The Effects of Problem Based Learning (PBL) Model on the Improvement of Student’s Mathematical Problem-Solving Skill in MAN in Pekanbaru City

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Abstract. Based on the preliminary study indicate that the problem-solving abilities of students of MAN Pekanbaru City are still low. The purpose of this research is to investigate the effect of PBL model on the improvement of student’s problem-solving skills in the 11th class MAN Pekanbaru city. The data in this research was collected by using problem-solving test, and analyzed by using paired t-test. The results showed that the problem-solving skills of students after implementing PBL model is better than before. This result means PBL model takes effect on the improvement of student’s problem-solving skills.

1. Introduction
Mathematical skills of Indonesian students are still far from satisfactory [1-13], especially mathematical problem-solving skills [1],[4],[12]. Krulik said [14] problem-solving skills are abilities where individuals use the knowledge, skills and understanding they have acquired to solve problems in unfamiliar situations. There are several reasons why problem-solving skills need to be mastered by students who study mathematics, namely: (1) mathematical problem-solving skills include methods, procedures and strategies which are the main and core processes in the mathematics curriculum or are the general objectives of learning mathematics, even as the heart of mathematics, meaning that problem-solving skills are the basic skills in learning mathematics; (2) mathematical problem-solving skills can help students think analytically in making decisions in daily life and help improve critical thinking skills in dealing with new situations [14], [15].

Based on preliminary study, the mathematical problem-solving skills of students of MAN Pekanbaru city are still low. The results of the study show that most students have difficulty solving non-routine problems as shown in Figure 1.
Figure 1 shows that students are confused in understanding the problem so that it is difficult to determine the information and questions. This results in the student trying to find solutions by manual method, but in the end the student is unable to continue solving and find answers. This proves that students have not fulfilled the problem-solving indicators and have not been able to analyze contextual and non-routine questions, so that the students’ problem-solving skills are still low.

Based on the observations and interviews, there were still many students who had a habit of learning how to still memorize the formula without understanding why the formula was used, students still complained when given problem solving questions and tended to expect help from others when working on the questions. In addition, the learning model used makes teachers seen as the only source of learning and students are seen more as objects, so that students' creativity and abilities are not optimal. This shows that we need a learning model that can develop student creativity and activity. Based on the results of the preliminary study, students' problem-solving skills need to be improved through improvement and renewal in the learning process. If this is allowed to continue, it will be very influential in learning mathematics in the future where the objectives of teaching mathematics will be hampered and become a big problem in the future. To address this, the application of a problem based learning (PBL) model is needed.

PBL is a model that begins by focusing students on real problems that are meaningful to students in everyday life [17]. The PBL model is a learning model that is able to improve students' problem-solving skills because according to Sanjaya [18], PBL can foster student initiative in work, make students become independent learners and help students to develop new knowledge and be responsible for the learning they do. In line with the above statement, this model has also been successful in many studies [4], [16].

Other factor determines the success of students in solving mathematical problems is the initial mathematical ability. The initial mathematical ability of students is the ability that students have previously had towards mathematics [19]. Initial skills are required in the PBL learning process. This is because at the time of group division based on initial abilities so that each group has heterogeneous members which makes students feel interdependent during the learning process. The PBL steps in this study are to provide student orientation on problems, organize students to learn, guide students in independent and group investigations, develop and present work, analyze and evaluate the problem-solving process. Based on the description above, it is believed that the application of PBL models will help students improve their mathematical problem solving skills optimally.

2. Materials dan Methods
This is a quasi-experimental design with One Group Pretest Posttest [20], which compares students' mathematical problem solving before and after being given PBL treatment. This design uses only an experimental group without a control group. Based on the design used, the relationship between variables in this study can be expressed in the form of a Winner Table as shown in Table 1.
The population in this research were students of MAN in Pekanbaru City, namely MAN 1 and MAN 2 Pekanbaru. Samples were taken randomly. MAN 1 and MAN 2 Pekanbaru with the same school accreditation taken one sample class, namely the experimental class from each school. Both classes are implemented by the PBL model. The variables in this study consisted of the PBL model as the independent variable, the problem-solving skills as the dependent variable and the students’ initial mathematical ability as the moderator variable. The instrument in this study was some tests. The test instruments were pretest and posttest in the form of essay questions based on problem solving indicators given before and after the application of the PBL model. The data analysis technique to analyze the effect of the PBL model on the problem-solving skills of students with high, medium and low KAM is to use paired t-test (if the data is normally distributed and homogeneous) and use the Wilcoxon test if the opposite [21].

| Tabel 1. The relationship between PBL, KAM, and problem solving |
|-----------------------------------|
| **Initial Abilities** | **Problem Solving (Y1)** | **Before Actions (D1)** | **After Actions (D2)** |
| High (E1) | D1Y1E1 | D2Y1E1 |
| Medium (E2) | D1Y1E2 | D2Y1E2 |
| Low (E3) | D1Y1E3 | D2Y1E3 |
| Sum | D1Y1 | D2Y1 |

Information

1. D1Y1E1 : Students’ mathematical problem-solving with high initial abilities before and after PBL model implementations.
2. D1Y1E2 : Students’ mathematical problem-solving with medium initial abilities before and after PBL model implementations.
3. D1Y1E3 : Students’ mathematical problem-solving with low initial abilities before and after PBL model implementations.
4. D1Y1 : Students’ mathematical problem-solving before and after PBL model implementations.

3. Result dan Discussion

The improvement of students’ mathematical problem-solving skills before and after the implementation of PBL model seen from the results of the problem-solving skills test in the form of essay questions, namely the pretest and posttest which was attended by 30 students from each school. The resulting data can be seen in Tables 2 and 3.

| Table 2. Students’ problem-solving test result |
|-----------------------------------------------|
| **Initial Ability** | **PBL Model** | **Experimental Class 1&2** |
| | N | Result | Pretest | Posttest | N-gain |
| High | 13 | \( \bar{x} = 72.00 \) | 88.31 | 0.617 |
| | | \( SD = 11.51 \) | 9.51 | 0.293 |
| Medium | 38 | \( \bar{x} = 57.42 \) | 72.21 | 0.355 |
| | | \( SD = 15.00 \) | 12.37 | 0.196 |
| Low | 9 | \( \bar{x} = 52.89 \) | 68.22 | 0.362 |
| | | \( SD = 17.55 \) | 19.53 | 0.209 |
| Sum | 60 | \( \bar{x} = 59.90 \) | 75.10 | 0.413 |
| | | \( SD = 15.92 \) | 14.74 | 0.243 |
Table 3. Students’ problem-solving test result by sampling group

| Initial Ability | Experimental 1 | PBL Model | Experimental 2 |
|-----------------|---------------|-----------|---------------|
|                 | N  | Result | Pretest | Posttest | N-gain | N  | Result | Pretest | Posttest | N-gain |
| High            | 6  | $\bar{X}$ | 71.00 | 87.33 | 0.593 | 7  | $\bar{X}$ | 72.86 | 89.14 | 0.637 |
|                 |     | $SD$ | 13.67 | 9.27 | 0.265 | $SD$ | 10.38 | 10.38 | 0.334 |
| Medium          | 19 | $\bar{X}$ | 56.00 | 69.89 | 0.334 | 17 | $\bar{X}$ | 61.76 | 75.88 | 0.372 |
|                 |     | $SD$ | 16.61 | 14.09 | 0.213 | $SD$ | 14.02 | 10.99 | 0.183 |
| Low             | 5  | $\bar{X}$ | 42.40 | 56.00 | 0.260 | 6  | $\bar{X}$ | 55.33 | 76.67 | 0.468 |
|                 |     | $SD$ | 10.04 | 17.61 | 0.203 | $SD$ | 13.78 | 8.45  | 0.148 |
| Sum             | 30 | $\bar{X}$ | 56.73 | 71.07 | 0.374 | 30 | $\bar{X}$ | 63.07 | 79.13 | 0.453 |
|                 |     | $SD$ | 17.18 | 16.59 | 0.243 | $SD$ | 14.14 | 11.52 | 0.239 |

Based on Table 2, the average postest score of two schools is higher than the pretest score, as well as in Table 3. Then the paired sample t test was performed on the pretest and posttest values. The test carried out is the one-tailed test (right-side test), then in the paired t-test, the P-value = 1/2 × the 2-tailed sig value and in the Wilcoxon test, the P-value used is Monte Carlo sig (1 - tailed). The criterion for testing the hypothesis is if the P-value > 1/2 α (for paired t-test) or P-value > α (for the Wilcoxon test), then the students' mathematical problem-solving ability after applying the PBL model is not better than before it was applied. PBL model. Vice versa, if the P-value ≤ 1/2 α (for paired t-test) or P-value ≤ α (for the Wilcoxon test), then the students' mathematical problem-solving skills after applying the PBL model is better than before the PBL model was applied. The results of data analysis for the two experimental classes can be seen in the Table 4.

Table 4. Analyst Result of Hypothesis Data Test

| KAM  | Hypothesis | Problem-Solving Experimental Class 1&2 | Hypothesis Test | Decision |
|------|------------|--------------------------------------|-----------------|----------|
| High | 2          | Wilcoxon test                         | $P$-value ≤ α   |
| Medium | 3      | Wilcoxon test                         | $P$-value ≤ α   |
| Low  | 4          | Wilcoxon test                         | $P$-value ≤ α   |
| Sum  | 1          | Wilcoxon test                         | $P$-value ≤ α   |

Based on Table 4, the problem-solving skills of students with high, medium and low initial abilities after applying the PBL model are better than before the PBL model was applied. This can be due to the influence of the PBL model steps, where during the learning process students are trained to develop their mathematical problem solving skills through group activities to jointly understand problems, identify problems, design problem solving strategies, present and evaluate the problem solving process. This shows that each step in the PBL model is interrelated to develop students' problem-solving skills. This is also confirmed by the findings of studies [16], [22]. In addition, this is in line with the opinion of experts [18], [23], [24] who agree that PBL is a learning model developed to help teachers improve student problem-solving skills.

4. Conclusion
The Problem Based Learning model can improve the mathematical problem-solving skills of students in MAN Pekanbaru city for all students who have high, medium or low initial mathematical abilities. The suggestion is the teachers should apply the PBL learning model as a reference in mathematics learning with optimal preparation of learning tools, time and student conditioning. In addition, teacher guidance and encouragement are needed to help students learn independently.
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