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Effect of Direct Instruction Models Toward Students' Understanding of Physics Formula

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Abstract

The research aims to obtain information on the ability to understand the physics formulas of high school students being taught through direct learning models. The population subjects in this study were 360 high school students. The research sample was taken using a random class technique, with a total sample of 79 students. This research used instruments in the form of tests of understanding students' physics formulas in the form of essays that have been tested before being used in research to determine the validity and reliability of the tests. The normality test is performing on the experimental class which obtained $X_{count}^2 < X_{table}^2$ (1,68 < 9,49) and the control class $X_{count}^2 < X_{table}^2$ (1,47 < 9,49), the normality of the two data groups is normal. Homogeneity testing of variance used F-test get value 1,15, which F_{table} = 1.74 ($F_{count} < F_{table}$), the variance of the two data groups is homogeneous. Data processing uses inferential analysis techniques with the "t" test. There is two class, which one class as an experimental class that was treated in the form of direct teaching-learning models and another class as a control class taught conventionally. The results there is an increase in the score of students' understanding of physics formulas taught through direct learning models. It can happen because students are invited to get accustomed to gaining procedural knowledge also can capture and interpret physics formulas that are taught through modeling or experiment.

Keywords: physics formulas; student understanding; direct learning model

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INTRODUCTION

Education is a process that cannot be separated from personal life as well as the life of the nation and state. The quality of the nation and state is determined by the quality of the educational process (Herawati, Siroj, & Basir, 2010). Education can be said to be a valuable investment. Physics has an important role in the world of education. Increasing understanding of physics at every level of education needs attention. It is a concern because students have not fully enjoyed physics. This is because students assume that physics is a difficult and boring subject (Atqiya, Jamal, & Mahardika, 2016).

The other reason, such as too many physics formulas and the way of the teachers in teaching from beginning to end, is monotonous, so students are less interested in learning physics (Refiana, Jamal, & Hartini, 2016). The physics learning process in class is when the teacher finishes explaining the subject matter and gives examples of questions (Amrita, Jamal, & Misbah, 2016; Noor, Zainuddin, & Miriam, 2017). At that time, students can follow it well. But if the questions given are different from the previous example, students get confused about solving the problem. Thus, many students have difficulty answering questions both from teacher assignments, daily tests, or general tests (Habibi, Zainuddin, & Misbah, 2017; Puspitasari, 2013). This is an indication that students' understanding of physics formulas is still questionable.

The teacher's role in the field of physics studies is required so that in embedded concepts (knowledge), laws, and theories to students must be creative and innovate using several methods combined into a learning model (Uzaedah, Nugroho, & Susanto, 2019). Physics teachers must have the ability to find an appropriate learning model, so students are interested in taking physics lessons (Kamsinah, Jamal, & Misbah, 2016; Uzaedah et al., 2019). Thus a positive attitude will raise students towards physics and become interested in learning physics (Nisa, Zainuddin, & Suriasa, 2014; Orrahmah, An'nur, & M, 2016).

Teaching and learning activities are seen as quality if they are effective, meaningful, and supported by existing facilities (Mahmud & Idham, 2017). Said to be successful, if students show a high level of mastery of learning tasks that must be mastered with learning goals and objectives (Haryandi, Zainuddin, & Suyidno, 2013). Therefore the teacher as an educator and instructor is responsible for planning and managing teaching and learning activities following the guidelines of the learning objectives to be achieved in each subject (Rahayu, 2017; Uzaedah et al., 2019). One of the problems faced by teachers is the difficulty in determining the right physics learning strategy that allows students to quickly understand the lessons delivered by the teacher (Polonia & Yuliati, 2019). These problems can be overcome by designing learning activities that can stimulate the achievement of the ability to understand optimal physics formulas (Zulmi, Darmayanti, & Zulkarnain, 2018).

Understanding physics formulas, namely scores obtained by students in tests of understanding physics formulas with indicators: the ability to interpret, model, and explain from formulas and shown by translating them in one form to another. The level of understanding students can understand physics formulas, not just memorizing and knowing teacher (Polonia & Yuliati, 2019). If students only memorize the formulas will be quickly forgotten and difficult to apply when the problem is slightly different from the formula he memorized, but if the student understands, it means he knows about something and can use it to solve the problems given (Audina, Arifuddin, & Misbah, 2019). In this level, students can provide explanations and descriptions about the purpose and meaning of a formula that he wrote and memorized (Riwanto, Azis, & Arafah, 2019).

Physics formulas are natural languages used in logic to solve problems related to physics in the form of mathematical equations to simplify and facilitate the explanation of matters relating to physics (Zulmi et al., 2018). The tendency of teachers to teach physics with the lecture method and further emphasize physics material in terms of mathematics makes the learning atmosphere monotonous. This event can be overcome if the teacher designs learning activities that can stimulate the achievement of understanding physics formulas optimally.

Direct teaching model learning is learning that focuses on declarative knowledge and procedural knowledge (Amrita et al., 2016; Habibi et al., 2017; Hadijah, Jamal, & M, 2016). Declarative knowledge is knowledge about something, while procedural knowledge is knowledge about how to do something. Memorizing specific physics laws or physics formulas is declarative knowledge. In contrast, procedural knowledge is higher in the level that requires knowledge in specific ways, for example proving the laws of physics through a demonstration (Herman, Wati, & Suyidno, 2014; Kamsinah et al., 2016).

It is very appropriate to use a direct learning model to improve students' understanding of physics formulas. Low student motivation to understanding physics formula can be seen from the attention towards the lack of lessons, low spirit, feel difficulties, and lack of enthusiasm in doing the tasks given, tend to make noise, easily complain, and pessimistic when experiencing difficulties to solve a physics problem. The low motivation of these students indirectly affects the low student learning outcomes. The cause of the low student motivation is a learning process that does not attract the attention of students, the material is considered difficult by students, and the learning process is less effective (Noor et al., 2017; Norhasanah, Jamal, & Suyidno, 2013; Normaliani, Jamal, & Suyidno, 2013).

Direct learning is a learning model specifically designed to help students learn the necessary skills and obtain information. The phase of direct instruction models are 1) Set the goals and establish set, 2) Demonstrate knowledge or skill, 3) Provide guided practice, 4) Check for understanding and provide feedback, and 5) provide extended practice and transfer (Arends, 2012). That phase gives little modify with the following teaching steps: conveying objectives, preparing students, presentations and demonstrations, achieving clarity, conducting demonstrations, reaching an understanding and mastery, practicing, giving guided practice, and checking to understand also giving feedback.

Most of the time, physics teaches to the student is more often taught with conventional learning (teacher-centered). The conventional learning model is learning that makes the teacher the main character in the classroom (Amry, Rahayu, & Yahmin, 2017). That learning is only centered on the teacher, and students are not actively involved in the learning process. The teacher makes small groups to discuss the lesson, but it is just an ordinary discussion group. Some methods in the conventional learning model are, setting the learning objectives, explanation of concepts and physics formulas by the teacher, and exercises in physics exercise. Besides that, the learning will only be centered on the teacher, and students are not actively involved in the teaching and learning process (Ulvah & Afriansyah, 2016).

The low motivation of student learning physics, especially physics formula, can be increased through various efforts, one of which is applying the direct teaching model with the demonstration method. This teaching is a teaching model in which the teacher must demonstrate knowledge or skills that will be trained to students step by step (Herman et al., 2014). The role of the teacher in learning is very dominant. However, it does not mean learning is authoritarian, cold, without humor. The learning management system carried out by the teacher, must continue to guarantee student involvement, primarily through paying attention, listening, question and answer planned task-oriented environment, and providing a high level of learning outcomes (Normaliani et al., 2013). Thus the existence of motivation in this teaching helps students in generating self-confidence or skills in carrying out the tasks to be achieved and if students who cannot direct themselves but still perform well if the direct learning model is used effectively.

The use of direct teaching-learning models to be successful and efficient requires a teacher to maximize his role besides knowing the steps and factors that influence the use of this learning model (Orrahmah et al., 2016; Pratiwi, Ain, & Igut, 2019). Through such models, it is hoped that students will be interested and motivated to improve their understanding of physics formulas (Zulmi et al., 2018).

METHOD

This type of research uses quantitative research with a true-experimental model Creswell (2013). The research design used a modified Posttest Control Group Design, where randomization is only done for the class (Daradjat, 2016).

The population subjects in this study were high school students consisting of 9 classes with a total of 360 students. The sample of this study consisted of one class as an experimental class that was treated in the form of direct teaching-learning models and another class as a control class taught by the conventional learning model.

This study sample consisted of one class as an experimental class that was treated in the form of direct teaching-learning models and another class as a control class, which was taught by the conventionally learning model. The samples were chosen by random cluster sampling. The research sample of the experimental class was 36 people, and the control class was 35 students. The research design is shown in Table 3 below.

Table 1 Research Design

Class	Treatment	Posttest
Experimental	X	T_1
Control	-	T_2

X = The treatment given is in the form of teaching a direct teaching model in the experimental class

\- = Without treatment that is physics learning which taught by conventional model in the control class

T_1 = Measurement of understanding physics formulas after the treatment phase ends in the experimental class (post-test)

T_2 = Measurement of understanding physics formulas after the treatment phase ends in the control class (post-test)

The data variables examined in this study used instruments in the form of tests of understanding students' physics formulas in the form of essays that have been tested before being used in research to determine the validity and reliability of the tests. The validity of the test items is done using the construct validity test, where the test items are constructed about aspects that will be measured based on specific theories, it is consulted with experts then.

The research framework can be seen in Figure 1. The research stage begins by making observations to the school and consulting with teachers, preparing lesson plans for each meeting, and making instruments or evaluation tools. The data were collected in the form of giving a test description to the students of the experimental class and the control class. The data analysis technique used inferential analysis techniques. Descriptive statistics are used to describe the characteristics of the distribution of scores in understanding physical formulas.

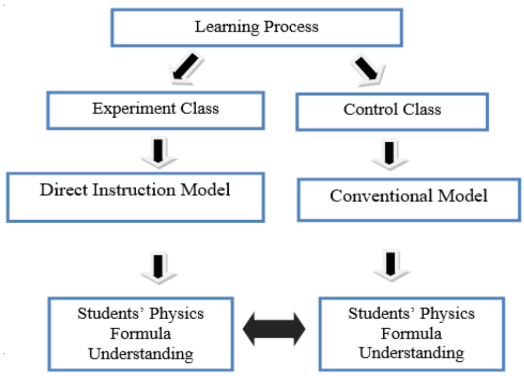

Figure 1 Research Framework

For this purpose, the average score, standard deviation, minimum score, and maximum score are used. The highest score is the highest score of the existing score, as well as the lowest score of the existing score. Inferential statistical analysis is used to test the research hypothesis. The null hypothesis (Ho) in this study is the understanding of the control class physics formulas is the same as the understanding of the experimental class physics formulas (there are no significant differences).

The alternative hypothesis is that the understanding of control class physics formulas is not the same as understanding the experimental class physics formulas (there are significant differences). Before testing the hypothesis, the prerequisite tests are normality and homogeneity tests. Hypothesis testing is intended to answer the hypotheses that have been proposed. For this purpose, the test is carried out using the t-test.

RESULT AND DISCUSSION

This discussion aims to explain the data contained in the study to analyze differences in learning outcomes of students in the experimental class and the control class. This discussion will discuss students' post-test results data, data on student learning outcomes improvement, and the post-test hypothesis test results. The results of the descriptive analysis of students' understanding of physics formulas in the experimental class (physics learning with direct teaching models) can be seen in table 2.

Table 2 Data experimental class

Statistic	**Statistic Value**
Sample	36.00
Lowest score	30.00
Highest score	90.00
Average score	59.86
Standar deviation	15.14
Variance	229.26

The indicator of students' understanding of physics formula used the revised edition of Taxonomy Bloom and Anderson (Armstrong, 2016), which includes 1) remember, 2) understand, 3) apply, 4) analyze, 5) evaluate, 6) create. In this study, we use the remember, understand, and apply to measure the students' understanding of physics formula.

The ability to use material learned in new and concrete situations can include applying the rules of methods, principles, concepts, laws, and theories. Students will master the ability to apply formulas if students have the essential cognitive ability to remember and understand (Atqiya et al., 2016). For example, students already know the physics formula and understand the variables and units in the formula, and then students will be able to apply the formula in doing the problems efficiently.

The results of the descriptive analysis of students' understanding of physics formulas in the control class (teach using conventional learning model) can be seen in table 3.

Table 3 Data control class

Statistic	**Statistic Value**
Sample	35.00
Lowest score	15.00
Highest score	75.00
Average score	44.14
Standar deviation	14.11
Variance	199.24

Figure 2 shows that of the 36 students in the experiment class who were the subjects of the study there who understood the physics formulas included in the excellent category, good category, fair category, and poor category.

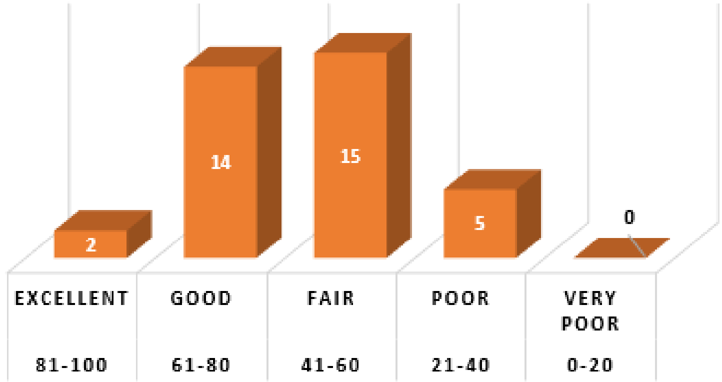

Figure 2 Frequency score of students (Experiment class)

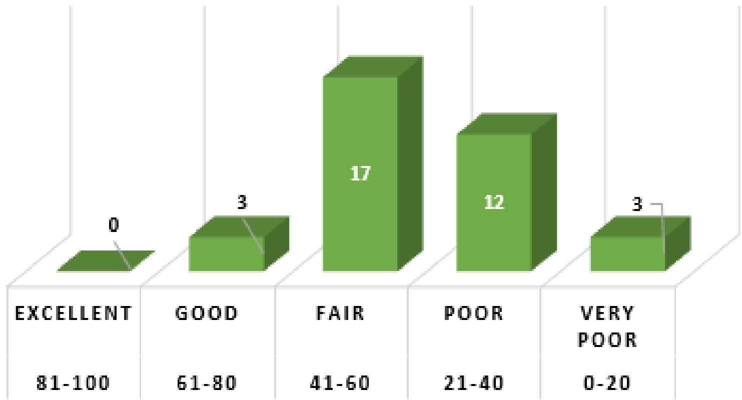

Figure 3 Frequency score of students (Control class)

Figure 3 shows 35 students in the control class who were the subjects of the study there who understood the physics formulas included in the excellent category, good category, fair category, poor category, and very poor category.

Normality testing is performed on the experimental class and the control class using the chi-square formula shown in Table 4 below. The score of students' understanding of physics formulas in the experimental class (physics learning using direct teaching models) obtained scores $\chi^2_{count} = 1{,}6862$ with scores $\chi^2_{table} = 9{,}49$, dk = 7 - 3 = 4 and significance level $\alpha = 0{,}05$. It can be concluded that the data used in the experimental class (learning physics using direct teaching models) come from populations that are normally distributed because $\chi^2_{count} < \chi^2_{table}$.

Table 4 Normality Test

Class	χ^2_{count}	χ^2_{table}
Experimental	1.6862	9.49
Control	1.4741	9.49

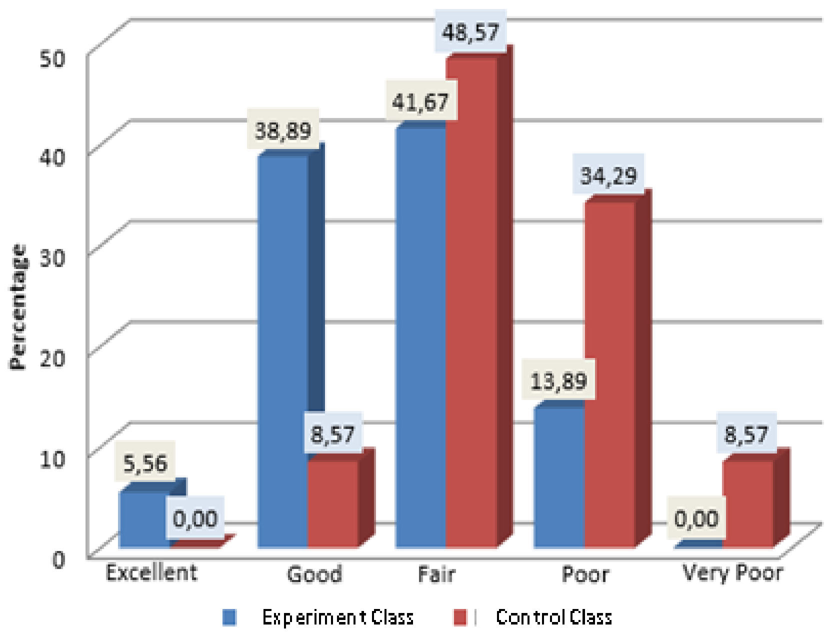

Figure 4 Percentage score of students (Experiment class and Control class)

The score of students' understanding of physics formulas in the control class (conventional physics learning) is obtained $\chi^2_{count} = 1{,}4741$ with score $\chi^2_{table} = 9.49$, dk = 7 - 3 = 4 and significance level $\alpha = 0{,}05$. So it can be concluded that the data used in the control class (conventional learning) comes from populations that are normally distributed because $\chi^2_{count} < \chi^2_{table}$.

Homogeneity testing of variance used the F-test, which compares the largest variance score with the smallest variance. From the calculation results obtained with the price of F_{count} = 1.151 while the price of F_{table} = 1.74 with the numerator dk (36-1 = 35) and the denominator dk (35-1 = 34) with $\alpha = 0.05$. Because the value of $F_{count} < F_{table}$ (1.151 <1.74), it can be stated that the variance of the two data groups is homogeneous. In this study, the hypothesis testing used the t-test. The hypothesis to be tested is:

Ha : There is a significant difference between the understanding of the physics formulas of students being taught with the direct teaching model and those which taught by conventional learning model

Ho : There is no significant difference between the understanding of the physics formulas of students being taught classrooms with direct teaching models and those which taught by conventional learning model

The hypothesis testing criteria is Ha is accepted if $t_{table} < t_{count} > t_{table}$. Ho is accepted if $t_{table} < t_{count} < t_{table,}$ then with a significant level $\alpha = 0.05$.

Based on the results of testing the research hypothesis using the t-test, a t_{count} value of 4.512 was obtained while the t_{table} value at the significance level α = 0.05 was 2.00. From the results of the analysis it can be seen that the value $t_{table} < t_{count}$ >

t_{table} (-2.00 < 4,512 > 2.00). Thus, it can be concluded that Ha (Ha: μo ≠ μi) is accepted and Ho is rejected.

The average score of understanding the physics formulas of the experimental group students (learning physics using the direct teaching model) obtained an average population score of 55<μ<64. This shows that the treatment of the experimental class through direct teaching models in the population obtained an average population score in the range of 55 to 64.

The average score of the control group students' physics learning outcomes (conventional physics learning) obtained an average population of 40 <μ< 48. This shows that the treatment of the control class through learning conventionally obtained an average value in the population in the range of 40 to 48.

In testing the hypothesis using the t-test shows the hypothesis Ho is rejected, and hypothesis Ha is accepted. It can be said that there is a significant difference between the understanding of the physics formulas of students taught through direct teaching models compared to students taught through conventional learning.

This effect can be seen in the score of understanding the physics formulas of each class, where the average score ($\bar{x}$) in the experimental class (direct teaching model) is higher than the control class (conventional learning model). The experimental class (direct teaching model) has a higher standard deviation than the control class (conventional model). It shows that the class taught by the direct teaching model has a higher deviation than the class taught by conventional learning model (Hadijah et al., 2016; Haryandi et al., 2013; Hikmawati, 2009; Kamsinah et al., 2016; Nisa et al., 2014).

Figure 5 Teacher engage students (experiment class) to be active in learning process

The teacher encourages students to practice what they have been taught by providing exercises so that students are directly involved in solving practice questions. When practicum activities, students are given intensive guidance in each group and given questions to connect the physics formulas, they learn with the phenomena found in students' daily lives. This treatment makes students motivated and understands physics formulas well.

The difference in understanding physics formulas in control and experimental classes is inseparable from the implementation of learning in the classroom. In the experimental class with a direct teaching model, students are invited to get accustomed to gaining procedural knowledge, because this teaching model rests on the principles of behavioral psychology and social learning theory, specifically about modeling (Amrita et al., 2016). Students can capture and interpret physics formulas that are taught through modeling or experiment (Atqiya et al., 2016).

Students listen more to the teacher's explanation and then only given practice at the end of the lesson in the control class. The material is presented just like that, so students sit down and memorize notes (Herman et al., 2014). This is what makes students lose interest in learning. The impact of understanding students' physics formulas is relatively low (Norhasanah et al., 2013; Normaliani et al., 2013).

Based on the results of data analysis, it can be said that the level of understanding of students 'physics formulas provides quantitative information about students' understanding of teaching material after the learning process. This indicates that the cognitive aspect provides a role in achieving an understanding of students' physics formulas after being taught through direct teaching models (Orrahmah et al., 2016; Pratiwi et al., 2019; Refiana et al., 2016).

Based on this, it is found that the average score of understanding students' physics formulas after being taught through the direct teaching model is in the medium category, while students who are taught conventionally get an average score in the low category.

CONCLUSION

The ability to understand the physics formulas of high school students being taught through learning direct learning models is better than those taught by conventional learning models, which can engage students in getting accustomed to gaining procedural knowledge. The direct teaching model rests on the principles of cognitive theory and social learning theory, specifically about modeling. Also, students can capture and interpret physics formulas that are taught through modeling or experiment.

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