Improvement of Mathematical Problem Solving Ability Through Problem Based Learning Model In Applied Mathematics Course II In Industrial Engineering

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Abstract. Problem based learning model is applicable in Applied Mathematics II course in order to obtain better students’ problem-solving skill in mathematic. In this research, one can learn the differences of student performance to solve problem by problem-based learning compared to traditional learning. Besides, observation has been done to student activities during class session. Data analysis shows significant of $a = 0.05$ gained $t_{count} = 2.16$ and $t_{table} = 1.72$ in other hand $t_{count} > t_{table}$, one can conclude that problem-based learning increase student performance in solving problem compared to those in control group in Applied Mathematics II course, Study Program of Industrial Engineering Polytechnic of South Aceh. The student activity was rate at 69.64% average.

Keyword: problem solving ability, problem based learning, applied mathematics

1. Introduction
The problem is the gap between desire or hope and reality. According to [1] a problem is the state of cause or event that must be altered in certain ways in order to gain desired result. In problem-based learning, small group of students are created in order to share ideas while discussing theme, plotting hypothesis, designing tests, conducting experiments, collecting data, interpreting data and make a conclusion. Then, students could prepare presentation, present their findings, have small discussion and finally submit their reports.

According to [2] problem-based learning is a learning where students work on authentic problems in order to gather their own knowledge, develop inquiry, improve learning skills, develop independence and self-confidence. As the interest grew, a research on the application of problem-based learning in Applied Mathematics II course aiming the better students’ performance in solving math problem in Industrial Engineering Study Program of Polytechnic of South Aceh has been conducted.

The objective of this research is to emulate the success of application problem-based learning model in Applied Mathematics II course and to know the average percentage of student activity during the learning process by using problem-based learning model in the Applied Mathematics II course in Industrial Engineering Study Program in Polytechnic of South Aceh. Besides, writers are able to comprehend student activities during the class session.

2. Methods
2.1 Types and research Approach
This is a quantitative research by experiment approach. Quantitative research can be seen in the use of numbers at the time of data collection, interpretation of data and the results [3].
2.2 Research Design

Research design that engaged in this study; random, pre-test, post-test. Traditionally, random, pre-test, post-test design models were shown below in figure 1.

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E R O₁ X O₂
K O₅ O₄
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**Figure** Error! No text of specified style in document. 1. Design models for the research

where the E is the experiment group, K is the control group, R is the random, O₁ is the initial stage of experiment group, O₂ is the final stage of experiment group, O₃ is the initial stage of control group and O₄ is the final stage of control group.

2.3 Population and Sample

Population is the number of all registered students in Industrial Engineering Study Program of Polytechnic of South Aceh. From this population, taken as sample as much as two group of students in the second terms of their first year namely group A and group B.

2.4 Data Collection

Data in this study were collected using test instruments both zero treatment (pre-test) and after treatment (post-test). In addition, data collection techniques used are observation sheets of student learning activities.

2.5 Data Analysis

Comparing the pre-test and post-test scores to look for gains that occur after learning in each group calculated by the normalized gain formula [4], namely:

\[
g = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}
\]

where the \( g \) is the normalized gain, \( S_{post} \) the post-test score, \( S_{pre} \) is the pre-test score, and the \( S_{max} \) is the maximum score.

The data to be analyzed is the data from the pre-test and post-test results in the form of test data on problem solving abilities. Data of the test results were analyzed using the t-test.

\[
t = \frac{X_1 - X_2}{S_{combined} \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}
\]

with combined variance \( (S^2_{combined}) \), as [4] can be measured as:

\[
S^2_{combined} = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}
\]

Hypothesis testing uses right-sided t-test at a significant level \( \alpha = 0.05 \). The testing average \( \mu_1 \) and \( \mu_2 \), correlative hypothesis \( H_0 \) and its counter part \( H_1 \):

\( H_0: \mu_1 = \mu_2 \) There is no difference in the improvement of students mathematical problem solving abilities between using problem-based learning models and increasing students' mathematical problem solving abilities using conventional learning.

\( H_1: \mu_1 > \mu_2 \) Improving students' mathematical problem solving skills using problem-based learning models is better than improving students' mathematical problem solving abilities using traditional learning.
Because the test used is the right-hand test, the applicable testing criteria rejects $H_0$ if $t > t_{1-\alpha(n_1+n_2-2)}$ and accepts $H_0$ if $t$ has other prices, with degrees of freedom $d_k = n_1 + n_2 - 2$ and chance $(1 - \alpha)$. If the data is not normally distributed, the hypothesis will be tested by non-parametric statistical tests. The test used is the Mann-Whitney test. According to [5] the Mann Whitney test is used to examine the average differences of two groups of samples mutually independent if one or both groups of samples are not normally distributed.

3. Result and Discussion
3.1 Pre-test and Post-Test
Table 1 and 2 below will illustrates the score on mathematical problem-solving abilities pre-test and post-test in the experiment class (A) and the control class (B).

| Students  | Pre-Test | Post-Test |
|-----------|----------|-----------|
| Student 1 | 55       | 95        |
| Student 2 | 60       | 75        |
| Student 3 | 52       | 90        |
| Student 4 | 65       | 85        |
| Student 5 | 75       | 80        |
| Student 6 | 45       | 75        |
| Student 7 | 70       | 100       |
| Student 8 | 55       | 85        |
| Student 9 | 60       | 70        |
| Student 10| 50       | 80        |
| Student 11| 65       | 90        |
| Student 12| 52       | 80        |
| Student 13| 55       | 70        |

Table 2. Control Class (B) Score on mathematical problem-solving abilities pre-test and post-test

| Students  | Pre-Test | Post-Test |
|-----------|----------|-----------|
| Student 1 | 50       | 75        |
| Student 2 | 70       | 80        |
| Student 3 | 52       | 70        |
| Student 4 | 50       | 60        |
| Student 5 | 45       | 60        |
| Student 6 | 60       | 80        |
| Student 7 | 55       | 68        |
| Student 8 | 50       | 65        |
| Student 9 | 62       | 70        |
| Student 10| 45       | 90        |

3.2 Result Data Analysis
3.2.1 Variance and Standard Deviation
Variance ($s_1^2$) and standard deviation ($s_1$) from pre-test in experiment class in order are 72.423 and 8.51. Variance ($s_2^2$) and standard deviation ($s_2$) from control group are 99.266 and 9.96 in sequence. Based on data analysis carried out by using the Lilliefors Test for both classes, it was found that the distribution of the experimental class and the test class initial test data was normally distributed. In addition, using the variance homogeneity test obtained that both classes are homogeneous for data pre-test.
3.2.2 N-Gain from pre-test and post-test

| Students in Experiment Group | N-Gain | Students in Control Group | N-Gain |
|------------------------------|--------|----------------------------|--------|
| Student 1                    | 0.89   | Student 1                  | 0.50   |
| Student 2                    | 0.38   | Student 2                  | 0.33   |
| Student 3                    | 0.79   | Student 3                  | 0.38   |
| Student 4                    | 0.57   | Student 4                  | 0.20   |
| Student 5                    | 0.20   | Student 5                  | 0.27   |
| Student 6                    | 0.55   | Student 6                  | 0.50   |
| Student 7                    | 1.00   | Student 7                  | 0.29   |
| Student 8                    | 0.67   | Student 8                  | 0.30   |
| Student 9                    | 0.25   | Student 9                  | 0.21   |
| Student 10                   | 0.60   | Student 10                 | 0.82   |
| Student 11                   | 0.71   |                            |        |
| Student 12                   | 0.58   |                            |        |
| Student 13                   | 0.33   |                            |        |
| **Sum**                      | 7.53   |                            | 3.80   |
| **Mean**                     | 0.58   |                            | 0.38   |

From table 3, the average value (\(\bar{x}\)) N-Gain the score of mathematical problem-solving ability for each class is obtained by the average N-Gain of 0.58 experimental class into the “medium” category, while the control class 0.38 is also in the “medium” category. Then, calculated the variance value and standard deviation of N-Gain Score of Mathematical problem-solving performance. The calculation results obtained by the experimental class variance value = 0.056 and the standard deviation value of the experimental class = 0.24. Control class variance value = 0.035 and control class standard deviation value = 0.19.

3.2.3 N-Gain Data Distribution Normality Test

Based on the N-Gain normality test scores of mathematical problem solving abilities using the Lilliefors Test, the N-Gain score data for both classes were normally distributed. In addition, the N-Gain data variance for both variance classes is homogeneous.

3.2.4 Hypothesis Test of N-Gain Data

The mean value and N-Gain variance obtained are:

\[ \bar{x}_1 = 0.58, \quad S_1^2 = 0.056, \quad S_1 = 0.24, \quad n_1 = 13 \]
\[ \bar{x}_2 = 0.38, \quad S_2^2 = 0.035, \quad S_2 = 0.19, \quad n_2 = 10 \]

Combining equation (2) gained combined variances (\(s^2\)), std dev combined (s) consecutively 0.047 and 0.22. Then using equation (1) obtained t value of 2.16. At a significant level \(\alpha = 0.05\) and degrees of freedom \(dk = n_1 + n_2 - 2 = 21\), so \(t_{\text{table}} = t_{1-\alpha(n_1+n_2-2)} = t_{(0.95)(21)} = 1.72\). The testing criteria is to reject \(H_0\) if \(t_{\text{count}} > t_{\text{table}}\), for other t-value, \(H_0\) is accepted. Based on the results of the above calculations obtained \(t_{\text{count}} = 2.16\) and \(t_{\text{table}} = 1.72\) or \(t_{\text{count}} > t_{\text{table}}\). Thus, \(H_0\) is rejected at a significant level of \(\alpha = 0.05\). It can be concluded that the improvement of students mathematical problem-solving skills taught with problem-based learning models is better than students taught with traditional learning in Applied Mathematics II courses in the Industrial Engineering Study Program Polytechnic of South Aceh.

3.3 Students Activities

The average student activity during the first meeting until the third meeting was 69.64%, so it can be concluded that student activities during the learning process use problem-based learning models in
applied Mathematics II courses in Industrial Engineering Study Program Polytechnic of South Aceh in the active category. This data can be seen in Table 4 below.

| Meeting | 1  | 2  | 3  | Mean |
|---------|----|----|----|------|
| Percentage | 66.07% | 69.64% | 73.21% | 69.64% |
| Criteria     | Active | Active | More Active | Active |

4. Conclusion
This work can be conclude by the improvement of students mathematical problem solving skills taught with problem based learning models which is better than students taught with conventional or traditional learning in applied Mathematics II courses and other than that, the average percentage of student activity during the learning process by using problem-based learning models in applied Mathematics II courses in the Industrial Engineering Study Program Polytechnic of South Aceh experienced an increase with the active category.

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