Application of Discovery Learning Models To Improve Conceptual Mastery of Newton Force And Law

Faradhillah[1] , Marhami [2], Izkar Hadiya[3]
[1,2] Department of Engineering, Universitas Malikussaleh, Lhokseumawe 24352, Indonesia
[3] Teacher at Madrasah Stanawiyah Negeri 1 Sabang, Sabang 23512, Indonesia

Coressponding Author. E-mail:
[1] faradhillah@unimal.ac.id
[2] Marhami1997@gmail.com
[3] izkar@hadiya.gmail.com

Received: December 12th, 2020 *Accepted:* January 26th, 2021 *Online Published:* January 30th, 2021

Abstract

This study aims to determine the increase in students' mastery of concepts in Newton's Force and Law material by applying the Discovery Learning model to 10th grade students of Public Vocational School 1 Bireuen. The research used was quasi-experimental research with Pretest-Posttest Group Design. Data was collected in 10th grade TKRO (Automotive Light Vehicle Engineering) as an experimental class with 38 students and 10th grade TBSM (Motorcycle Business Engineering) as a control class with 38 students. Data obtained from the results of this study using SPSS for Windows Version 18. Based on the results of data analysis to see the results of mastery of students' concepts obtained an average value of 85.16 and the control class average value of 79.95. Data obtained from the test results are used to test the research hypothesis using the Independent Sample T-test and N-Gain test. From the results of the analysis obtained from the results of the Independent Sample T-test results of the initial and final test values obtained $t_{count}t > t_{table}$ is 3.901> 1.992 with sig (2-tailed) of 0.00 lower than 0.05. The N-Gain value in the experimental class was 42.24%. Whereas the control class was 38.96%. The results of the analysis of student responses using the Discovery Learning model obtained the percentage of strongly disagreeing at 8.2%, disagreeing at 12.3%, agreeing at 48.1%, and strongly agreeing at 31.2%. Based on the results of the study it can be concluded that with the Discovery Learning model the mastery of students' concept mastery especially on Newton's Force and Law material is more improved than using conventional learning models.

Keywords: Newton's Force and Law; Concept Mastery; Discovery Learning Model

How to cite this article :

Faradhillah, F. Marhami, M. & Hadiya, I. (2021). Application of Discovery Learning Models To Improve Conceptual Mastery of Newton Force And Law. *IJIS Edu : Indonesian Journal of Integrated Science Education, 3*(1), 69-77. doi:http://dx.doi.org/10.29300/ijisedu.v3i1.4174

INTRODUCTION

Learning physics at the Vocational High School (SMK) level aims to master the knowledge, concepts and principles of physics and have the skills to develop knowledge, skills and a confident attitude so that they can be applied in everyday life and as a provision for continuing education at a higher level.

Based on observations made at Public Vocational High School 1 Bireuen, generally students are less motivated in learning physics. The problem in the physics learning process at this time is that students do not play an active role in building and discovering their own knowledge so that currently they are still taught through learning that comes from books or theoretically and is impressed as a process of transferring knowledge from the teacher's mind into the student's mind.Students are also less active in asking questions about concepts that are less understood. Students tend to do other activities than pay attention to the teacher who is teaching, so learning tends to be teacher-centered. This causes learning that occurs only in one direction, students are less brave to express their opinions. Students are more directed to memorize information without being required to understand and develop information, and less associated with everyday life, so that students 'understanding of concepts is very low According to Flores & Hinton (2019) students' skills in understanding the material are needed because it affects student learning outcomes and mastery of concepts that exist in students.

One way that teachers can do so that students feel interested in the learning presented is through the selection of learning methods and models that are in accordance with the material being taught. So that the learning outcomes will be satisfying together as well as teachers and students can increase the learning outcomes of physics in the odd semester of 10th grade. To achieve learning objectives, it can be done by measuring the level of achievement of the specified minimum completeness criteria (KKM). There are many innovative learning methods and models that can be of direct benefit to teachers and students in an effort to improve mastery of physics learning concepts, especially material of Newtonian forces and laws. The right learning to overcome the problem of students' mastery of physics concepts is by applying the Discovery Learning model. Discovery Learning is a learning method that requires teachers to be more creative in creating situations that make students learn actively and discover their own knowledge (Bicknell-Holmes & Hoffman, 2000; Maharani, 2017). Discovery Learning is a learning process in which the delivery of the material is not complete, because the Discovery Learning model requires students to be actively involved in the learning process and find out for themselves a lesson. Discovery Learning is one of the most complex types of cooperative learning. Students are involved in planning both the topic to be studied and how their investigation will proceed. This model teaches students in discussion, question and answer and processing in groups. The Discovery Learning model was developed to build all aspects of student abilities both in the cognitive, psychomotor and affective fields (Fitri, 2015; Kadri & Rahmawati, 2015; R. H. Putri et al., 2017).

D. R. Putri et al. (2017) in her research also said that the use of the Discovery Learning model had a great influence on students' mastery of concepts. In Discovery Learning, students are encouraged to learn largely through their own active engagement with concepts, and teachers encourage students to have experiences and conduct experiments that allow them to discover principles for themselves.

METHOD

This research uses quantitative research. This research was conducted at Public Vocational School 1 Bireuen which is located at Jl. Student Park No. 2, Kota Juang District, Bireuen Regency, academic year 2018/2019 When the research was carried out on September 30, 2019 to October 12, 2019. The population in this study were all students of 10th grade Public Vocational School 1 Bireuen, totaling 325 students. The sample in this study amounted to 76 students with the sample selection technique used was purposive sampling technique. The research design is as in table 1

Table 1. Research Design

Class	Pretest	Treatment	Postest
Experiment	O_1	X_1	O_2
Control	O_1	X_2	O_2

Fraenkel and Wallen (in Nurrohmah, 2018: 27)

Information:
O_1 and O_2 = students' concept mastery score
X_1 = Learning physics using Discovery Learning
X_2 = Physics learning uses conventional learning

Data collection techniques in this study were test and non-test. For the test questions given a total of 20 questions that have gone through the validation process both construct and content validation. The test technique given to students is the pre-test (pretest before action is taken on learning. This test aims to determine the students' initial abilities. After being given the pretest, posttest activities are carried out which give tests to students after the learning action is carried out. is to determine the extent of student mastery in studying a given material and to what extent the improvement from the pretest. The non-test technique in this study is a questionnaire. The questionnaire used in this study is a closed direct questionnaire. This non-test technique of this study aims to determine the participants' responses. students about the models used in learning during research.

Data analysis in this study used an independent sample t-test with the help of SPSS for Windows Version 18.0, which previously had prerequisite testing, namely homogeneity and normality tests .

Independent sample t-test was used to determine the effect of the application of the Discovery Learning Model to Improve Concept Mastery in the Material of Newtonian Force and Law. Riduwan (2015) states that if the data is normally distributed and the variant data is homogeneous, the different test used to test the hypothesis is the Independent Sample T-test at the significance level of 5% (0.05) with n1 ≠ n2, namely
:

$$t_{Count} = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1 - n_2)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

Information :
$\bar{X}$ = Average value of each group
n = Number of subjects per group
s^2 = Variant per group

Independent Sample T-Test is the decision making criteria that the value of t_{count}> t_{table}, and the significance value is 0.00 <0.05, so that H0 is rejected and H1 is accepted. Hypothesis testing whether there is an increase in the students' mastery of concepts between the pretest and posttest scores with the parametric statistical test. In this study, researchers processed the data assisted by the help of a computer program, the SPSS for Windows Version 18 software.
The hypothesis formulated is as follows:
H_0 = tc_{ount} <t_{table} and a significance value> 0.05, then H_0 is accepted, H_1 is rejected.
H1 = t_{count}> t_{table} and a significance value <0.05, then H_1 is accepted, H0 is rejected.
Information:
H_1 = There is an increase in students' mastery of concepts through the Discovery Learning model on the material of Newtonian force and law (t_{count}> t_{table} and significance value <0.05).
H_0 = There is no increase in students' mastery of concepts through the Discovery Learning model on the material of Newtonian force and law (t_{count} <t_{table} and significance value> 0.05).

To find out the value of the t table, it can be found using a formula and looking at the results in the statistical table. The formula used is as follows:

Df = n-k
Information:
Df = Distribution t
n = number of samples
k = number of dependent variables
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RESULTS AND DISCUSSION

The test instrument in this study was conducted to see the level of validity, reliability, difficulty level and distinguishing test questions. In this study, researchers used the help of Microsoft Excel to see the test instrument questions.

1. Prerequisite Test Results

The prerequisite analysis test is needed in order to determine whether the data analysis for hypothesis testing can be continued or not. Some data analysis techniques require testing of analysis prerequisites. Analysis of variance requires that the data come from a normally distributed population and homogeneous compared groups. Therefore analysis of variance requires a test for normality and homogeneity of data.

a. Normality test

Table 2. Normality Test Results

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistik	Degrees of Freedom	Significancece	Statistic	Degrees of Freedom	Significance
Mastery Concept	Pretest Experiment Class	0.130	38	0.200	0.975	38	0.543
	Posttest Experiment Class	0.109	38	0.200	0.950	38	0.089
	Pretest Kontrol class	0.110	38	0.200	0.960	38	0.190
	Posttest Control Class	0.124	38	0.147	0.963	38	0.239

Based on table 2, the probability number or Asymp is obtained. Sig (2-tailed). This value is compared with 0.05 (because it uses a significant level of 5%) for decision making using the following test criteria: If Asymp. Sig (2-tailed) <0.05 then the data distribution is not normal and Asymp. Sig (2-tailed)> 0.05, then the data distribution is normal. Therefore, it can be stated that the results of the above decisions in the experimental class and control class obtained all normally distributed data

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b. Homogeneity Test

Table 3. Homogeneity Test Results

Levene Statistik	Degrees of Freedom 1	Degrees of Freedom 2	Significance
3.520	1	74	0.065

Based on table 3, the results of the pretest and posttest data homogeneity test of students' mastery of concepts obtained a significance> 0.05. Thus it can be said that the data from the results of the pretest and posttest homogeneity of the students' concept mastery of the experimental class and the control class were homogeneous.

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2. Hypothesis Test Results

Hypothesis testing is done to find out whether the hypothesis that has been proposed is accepted or rejected. The hypothesis will be accepted if the data that has been collected can prove the statement in the hypothesis. Conversely, the hypothesis will be rejected if the data that has been collected cannot prove the statement in the hypothesis. The hypothesis test used in this study is the Independent Sample T-test and the N-Gain test as follows:

a. Independent Sample T-test

Independent Sample T-test is to make a decision whether the research hypothesis is accepted or rejected. The hypothesis is accepted if the significance value is less than 0.05 and the hypothesis is rejected if the significance value is greater than 0.05.

Based on the results of the Independent Sample T-test, the pretest and posttest values are seen in table 4:

Tabel 4. Independent Sample T-test Results

Dependent variable	Variant	T	T test for means of equations
			Significance 2 tailed
Results of Students' Concept Mastery	The same variant is assumed	3.901	0.000
	Same variant is not assumed	3.901	0.000

From the results of table 4, the results of the same variant are assumed to obtain the t_{count} of 3.901. While the t-table value is 1.992. In accordance with the basis of decision making, the value of $t_{count} > t_{table}$, and the significance value is 0.00 <0.05, so that H0 is rejected and H1 is accepted. Therefore, it can be stated that there is a significant difference in the students' mastery of concepts between the experimental class and the control class. Based on the results of the Independent Sample T-test, it can be said that using the Discovery Learning model has a significant difference, which means that there is success in increasing students' mastery of concepts after using the Discovery Learning model.

b. N-Gain test

To determine the quality of the increase in the conceptual mastery ability of the experimental class and control class students after learning using the Discovery Learning model and conventional learning models can be shown in table 5. below:

Table 5. N-Gain Test Results for Experiment Class and Control Class

Class	N-Gain
Eksperimen (*Discovery Learning*)	45.24%
Control (Konvensional)	38.96%

From the results of table 5 the comparison between the experimental class and the control class is to see the results of the students' mastery of the concept of learning. So the N-gain result in the experimental class is 45.24%. While the control class is 38.96%.

Results of Data Analysis of Student Responses to the Discovery Learning Model

The student questionnaire conducted in this study aims to determine the extent to which students respond to the Discovery Learning model. This questionnaire is given to students after the learning activities in the experimental class have finished learning. Each statement has four responses, namely SS (Strongly Agree), S (Agree), TS (Disagree), and STS (Strongly Disagree). Each response given by students has a different value, for a score of 4 is given for those who choose a strongly agree response, a score of 3 is given for those who choose an agreeable response, a score of 2 is given for those who choose a disagreeing response, and a score of 1 is given for those who choose a response that agrees choose response strongly disagree. Analysis of the questionnaire data using Microsoft Excel. The percentage of student response questionnaires using the Discovery Learning model is as follows:

Table 6. Percentage of Student Response Questionnaire

No	Student Response	Percentage
1	Strongly Disagree	8,2 %
2	Disagree	12,3 %
3	Agree	48,1 %
4	Strongly agree	31,2 %

Based on table 6, it can be seen that of the 20 indicators of student responses, 8.2% strongly disagree, 12.3% disagree, 48.1% agree, and strongly agree 31.2%. Furthermore, it can also be seen in the diagram in figure 1:

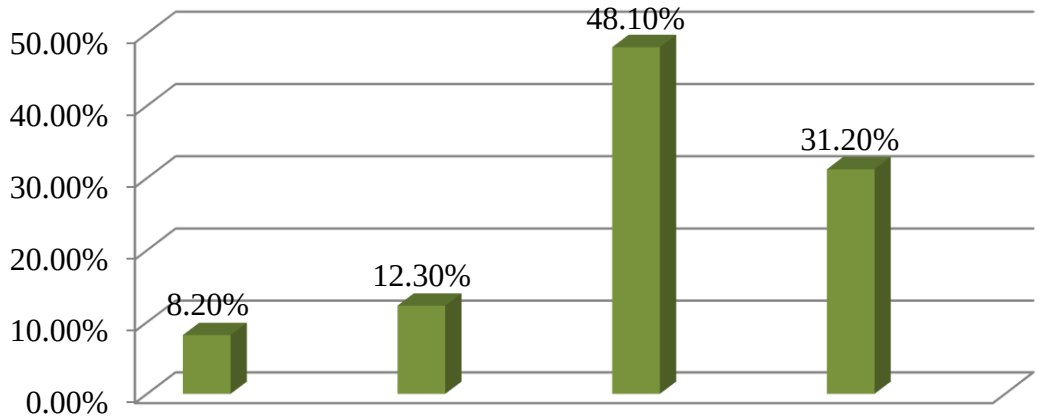

Figure 1 Student Response Questionnaire

The results of students' mastery of concepts were measured through a written test in the form of 30 questions in the form of multiple choice questions, which were followed by the two classes each totaling 38 students. The results of the experimental class pretest data on the material of force and Newton's law obtained an average score of 72.16. While the results of the control class pretest data obtained an average score of 67.13. According to Fitri (2015)

states that the low average score of students' pretest is because they have not been taught on Newton's force and law material, so that students have not obtained initial knowledge about this material and make it difficult for students to work on pretest questions given by the teacher. Based on the results of the posttest score of the experimental class on the material of force and Newton's law, the average score of the posttest score was 85.16. While the results of the posttest data from the control class, the average score was 79.95. So it can be said that the average value of the pretest and posttest results in the experimental class is higher than in the control class. This is because students are more active in learning with the Discovery Learning model than using conventional learning models. Indarti (2019); R. H. Putri et al., (2017); Vahlia et al., (2017); Valmarska et al., (2017) states that there is an increase in results student learning is taught with the Discovery Learning model rather than using conventional learning models. This is because students are not active in learning activities, do not directly conduct experiments, students only see demonstrations given by the teacher in front of the class. In accordance with the opinion of Sanjaya (2011) that learning in the conventional learning model, students listen more to the teacher's explanation in front of the class and carry out assignments if the teacher provides practice questions, so that learning outcomes are less good. Whereas in the experimental class the concept mastery ability was higher in level. This is because students can make a study of what might happen and predict the pattern of the data presented. So that the Discovery Learning model is superior to conventional learning models (Ashfahani et al., 2020; Hafiz & Dahlan, 2020; Hudha & Batlolona, 2017; Miatun, 2018; Samputri, 2020; Tompo et al., 2016; Widada et al., 2019).

Based on the results of research that have been tested for normality and homogeneity, then the hypothesis is tested. Hypothesis testing in this study is carried out by testing using the Independent-Sample T Test and N-Gain test. The results of the analysis shown in Table 4.9 are the results of the same variant which is assumed to be the t_{count} of 3.901. While the t-table value is 1.992. In accordance with the basis of decision making, the value of $t_{count} > t_{table}$, and the significance value is 0.00 <0.05, so that H0 is rejected and H1 is accepted. Therefore, it can be stated that there is a significant difference in the students' mastery of concepts between the experimental class and the control class. Based on the results of the Independent Sample T-test, it can be said that using the Discovery Learning model has a significant difference, which means that there is success in increasing students' mastery of concepts after using the Discovery Learning model.

The results of the N-Gain test are to see the comparison between the experimental class and the control class on the results of mastery of the learning concept. So the N-gain result in the experimental class is 45.24%. While in the control class amounted to 38.96%. For more details, see table 4.10. The results of this study are in line with Kusuma & Harijanto (2015) which states that the application of the Discovery Learning model to improve student learning outcomes goes well, students look enthusiastic and interested in taking lessons, and can increase student activity shown through teamwork in groups with use simple props, presentations, and ask questions. D. R. Putri et al. (2017) also states that learning using Discovery Learning has a very high practicality in improving students' conceptual mastery abilities. The Discovery Learning model used by the teacher provides freedom for students to find their own knowledge. Students gain knowledge that was previously unknown without notification, but it was discovered by students themselves, because by finding themselves students could better understand the material in depth. This self-found knowledge can improve students' mastery of concepts better.

The difference in the results of students' mastery of concepts in the experimental class and the control class was caused by several different activities that occurred in the two classes during the learning process. In learning activities in the experimental class students are taught using the Discovery Learning model which is more able to explore material that finds its own concepts, while in the control class students only receive information from the teacher and learning tends to be monotonous. This causes students to lack meaning in the material being studied. Students who learn with the Discovery Learning model will go through a series of structured discovery learning stages so that students can better remember, understand, apply and analyze the material being studied. This is supported by the results of interviews with several students in the experimental class

that the Discovery Learning model makes it easier for students to understand the lesson. This is in accordance with Wenning (2010) which states that the systematic learning stage will help students develop the ability to think independently rather than learning that only listens or reads. Based on the reality in the field when doing research in class by applying the Discovery Learning model, there are weaknesses that appear during the learning process which takes a longer time. This is because there are more learning steps in applying the model. However, it can be overcome by being more disciplined in the use of learning time so that learning objectives can be fulfilled in an efficient time.

The respondents to the implementation of the Discovery Learning model were students in the experimental class. To see and find out student responses to learning activities using the Discovery Learning model, it is done by distributing questionnaires to students containing questions about the Discovery Learning model questionnaire. Discovery Learning model makes students not feel difficult in conducting experiments and discoveries about a problem related to the material, because students do it together or discuss with their groups. This is related to Akgun et al. (2012) theory that interaction with social friends spurs the formation of new ideas and enriches students' intellectual development.

Students do not feel bored with physics learning activities that use the Discovery Learning model, because students are directly involved in learning activities. Students find it easy to understand and understand the material because students conduct experiments and experience it firsthand about the material they are learning, especially in the material of force and Newton's laws, so that learning can be more meaningful for students. This is in accordance with Widodo (2017) research that meaningful learning is learning to understand what has been obtained, then linked and developed with other circumstances so that learning is better understood. According to Bruner (1960) that by getting to know the concepts and structures included in the material being discussed, children will better understand the material they must master.

Based on the results of the student response questionnaire test, the percentage value of strongly disagree was 8.2%, 12.3% disagree, 48.1% agree, and 31.2% strongly agree. It can be seen that the high percentage of student responses who give agreed answers to the statements submitted to the Discovery Learning model is 48.1%. Therefore, the high student response given also shows the high mastery of student learning concepts, so that learning can be well received by students. This is in accordance with Maharani (2017), the percentage of average value and classical provisions obtained by students using the Discovery Learning model is higher than the learning motivation of students who use the lecture method. Therefore, from the percentage results of the overall student response questionnaire using the Discovery Learning model, especially on the material of Newton's Force and Law, it can be said that they agree with applying the Discovery Learning model.

CONCLUSIONS

Based on the results of the Independent Sample T-test, it was found that there was a significant difference between students' understanding of concepts taught using the Discovery Learning model, which means that there was an effect of the application of the Discovery Learning learning model on students' mastery of concepts. Discovery Learning model can improve the results of students' mastery of concepts, especially in the subject of Newton's Force and Law. The increase can be seen by the calculation of the N-gain, namely the N-gain in the experimental class is 45.24%. While the control class is 38.96%. Mastery of this concept can be improved by the application of discovery learning properly

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