67	95
Total	3615	5158
Average	56.48	80.59

Table 2 showed that there was an increase in the results of problem solving abilities during the pretest and posttest. The minimum score of the pretest was 33, while the posttest was 57. The maximum score in the pretest was 67, while the posttest was 95. The average score of problem solving ability before learning was 56.48, and after learning it was 80.59.

In this study, the instrument used to measure students' mathematical problem solving ability is a test in the form of description. Indicators of problem solving ability that are used are based on NCTM indicators (2000) and stages of problem solving that must be mastered using problem solving stages (Polya, 1985). Polya's problem solving steps and NCTM problem solving indicators are summarized in Table 3.

Table 3. Steps and Indicators of Problem Solving

No	Problem Solving Steps	Problem Solving Indicators
1	Understanding the problem	Students can identify the elements that are known, asked, and the adequacy of the elements needed.
2	Planning the completion	Students can formulate mathematical problems or arrange mathematical models.
3	Carrying out Planning	Students can apply strategies to solve various problems inside or outside of mathematics.
4	Doing crosscheck	Students can explain the results according to the original problem, and can use mathematics meaningfully.

Each stage consisted of several indicators with a certain score. Scores in the pretest and posttest were then compared to check whether there was an increase in students' problem solving abilities or not. Improvements for each indicator are presented in Figure 1.

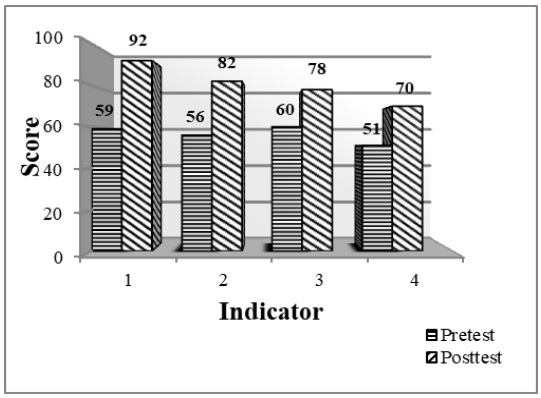

Figure 1. The Improvement on Problem Solving Ability Indicators

Figure 1 showed that the first indicator on the pretest results has an average score of 59 and an average posttest score of 93, which means that there was an improvement in the first indicator. Similar results were found in the second indicator, the problem-solving ability on the second indicator increased from an average score of 56 to 82. In the third indicator, the average pretest was 60, while the posttest increased up to 78. Furthermore, in the fourth indicator, the pretest results had an average score of 51 and an average posttest score of 70. Thus, there was an improvement in the problem solving ability in the fourth indicator.

The overall calculation results of each indicator of students' mathematical problem-solving abilities, with a total of 64 students, showed that there was an improvement in the problem-solving ability which was categorized as having low, medium and high as presented in Figure 2.

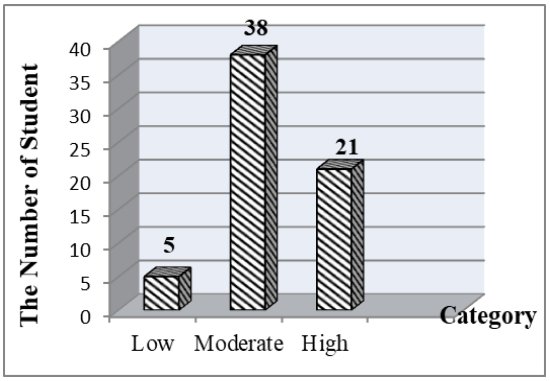

Figure 2. Recapitulation of Improvement on Problem Solving Abilities

Based on Figure 2, it can be seen that there are three categories of calculation of N-Gain scores. Five students got low categories with a range of scores N-Gain <0.30, 38 students got medium categories with a range of scores 0.30 ≤ N-Gain <0.70 and 21 students got high categories with a range of scores N-Gain ≥ 0.70.

Mathematics learning using PBL model assisted by GeoGebra can improve students' problem solving abilities. This statement is supported by the results of the calculation of the N-gain scores. Analysis of the improvement in the problem-solving ability using PBL model assisted by GeoGebra has an average increase of 0.55 with a medium category.

In the implementation of PBL model, students did not fully accept the information provided by the teacher, but they played an active role in finding information about the material being learned, namely geometry volume of cubes and blocks. Learning begins by presenting problems related to daily life, students were divided into groups to find information and do discussions so that they can provide solutions to the problems encountered. Implementation of PBL that focused on students-centered made they become active learners, so they are able to develop

their problem solving skills (Ali, Hukamdad, Akhter, & Khan, 2010). PBL also has a positive and significant effect on problem solving skills compared to conventional learning (Sahyar & Fitri, 2017).

PBL can be an alternative to present problem-based learning related to students' real life. PBL can improve students' problem solving skills because the presentation of problems related to the real world. It also can arouse students' spirit and enthusiasm, because lessons are not only fixated on memorizing formulas (Zulfah, Fauzan, & Armiati, 2018). Learning geometry using PBL can bridge students in the learning process because problem solving in PBL helps students to transfer knowledge in order to understand problems in real life (Fitrianawati & Hartono, 2016). Learning mathematics by using PBL model is effective in improving students' problem solving abilities (Primadoni, Suharini, & Mulyono, 2020; Susilawati, 2019).

During the lesson, the first step was showing an example of construction modeling of cubes and blocks. Next, the shapes of the cubes and blocks were displayed on Geogebra, and students analyzed what properties the cubes and blocks have. The figure 3 below is an example of the display of a cube on Geogebra.

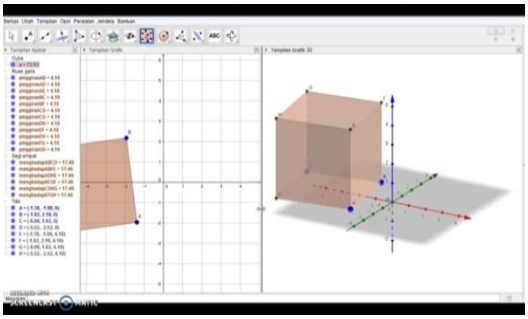

Figure 3. The display of the cube model on GeoGebra.

The cube displayed in the GeoGebra was used to help students analyze what properties they have and how the cube nets are. The next step, students investigated how to find the volume of a cube with the assistance of GeoGebra. The example of the blocks display on Geogebra is presented in Figure 4.

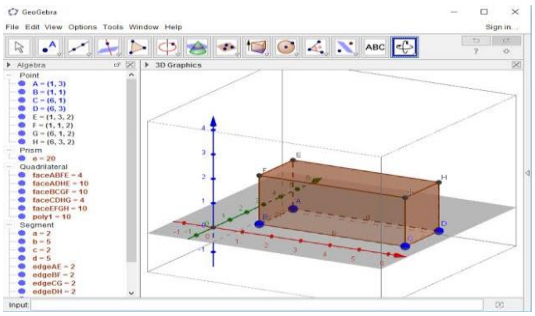

Figure 4. The display of the block model on GeoGebra.

The blocks in the GeoGebra display were also used to help students analyze what properties they have and how the blocks nets are. Similar to the cube material previously, students also investigate how to find the volume of the blocks with the assistance of GeoGebra.

The use of GeoGebra as a learning tool can train students to find and understand geometry material especially about cubes and blocks volume. Besides, it also can train students to move from the concrete to the semi-concrete stage in accordance with the stages of student development. Tatar Research (2013) revealed that Geogebra makes a positive contribution to learning activities, visualization, making abstract concepts become concrete, resulting to more effective learning.

Learning using GeoGebra demands the active role of students in following the learning process. In the implementation of learning in classroom, students were given a handout that

contains instructional materials about cubes and blocks volumes that were equipped with LDS as a means and guide for the stages of learning activities. Students can explore their understanding towards the material being studied and even make examples of objects that would be studied directly. As a result, students became more active during the learning process. This could be seen when students were directly involved in discovering the properties of cubes and blocks and how to calculate their volume using GeoGebra.

GeoGebra is a dynamic and interactive program that allows a lot of exploration that can be done on a mathematical concept, so it can stimulate student thinking skill, especially geometry, algebra, and calculus. Research by Fitriyani & Sugiman (2014) suggested that learning mathematics assisted by GeoGebra can be used as an alternative learning media, especially in geometry materials. GeoGebra is dynamic, so students can explore the material interactively during group discussions. Geogebra assisted teacher to maximize the efficiency of the learning process, making students actively participate in the process of gathering knowledge and changing static exploration into dynamic one especially in learning geometry (Ljajko & Ibro, 2013).

The use of GeoGebra as a tool in learning mathematics can help students to clarify the meaning of a material because it is not only limited to verbal, but also becomes more varied and active learning. Visualizations in GeoGebra that are displayed interestingly, moveable and transformable shape and size, provide more opportunities for students to explore and observe easily (Supriadi, 2015).

The implementation of learning using PBL model assisted by GeoGebra gives a good influence in improving students' mathematical problem-solving skills. This research showed that initially students tend to feel anxious, passive and afraid if they are given math questions that contain problems. This result was proven from the pretest results in which many students had difficulty in solving the problems presented.

After learning using the PBL model assisted by GeoGebra, students become more active and enthusiastic in learning because they are actively involved in the use of GeoGebra as a learning tool to understand the material about cubes and blocks volume. The implementation of PBL model assisted by GeoGebra makes student' group discussions become more active, which give positive impact to student enthusiasm in calculating the cubes and blocks volume with new and interesting learning.

The high enthusiasm and involvement of students in learning causes students' problem solving abilities extremely increased. This result is proven through the result of posttest. Many students are able to solve the problems presented in posttest correctly, so that it can be said that the students' mathematical problem solving ability had an improvement. The results of this study are relevant to previous study conducted by (Asmara, 2016; Ramadhani, 2016) which revealed that the improvement of mathematical problem solving ability of students with PBL model assisted by Geogebra are higher than those who are without any assistance.

CONCLUSION

Based on the research results presented above, it can be concluded that learning using PBL model assisted by GeoGebra can provide a good influence in improving students' mathematical problem solving abilities. The results achieved indicate that students' mathematical problem solving abilities encounter an average increase of 0.55 with a medium category.

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