The Effect of Geogebra-Aided Problem-Based Instruction Model and Mathematical Disposition on Problem Solving Ability

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Abstract

This study aims to determine: (1) The effect of Problem-based Instruction (PBI) in GeoGebra Assisted Learning through problem-based solving; (2) Difference of ability to solve between students taught by PBI in GeoGebra Assisted Learning with Direct Instruction; (3) Difference of ability for solving from mathematical disposition; (4) The interaction between Learning Model and mathematical disposition. The research method used was factorial design. The sample in this study were eleventh grade students in nursing major. Data analysis technique was two-way ANOVA. The results provided information as follow: The effect of the GeoGebra-assisted PBI model on problem-solving ability is moderate with an effect size value of 0.5929. There is a significant difference in problem-solving abilities between GeoGebra-assisted PBI model learning and direct learning with a significance value of 0.001. The significant difference in problem-solving abilities between students who have high and low mathematical disposition with a significance value of 0.000 and significant interaction between the learning model and students’ mathematical disposition.

Keywords: Problem Based Instruction, Geogebra, Mathematical Disposition, Problem Solving Ability

INTRODUCTION

Education in Indonesia has entered the era of the 21st century, which requires students to be able to compete in facing the revolutionary era 4.0. Therefore, education in Indonesia must receive considerable attention so that education in Indonesia can always develop in accordance with the demands of the times.

However, education in Indonesia is still not as expected. When compared with other countries, Indonesia is still far behind. Simple evidence can be seen based on the results of the Program for International Student Assessment (PISA). In 2000, PISA results showed that Indonesia was ranked 39th out of 41 countries (oecd.org, 2003). In 2015 these results also did not show any change, with Indonesia's achievements being ranked sixty-four of the sixty-nine countries that participated (oecd.org, 2016).

According to Bidasari (2017), PISA questions are not only questions that measure the ability to solve ordinary problems but also see how students are able to solve problems, starting from analyzing
them, formulating them and communicating their ideas to others. Wena (2012) states that problem-solving is a series of learning activities to combine the knowledge they have in overcoming new situations that they have not encountered before. Students are expected to have problem-solving abilities, including understanding problems, designing mathematical models, and completing and interpreting models (BSNP, 2006).

The problem-solving abilities possessed by students must continue to develop. However, expectations do not always match reality. Students' problem-solving abilities are still unable to develop significantly in certain materials, one of which is the three-dimensional topic. Based on the interviews conducted by researchers with eleventh-grade students of Private High School (SMKS) Reformasi in Pontianak, students agreed that three-dimensional material was quite difficult for them to understand because the material was abstract and difficult to imagine. It is in line with Kusumawardani (2017) study, which concluded that students did not have good problem-solving skills in three-dimensional topics.

Students' low ability to solve problems could be caused by learning activities that have not been able to create an active learning atmosphere. Students tend to wait and rely on notes given by the teacher. It often results in students appearing insecure and less persistent in solving problems. The persistence of students towards mathematics is called mathematical disposition. Many alternatives can be done to improve students' mathematical disposition and problem-solving abilities, one of which is to choose an appropriate learning model or learning media.

Researchers' observations at the SMKS Reformasi indicated that the teacher often implements the direct learning model by combining the expository method, namely by giving exercises and question and answer questions. The observation also showed that the learning carried out did not improve students’ knowledge. As a result, students' problem-solving abilities were challenging to develop due to the lack of students' mathematical disposition to enhance their problem-solving abilities.

According to Sumarmo (2012), the disposition of mathematics is a positive attitude in solving math problems, which can be in the form of high persistence and awareness and the confidence that appears in using mathematics. Students' learning outcomes with the same problem-solving abilities but their different mathematical disposition does not necessarily get the same results. It is because students with high mathematical disposition have a higher endurance in solving math problems.

Students who seem to enjoy mathematics do not always have a high mathematical disposition. Mathematical disposition can be seen through solving math problems or tasks. The observation can be conducted when the students work on math problems or assignments given by the teacher. The mathematical disposition can be seen from the students’ efforts in solving complex math problems. Students who have a high mathematical disposition will continue to strive until they are able to solve these problems. Therefore, the level of mathematical disposition of students will affect their problem-solving abilities.

Learning activities should focus not only on the knowledge that students must know but also on using this knowledge to solve problems. Therefore, choosing a learning model that fits the material is very important, so the teacher must select a model that can develop students' problem-solving abilities that they already have.

One of the alternative learning models capable of developing problem-solving abilities is PBI. According to Kurniasih (2015), the most important thing from the PBI learning model is exploring new ideas that can bring out the creativity in students to think and so that students continue to be motivated to learn. Komalasari (2010) states that the learning syntax with the PBI model is as follows: (1) The teacher explains the stages of PBI learning; (2) The student's orientation to the problem; (3) Organizing students to learn; (4) Guiding individual and group investigations; (5) Developing and presenting the work; (6) Analyze and evaluate the problem-solving process; (7) Making Conclusions.

In addition to the learning model, learning media can also affect students' problem-solving abilities. The use of technology to facilitate learning will greatly assist students in developing their problem-solving abilities. Many applications can be used, one of which is the GeoGebra application. GeoGebra is a mathematical application that can combine the concepts of flat geometry, algebra, and flat calculus. GeoGebra can help students develop problem-solving skills because students can carry
out investigations to solve problems in the GeoGebra application. It is in line with Sari et al. (2019), which concluded that GeoGebra-assisted learning positively affects the mathematical problem-solving abilities of junior high school students. Based on the description above, we intend to conduct a study with the title "The Effect of Geogebra-Aided Problem-Based Instruction Model and Mathematical Disposition on Problem Solving Ability".

METHOD

In this study, the research design used was experimental. Because this study has moderator, independent and dependent variables, the form of this research was a factorial design. According to Sugiyono (2013), factorial design is a transformation of true experimental design, namely by observing the possibility of other variables, namely the moderator variable that affects the treatment (independent variable) on the result (dependent variable). The research design is described as follows:

<table>
<thead>
<tr>
<th>Mathematical Disposition (Y)</th>
<th>Learning Model (X)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Problem Based Instruction (X₁)</td>
<td>Direct Instruction (X₂)</td>
<td></td>
</tr>
<tr>
<td>High (Y₁)</td>
<td>(X₁Y₁)</td>
<td>(X₂Y₁)</td>
<td></td>
</tr>
<tr>
<td>Low (Y₂)</td>
<td>(X₁Y₂)</td>
<td>(X₂Y₂)</td>
<td></td>
</tr>
</tbody>
</table>

Sugiyono (2013)

This research was conducted at SMKS Reformasi Pontianak. The population in this study were all eleventh-grade students consisting of nursing and pharmacy majors. The samples taken were two classes of eleventh grade of nursing major. Obtained B-class as an experimental class, namely the class that was given learning using the GeoGebra-assisted Problem Based Instruction model and A-class as the control class, namely the class that was given learning using the direct learning model.

First, students were given a test for both classes. The test used was an essay test because we want to analyze the students' problem-solving abilities. The test was given twice, the first test is a pre-test to measure problem-solving abilities before the implementation of learning, and the second is a post-test that is given after the learning has been carried out. Then, students were given a learning motivation questionnaire to assess students' learning motivation before the intervention was carried out.

After the data is obtained, the data will be analyzed with a two-way ANOVA test, using SPSS 17 to see if there are differences in students' problem-solving abilities between the experimental and control classes. Then to see the effect of the problem-based learning model on students' conceptual understanding, and Effect Size analysis will be carried out with the following formula:

\[ ES = \frac{\bar{x}_1 - \bar{x}_2}{S_{comb}} \]

Note: ES is the effect size; \( \bar{x}_1 \) is the mean score of the experimental class; \( \bar{x}_2 \) is the mean score of the control class; \( S_{comb} \) is the combined standard deviation. With the following criteria: \( ES \leq 0.20 \), the effect size is low, \( 0.20 < ES \leq 0.8 \), so the effect size is moderate and \( ES > 0.80 \), then the effect size is classified as high.

RESULTS AND DISCUSSIONS

Results

Based on the calculation of the effect size, the value of the effect size was 0.5929. From these results, it can be classified that the effect size was moderate. It indicated that an influence of the GeoGebra-aided PBI model on students' problem-solving abilities.
The following are the results of the post-test problem-solving abilities, which are grouped based on students' mathematical disposition summarized in the following table:

**Table 2. Post Test Result Grouping based on Mathematical Disposition**

<table>
<thead>
<tr>
<th>Mathematical Disposition</th>
<th>Learning Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Geogebra-Aided PBI</td>
</tr>
<tr>
<td>High</td>
<td>70, 70,70, 73, 75, 85, 86, 90,91</td>
</tr>
<tr>
<td>Low</td>
<td>30, 30, 30, 35, 35, 40, 40</td>
</tr>
</tbody>
</table>

After the post-test scores were grouped based on the two-way ANOVA table, the post-test results were analyzed by SPSS 17 along with the results of the calculations.

**Table 3. Results of two-way ANOVA Analysis**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>11511.079&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3</td>
<td>3837.026</td>
<td>57.425</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>82161.161</td>
<td>1</td>
<td>82161.161</td>
<td>1299.615</td>
<td>.000</td>
</tr>
<tr>
<td>DISPOSITION</td>
<td>9568.286</td>
<td>1</td>
<td>9568.286</td>
<td>143.198</td>
<td>.000</td>
</tr>
<tr>
<td>MODEL</td>
<td>838.294</td>
<td>1</td>
<td>838.294</td>
<td>12.546</td>
<td>.001</td>
</tr>
<tr>
<td>DISPOSITION * MODEL</td>
<td>861.669</td>
<td>1</td>
<td>861.669</td>
<td>12.896</td>
<td>.001</td>
</tr>
<tr>
<td>Error</td>
<td>1870.921</td>
<td>28</td>
<td>66.819</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>104120.000</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>13382.000</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3 illustrate that the sig value for the learning model is 0.001. The sig value for mathematical disposition is 0.000, and the sig value for the learning model * mathematical disposition is 0.001. The test criteria: If the value of sig ≥ α, then Ho is accepted. If the value of sig < α, then Ho is rejected, with a significance of 0.05. Due to the results of the three sig values <0.05, Ho is rejected.

The results of the first hypothesis test identified that there was an effect of the GeoGebra-aided PBI model on students' problem-solving abilities. These results indicated that the GeoGebra-aided PBI model is better than the direct learning model in developing students' problem-solving abilities. These results were in accordance with the research results of Fatona (2019). Learning with the PBI model positively affects problem-solving abilities because PBI can generate activeness in solving problems.

The second hypothesis test analysis results showed significant differences in problem-solving abilities between students who have a high mathematical disposition and students with a low mathematical disposition with a significance value of 0.000. It indicated that students who have a high mathematical disposition have problem-solving abilities, and their problem-solving abilities were better than those who have a low mathematical disposition.

The third hypothesis test analysis results showed an interaction between learning models and mathematical disposition with a significance value of 0.001. The result indicated that students who are taught using the PBI model assisted by GeoGebra with low mathematical disposition have lower problem-solving abilities than students who have a low mathematical disposition, who are taught using the direct learning model.

Students with low mathematical disposition tend to be not ready in the learning process using the Geogebra-aided PBI model. In the PBI model, there were activities to develop problem-solving
abilities in the discussion. Students with a low mathematical disposition tend to look passive when discussing, and students were less confident in completing assignments in groups. Due to the lack of self-confidence of students, students were reluctant to have an opinion during the discussion. They prefer to maintain old learning habits rather than renewal in learning as well.

The mathematical problem-solving ability of students who are given learning with the PBI model assisted by GeoGebra with high mathematical disposition confirmed that problem-solving abilities are higher than students who are given learning with direct learning models. The high mathematical disposition makes students more eager to start mathematical activities. Students are more ready to accept learning with the GeoGebra-aided PBI model, marked by students' activeness in exploring new knowledge and things that they have not encountered before in three-dimensional topic.

CONCLUSIONS

The current study concludes that learning with the GeoGebra-assisted problem-based instruction model is sufficient to influence student problem solving as indicated by the Effect Size value of 0.5929. There are differences in problem-solving abilities between students who are given learning using the geographic-assisted PBI model and students who are given learning using the direct learning model on the three-dimensional topic with a significance value of 0.001. There are differences in students' problem-solving abilities in three-dimensional material seen from the mathematical disposition with a significance value of 0.000. There is an interaction between learning with the PBI model and the mathematical disposition toward problem-solving abilities.

REFERENCES


