Differences in students’ learning outcomes between discovery learning and conventional learning models

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Abstract. The number of students’ learning outcomes of Year 9 SMP Negeri 1 Pekanbaru, Indonesia, were still under minimum completion criteria (less than 82). The objective of this research is to see the difference in learning outcomes between students who follow the learning through the discovery learning model implementation and conventional learning on 3-dimensional shapes with curved surfaces. This study used a pre-experimental research design (Static Group Comparison) involved 2 sample classes, experiment, and control classes. The results showed that there were differences in learning outcomes between students who learned by discovery and conventional learning models.

1. Introduction

Education is the key to form the intelligent society. According to the Indonesian government regulation, the goals of mathematics learning are to have knowledge and skills, to foster faithful and devoted persons to the one almighty God, to be noble, to have physical and spiritual health, to have a solid and independent personality, and to have a sense of community responsibility and nationality [1]. The achievement of the learning objectives will affect the learning outcomes. Good learning will result in a good quality of learning outcomes. Based on the national 2013 curriculum, a good lesson is student-centered learning, where students will have hands-on experience in learning. Thus, the success of a learning process can be seen in the learning outcomes.

According to ECTS Users’ Guide in [2], the learning outcomes refer to what a learner is expected to know, understand and/or be able to demonstrate after completion of a process of learning. Thes’ learning process can determine Students’ learning outcomes. Learning outcomes are the level of students’ abilities in accepting, rejecting, and assessing the information gained through the teaching and learning process [3]. Thus, the learning outcomes are the results that are achieved by students in the form of scores after participating in a test at the end of each lesson.

The result of mathematics learning is defined by Gagne in [4] as the change of students’ behavior after receiving mathematical learning experiences, that can be measured through their knowledge, behavior, attitude, and skills. Based on the definition, it can be concluded that the results of learning mathematics are the score obtained by students after learning mathematics. The result of learning mathematics in this research is students’ scores after following discovery learning in the experimental class and conventional learning in the control class on the topic of 3-dimensional shapes with curved surfaces.

This research aimed to develop learning materials on 3-dimensional shapes with curved surfaces for Year 9. The study used 4D development model. This paper explained the development phase related effectiveness test toward learning materials that have been developed.
Several studies have shown low learning outcomes of Junior High School students [5][6]. There are several factors that affect the low learning outcomes of natural sciences especially students of Junior High School level, such as: (1) the high difficulty level of the materials; (2) the lesson presented by the teacher is still a conventional learning model; (3) students were relatively passive in accepting and following what is presented by the teacher; (4) teachers rarely used appropriate instructional media so that students' basic understanding was still low; (5) teachers had difficulty in finding the right models and methods to present innovative learning; and (6) student's learning motivation was still low, indicated by less attention by playing with their friends [5]. Besides, many teachers used the teacher-centered learning the model [6].

The results of observations by the researcher in some junior high schools in Pekanbaru showed that many schools had implemented the national 2013 curriculum on Year 9. However, the learning model that was used was still teacher-centered. Teachers used lecturing method, which caused some students inactive and unengaged. Whereas, learning activities should use learning models, learning methods, learning media, and learning resources that could adjust to the characteristics of students and subjects [7].

Based on the interview results with teachers, many students were less active and not focus during the learning process, which caused a decline in students’ learning outcomes. Based on the data of the students' learning outcomes in SMP Negeri 1 Pekanbaru on the current daily test results, the score were 42% in Year 9 Hang Jebat, 100% in Year 9 Tuanku Tambusai, 72.5% in class Hang Tuah, 87.8% in Hang Nadim class, with minimum completion criteria score is 82. Based on the results of interviews with some students, it is found that students were less interested in mathematics because it only focuses on solving problems with many formulas, students had a poor understanding of what the teacher explained in the classroom.

The potential solutions to overcome these problems is to apply the discovery learning model. Discovery learning is a model for developing active student learning by discovering by themselves, self-investigating, the results obtained will be long-lasting in memory and will not be easily forgotten by students[8]. In discovery learning, the teaching materials are not presented in the final form. Students are required to perform various activities of collecting information, comparing, categorizing, analyzing, integrating, organizing materials and making conclusions [10]. Also, students are required to find a concept with the help of a given stimulus, and this will make the learning will be students oriented. The procedure of applying the discovery learning model according to Syah (in [9]) is shown in Table 1.

| Table 1. The procedure of discovery learning model implementation. |
|-------------------------------------------------------------------|
| **Stages** | **Teacher Activity** |
| Stimulation | Ask the question, recommend reading a book and other learning activity that lead to the preparation of the problem |
| Problem Statement | Give opportunity for students to identify and analyze problems that students face so can create a hypothesis |
| Data Collection | Give the opportunity for students to gather as much as possible relevant information to prove whether or not the hypothesis is correct. |
| Data Processing | Guide students in processing data and information that has been obtained either through interviews, observation and so on and interpreted. |
| Verification | Guide students to perform a careful examination to prove whether or not the hypothesis has been established and associated with the data processing result. |
| Generalization | With students draw a conclusion that can be the general principles and apply to all the same events or problems, pay attention to the verification result |
The objective of this research was to know the difference in mathematics learning outcomes between students who learn through discovery learning model and conventional learning. The research hypothesis was "there is a significant difference in mathematics learning outcomes between students who learned through discovery learning and conventional learning."

2. Method
Validation process, small group tests, and big group tests have been conducted at the developed phase to produce mathematical learning materials that are feasible to be tested for effectiveness. This paper describes the developed phase related to the effectiveness of learning materials that have been developed. Experiment design in Table 2 that was used in this research is The Static Group Comparison Design [11].

| Group     | Treatment | Post-test |
|-----------|-----------|-----------|
| Experiment| \(^aX_1\) | \(^cO\)   |
| Control   | \(^bX_2\) | \(^cO\)   |

\(^aX_1\) : Discovery learning model  
\(^bX_2\) : Conventional learning  
\(^cO\) : Post-test

The population in this research was all student Year 9 of SMP Negeri 1 Pekanbaru academic year 2017/2018 consisting of six classes. All students were given a mathematical pre-test to assess students' early mathematical abilities, which would be used as research samples. Furthermore, the purposive sampling technique was used by looking at the schedule of mathematics subjects that were not overlapped, including four classes (Year 9 Hang Jebat, Year 9 Hang Nadim, Year 9 Tuanku Tambusan, and Year 9 Hang Tuah). The random sampling technique was used to determine the sample class from classes that have not crossed the timetable by drawing a draw. Testing was then conducted to see mathematical ability. The sample was Year 9 Hang Jebat to implement the discovery learning model (experimental group) and Year 9 Tuanku Tambusai to implement conventional learning (control group).

3. Result and Discussion
3.1 Mathematical Early Ability Test Data Analysis
An early test is given in the form of pre-requisite questions to learn the main subject of curved side space. Testing was done by using SPSS software version 23 for windows. Test results with Kolmogorov Smirnov test and Leneve-test indicated that the test scores students’ mathematical pre-test were not normally distributed. Since the data were not normally distributed, the average analysis was performed by non-parametric statistical tests. The nonparametric test used was the Mann Whitney test. The hypothesis formulation for the Mann Whitney test on the test scores of mathematical pre-test of students Year 9 Hang Jebat and Year 9 Tuanku Tambusai are as follows.

\(H_0\): There was no a significant difference between test scores of mathematical pre-test of students Year 9 Hang Jebat and Year 9 Tuanku Tambusai

\(H_1\): There was a significant difference between test scores of mathematical pre-test of students Year 9 Hang Jebat and Year 9 Tuanku Tambusai

Table 3 shows students' pre-test results by using Mann Whitney test in software SPSS version 23 for Windows
Table 3. Mann-Whitney test result of students’ pre-test score using SPSS.

| Class                  | N  | Average | Z    | Sig.(2-tailed) | H_o   |
|------------------------|----|---------|------|----------------|-------|
| IX Hang Jebat          | 37 | 89.59   | -1.855 | 0.064          | Rejected |
| IX Tuanku Tambusai     | 36 | 83.94   |       |                |        |

Based on Table 3 above shows that the significance value (sig.) is more than $\alpha = 0.05$ which means $H_0$ was accepted and $H_1$ was rejected. This value means that at the value 95% confidence level, there was no average difference between Year 9 class Hang Jebat and Year 9 Tuanku Tambusai or in other words students in both classes have the equal mathematical ability.

3.2 Post-test Data Analysis

A post-test analysis is an analysis of the students’ learning outcomes in the curved side space material. The result of the normality test with Kolmogorov Smirnov test showed that the posttest score data of the student was not normally distributed. Furthermore, hypothesis testing using Mann Whitney nonparametric statistical test. The verbal hypothesis formula for Mann Whitney test on posttest score data of experimental class and control class is as follows.

$H_0$: There was no a significant difference in students' learning outcomes between experiment class and control class

$H_1$: There was a significant difference in students’ learning outcomes between experiment class and control class

Table 4 shows the result of hypothesis testing by using Mann Whitney test on software SPSS version 23 for windows.

Table 4. Mann-Whitney test result of post-test score data using SPSS.

| Class      | N  | Average | Z    | Sig.(2-tailed) | H_o    |
|------------|----|---------|------|----------------|--------|
| Experiment | 37 | 95.65   | -6.336 | 0.000          | Rejected |
| Control    | 36 | 65.89   |       |                |        |

Based on Table 4, it could be seen that the significance value (sig.) was less than $\alpha = 0.05$, so $H_0$ was rejected, and $H_1$ was accepted. This value means that at value 95% confidence level, there was a significant difference in students' learning outcomes between experiment class and control class.

3.3 Discussion

The discovery learning model is one of the learning models that can be applied in the implementation of the curriculum 2013 [9]. The implementation of the model discovery learning could give students stimulus so that students can think critically and at the end, they can solve the assigned problems. It is expected to increase students' skills so that ultimately able to improve student learning outcomes. Table 5 shows the percentage of students’ completeness in the sample class.

Table 5. Percentage of the completeness of class sample students

| Class      | Students’ score in % Complete | Incomplete |
|------------|-----------------------------|-----------|
| Experiment | 89.2                        | 10.8      |
| Control    | 36.1                        | 63.9      |

Based on Table 5, it shows that the class that has the highest learning achievement was the experimental class while the control class had lower learning achievement than the experimental class. After the hypothesis test on the post-test score of each class using Mann-Whitney test with SPSS help
obtained sig = 0.000, which is smaller than the level of significance 0.05. This value shows that \( H_0 \)
was rejected, which means that there was an average difference between the experimental classes
treated with the discovery learning model and the control class average with conventional learning. So
it could be said that there are differences in learning outcomes between experimental class students
with the discovery learning model implementation and control class students with the application of
conventional learning.

4. Conclusion
Based on the results of data analysis and hypothesis testing, it can be concluded that there were
differences in learning outcomes between experimental class students with the discovery learning
model and control class students with the conventional learning on Year 9 SMP 1 Pekanbaru. The
average student learning outcomes used the discovery learning model was 95.65 and the average of
student learning outcomes used conventional learning was 65.89.

Based on the research result and discussion, the researcher recommends for teachers or researcher
who want to do research using the discovery learning model and using student worksheet to design the
stimulus and problem statement carefully. It is because in this study many students who less able to
establish a temporary hypothesis that exists in the problem statement stage.

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