



**THE EFFECT OF PHET-COLORADO ASSISTED PROBLEM BASED LEARNING
LEARNING MODEL ON LEARNING OUTCOMES AND PROBLEM SOLVING
DYNAMIC ELECTRICAL MATERIALS IN JUNIOR HIGH SCHOOLS**

Mona Mahyuny H¹⁾, Wasis Wuyung W., B.²⁾, and Roma S³⁾

¹⁾Department of Science Education Universitas Negeri Medan, Indonesia

Department of Biology Education Universitas Negeri Medan, Indonesia

Science Education Teacher of 3th Junior High School Medan, Indonesia

Monamahyuny16@gmail.com

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Abstract

This study aims to determine the effect of applying the PhET-Colorado-assisted problem-based learning (PBL) learning model on the learning outcomes and problem solving of junior high school students in class IX on Dynamic Electricity. The study was conducted using experimental quasi pretest-posttest in one of the country's junior high schools on the ground. Sample taking technique using purposive sampling. The research sample consisted of two classes each consisting of 32 students, class IX-J was an experimental class that applied the PhET-Colorado-assisted problem-based learning (PBL) model and class IX-D was a control class that applied study conventional. The research instrument used was a multiple-choice test with 4 answer choices to measure cognitive learning outcomes and description tests for students' problem-solving tests on dynamic material. The average pretest and posttest data on learning outcomes in the experimental class were 49.37 and 80.31, while those in the control class were 51.09 and 66.40, respectively. The average pretest and posttest data on student problem solving in the experimental class were 35.31 and 72.12, while in the control class they were 36 and 66.40, respectively. Data were analyzed using the Manova test (multivariate analysis of variance). Based on the hypothesis test, there are significant differences in learning outcomes and problem solving with the application of the PhET-Colorado-assisted Problem Based Learning (PBL) model on science material in junior high schools, so that there is an effect of the PhET-Colorado-assisted Problem Based Learning (PBL) model on learning outcomes and solving student problems. The percentage increase in N-gain learning outcomes in the experimental class was 62.09 in the medium category and the control class was 30.48 with the medium category, and problem solving in the experimental class was 56.90 with the medium category and the control class was 22 with the low category.

Keywords: Problem Based Learning, PhET-Colorado, learning outcomes, Problem Solving

Introduction

Science is one of the subjects for junior high school students showing the results of activities in the form of knowledge, which discusses nature and is obtained from a series of experiences through the scientific process. Science learning is not maximized if you only know a product but must be able to understand how the process of making the product is and with that it can be known that the development of students' scientific attitudes in science lessons contains dynamic electricity material (Prihatiningtyas et al., 2013).

Results of an interview with a science teacher who teaches at 3th Junior High School Medan, he said that the science learning outcomes of students at the school were still relatively low or many students had not reached the Minimum Completeness Criteria (KKM) as seen from the student's test scores, where the KKM at the school was 75. The inability of students to work on problems that are problem-solving leads to critical thinking in science makes student scores unsatisfactory, in science learning students' ability to solve problems is still relatively low, it is proven when working on questions students tend to directly use mathematical equations without analyzing, guess the formula and memorize the example questions. Students are able to work on simple questions, questions that are only solved through formulas, but when faced with more complex problems students cannot solve the problem. Support in research identifying the problem, that is (33.25%), the describing the problem is (35%), stage of planning a solution is (65%), Implementing problem solving solutions namely (50%) and indicators Carry out evaluation by (64.50%). Based on the results of the average score of the five stages, the lowest average score for students' science problem solving abilities is in the problem identification stage.

Teacher-centered learning so that students feel bored and cannot understand the concepts taught by the teacher, as well as the lack of learning by using practicum or simulation. supported by the results of the author's interviews with students at the school that during their learning they rarely do practicum or simulation, the teacher in question also said that not doing practicum was constrained by the too short learning time, students said that science was difficult and less interesting because according to science students, it cannot be separated from the formula that must be memorized, this causes

students to be less able to solve problems because they are required to always memorize the formula but do not understand the formula, with the implementation of Limited Face-to-Face Meetings (PTMT) in the school, there will be learning adjustments that are initially online and back to face-to-face learning so that innovative models and media are needed to improve student learning outcomes.

Learning is not only seen as an interaction between what students learn with concepts that have been previously owned, but is based on the acceptance and understanding of a new idea that is understandable and rational, therefore we need a teaching model that is able to facilitate the student learning process. including the problem-based learning model, in this model students learn not only concepts related to problems but scientific methods to solve these problems so that they can produce higher-order thinking patterns. (Ngalimun, 2013).

Problem-based learning model is a model designed to help students develop academic skills, think and solve problems through simulation (Arends, 2012). Problem based learning (PBL) in science lessons on dynamic electricity is very necessary because it requires experiments and guides students to think critically so that students will easily understand dynamic electricity. The researcher offers a solution to this problem by using the PBL model on dynamic electrical materials at 3th Junior High School Medan. Andini (2016) suggested the effect of PBL learning on science learning outcomes for fourth grade elementary school students in Rendang District, there were differences in the application of the PBL model affecting science learning outcomes compared to conventional learning. PBL is a learning model that utilizes life problems as something that students learn to train and improve critical thinking, reasoning, and problem-solving skills and gain new knowledge from problems (Suratno et al., 2020).

The PBL model is an innovative learning that creates an active learning situation for students so that students' activities and science learning outcomes become better and increase. Amin (2017) in his research on the The PBL model proves that the learning outcomes of students taught by the PBL model are better than those taught by conventional methods. Evidenced by Zabit (2010) states that the use of the PBL model is used because it improves students' thinking skills in finding their own solutions to each problem discussed by students.

PhET simulation shows the relationship between real-life phenomena and the underlying science, supports interactive and constructivist learning, provides feedback, and serves as a creative workspace (Finkelstein, 2006). PhET simulation that researchers will use is ohm's law, electrical circuits, and energy changes. The advantages of PhET simulation are that it can make it easier for students to find data and the relationship between current, resistance and voltage formulas, PhET simulations make it easier for students to visualize concepts that exist in direct practicums so that they can understand and solve broader problems than problems solved during practicum. The way that can be done to improve the science learning process from these problems is to use the PhET-Colorado-assisted PBL learning model.

Student learning outcomes with the PhET-Colorado-assisted problem-based learning model on Newton's law material have increased (Gusniar, 2019). PhET-assisted problem-based learning model has an effect on student physics learning outcomes (Jauhari, 2017). The PBL model can hone students' thinking skills in solving real problems (Baber et al., 2015).

Research on the effect of PBL was conducted by Alpindo (2014) in this study used 2 groups, the first group receiving treatment using the PBL model and the second group using conventional learning and media. This study shows that the learning outcomes of students who are taught using the PBL method are better than students who are taught using the conventional method.

The solution that can be done by science teachers to overcome this problem is to apply a PhET-Colorado-assisted problem-based learning learning model. Dynamic Electrical Materials in Junior High School". The purpose of this study was to determine the effect on student learning outcomes and problem solving on dynamic electrical materials using the PhET-Colorado-assisted PBL learning model and to determine the improvement of student learning outcomes. and problem solving taught with the PhET-Colorado-assisted PBL learning model.

Research Method

The design in this study was a two-group pretest-posttest design, applied in two classes, namely the experimental class and the control

class.

Table 1 Research Design two group pretest-posttest

Class	Pre-test	Treatment	Post-test
Eksperiment	T ₁	X ₁	T ₂
control	T ₁	X ₂	T ₂

Description:

T₁ : Pretest learning outcomes and problem solving

T₂ : Post-test learning outcomes and problem solving

X₁ : PhET-assisted problem-based learning model

X₂ : Conventional learning

This study was conducted at 3th Junior High School Medan. The research sampling technique used is purposive sampling. The selected class samples were class IX-J and class IX-D each with 32 students.

The data collection method used is a multiple-choice with 4 options to measure student learning outcomes while an essay test is to measure student problem solving. Before the test was tested on students, the instrument was validated by expert lecturers with construct validity, after that the prediction was validated, the questions were given to students who were not the research sample and then analyzed to see the validation of the questions, reliability, level of difficulty and discriminating power of the questions. Meanwhile, for data analysis using manova test (to determine the effect of the PhET-Colorado-assisted problem-based learning (PBL) learning model on student learning outcomes and problem solving), and the N-gain test (to determine how much the increase in student learning outcomes). pretest-posttest).

Results and Discussion

Results

Based on the results of the analysis test stating that the validation of the instrument test that has been carried out by expert lecturers, to test aspects of each indicator of learning outcomes and problem-solving tests, the results obtained are the feasibility of being used after revisions are made to match the

dynamic electricity material, the results of forecast validation also show validity. questions, learning outcomes test questions from 30 questions there are 20 valid questions, for the problem-solving test 8 questions there are 5 valid questions. Based on the calculations, the results of the reliability test of learning outcomes were 0.895 and the reliability results of the problem-solving test were 1.00. Of the 30 learning outcomes test questions, there are 21 easy category questions, 8 medium category questions, 1 difficult category question, and from 8 problem solving test questions there are 4 medium category questions and 4 difficult category questions. Of the 30 multiple choice test questions, there are 3 questions in the very good category, 16 questions in the good category, 3 questions in the sufficient category, and 7 questions in the bad category. And from the 8 problem-solving test questions, there are 5 questions in the very good category, 2 questions in the sufficient category, and 1 question in the bad category. From the results of the forecast validation, the instruments used were 20 multiple choice questions and 5 essay questions.

Student learning outcomes were measured by giving a test of 20 multiple choice questions and 5 essay questions for problem solving tests. The recapitulation of pretest and posttest data on learning outcomes in the control class can be shown in Table 2 and the experimental class is shown in Table 3 below.

Table 2. Pretest and Posttest Data on

Component	Pre-test	Posttest
Number of students (n)	32	32
The highest score	75	85
Lowest value	20	45
Average (mean)	51,09	66,40
Standard deviation(s)	14,52	9,09

Learning Outcomes for Control Class.

Table 3. Pretest and Posttest Data on Experimental Class Learning Outcomes

Component	Pre-test	Posttest
Number of students (n)	32	32
The highest score	75	95
Lowest value	20	65
Average (mean)	51,09	80,31
Standard deviation(s)	14,52	8,41

Based on the results of the normality test and the homogeneity test of the data, it was found that the two samples were normally distributed and had homogeneous variance. The hypothesis test of the pretest data in this study used the average pretest similarity test using the Manova test. Manova test using SPSS 20.0.

The recapitulation of pretest and posttest problem solving data in the control class can be shown in Table 4 and the experimental class is shown in Table 5 below.

Table 4. Summary of Manova Test Calculations Learning Outcomes and Problem Solving

Effect	Value	F	Hypothesis	Error df	Sig.
<i>Pillai's Trace</i>	0,432	23,205 ^b	2,000	61,000	0,000
<i>Wilks' Lambda</i>	0,568	23,205 ^b	2,000	61,000	0,000
<i>Hotelling's Trace</i>	0,761	23,205 ^b	2,000	61,000	0,000
<i>Roy's Largest Root</i>	0,761	23,205 ^b	2,000	61,000	0,000

Table 5. Test Results Between Subject Effects on Learning Outcomes and Problem Solving

Source	Dependent Variabel	Df	Mean Square	Sig
Kelas	Hasil Belajar	1	4016,391	,000
	Pemecahan Masalah	1	1072,563	,000

Based on table 4 shows the class effect has a significant value of 0.00. Significant value $0.00 > 0.05$ which means H_a is accepted, H_0 is rejected. It can be concluded that there is a significant effect of the PhET-Colorado-assisted problem-based learning model on student learning outcomes and problem solving in the dynamic electricity material for class IX semester I at 3th Junior High School Medan Academic Years 2021/2022.

Based on the data in table 5 shows that there is an effect of the PhET-Colorado-assisted problem based learning model on the learning outcomes and problem solving of class IX students of 3th Junior High School Medan. Table 5 shows the Source class, the significant value of the experimental class and control class for learning outcomes is 0.000 and the significant value of the experimental class and control class for problem solving is 0.000. Because the significant value of learning outcomes and problem solving from table 4.10 < 0.05 , it can be concluded that H_0 is rejected. H_0 is rejected, then there is a significant effect of the problem based learning model assisted by PhET-Colorado on student learning outcomes and problem solving in dynamic electricity class IX semester I at 3th Junior High School Medan Academic Year 2021/2022.

The mean values of pretest and posttest of learning outcomes in the control class were 51.09 and 66.40 (Table 2) and in the experimental class were 49.37 and 80.31 (Table 3). Analysis of the percentage increase in N-gain learning outcomes based on the pretest and posttest scores that have been obtained and is presented in Table 6.

Table 6. N-gain Learning Outcomes

No	Class	Average Pretest	Average Posttest	N-gain (%)	Categori
1.	Control	51,09	66,40	30,48	Medium
2.	Eksperiment	49,37	80,31	62,09	Medium

The N-gain of the experimental class is 62.09% and the control class is 30.48%, respectively, in the medium category. Each question consists of 6 indicators of learning outcomes.

Table 7. N-gain Solution to Problem

No	Class	Average Pretest	Average Posttest	N-gain (%)	Categori
1.	Control	36	50,56	22	Low
2.	Eksperiment	35,31	72,12	56,90	Medium

The N-gain of the experimental class is 56.90% and the control class is 22%, the experimental class has a medium category while the control class has a low category. Each question consists of 5 problem solving indicators.

Discussions

The hypothesis tested in this study is that the PhET-assisted PBL model has an influence on student learning outcomes and problem solving on dynamic electrical materials. Based on statistical data, it can be concluded that there is an effect of applying the problem based learning model assisted by PhET-Colorado on student learning outcomes and problem solving on dynamic electricity material. This is supported by the results of Ariani's research, (2020) which states that the use of the problem based learning model can have a positive impact on learning in the classroom, students are motivated during learning so that student learning outcomes are better. The second phase is organizing students to learn, in this phase organizing students in study groups, the researcher divides students into 3 groups, each group consisting of 4-5 people and researchers also distribute problem-based worksheets, and guide students to understand problem solving through LKPD.

The information sought is related to dynamic electrical material that supports the problem solving process, students also find concepts by using PhET to make it easier to understand the material, in this phase students begin to be trained to learn on their own so that learning is student-oriented. In this phase, students in each group begin to describe the facts on the problem in dynamic electricity concepts and occasionally ask questions for students who do not understand, for example by asking again the problem of sparks in the socket. Students in groups begin to organize and divide tasks during the investigation so as not to spend a long time, and identify the existing work steps they will do together to be able to solve the problems contained in the LKPD, this is in accordance with the research of Fitriani, et al. (2019) which says that the problem-based learning model can improve student collaboration skills with learning activities carried out in groups by working on LKPD creating an atmosphere of discussion and collaboration between group members. The third phase is guiding the investigation, the researcher facilitates and guides students in completing the LKPD in groups and facilitates each group in the problem solving process.

Students also analyze the arguments to decide which problem-solving ideas will be made. This is supported by the research of Utomo, et. al (2020) which states that the application of problem based learning (PBL) learning models can influence critical thinking skills better. After students feel sufficient for the information and ideas collected, then in this investigation phase students do a simple practicum using a practicum kit that has been prepared by the researcher in which there is an arrangement of circuits along with led lights then students assemble the kit according to the directions on the LKPD and look for In solving the problems presented in the LKPD, students carry out a problem solving process with predetermined steps in each group using the concept of dynamic electricity. This is supported by Susanto's research (2019) which states that during the learning process using the PBL model assisted by PhET students can develop thinking, problem solving and intellectual abilities through real activities carried out by students.

Before showing the work of each group, the teacher directs students to use PhET

simulations to see the speed and direction of the current from the experiments carried out, by using PhET students will become more aware of what has been practiced previously. This is supported by research by Salame & Makki (2021).) which stated that the interactiveness of the PhET simulation had a positive impact on students' attitudes and perceptions during learning, and that the PhET simulation developed students' skills to improve.

Based on the N-gain test, the percentage increase in the N-gain of student learning outcomes in the experimental class was 62.09 n in the control class was 30.48%, the increase in student problem solving was higher in the experimental class than the control class. This is supported by the results of research by Siboro, et al (2021) which states that with the help of PhET can improve intellectual skills in real experiences and simulations. Based on the results of the study, it was shown that students who were taught with the PhET-Colorado-assisted problem based learning model had higher learning outcomes compared to conventional learning. With the help of PhET, it can reduce students' misconceptions about science concepts so as to improve student learning outcomes. This is supported by research by Ramnarain & Moosa (2017) which states that the use of simulations in science education can reduce the number of misconceptions students have.

Based on the results of the study, it showed that students who were taught with the PhET-Colorado-assisted problem based learning model had a higher problem solving improvement than conventional learning. This is supported by Larasati (2019), Siregar and Wahyuni (2016), and Putri, et al (2020) which state that problem-based learning can improve problem solving skills. Conventional learning has three phases, namely introduction, core and closing in the core phase the teacher asks students questions about this material can improve student learning outcomes, it can be seen from the results of the N-gain test which increased by 30.48%, then the teacher gives practice questions to students. This can slightly improve students' problem solving as seen from the results of the N-gain test which increased by 22%.

The advantage of this research is the use of PhET-assisted PBL model which encourages students to build knowledge collaboratively in groups, this can develop students' cognitive through interaction between students. Another advantage of this research is the use of problem-based worksheets with the help of PhET which can make learning more interactive.

Conclusion

The results of the research and discussion concluded that the results showed that the PBL model assisted by PhET had a significant influence on student learning outcomes and problem solving in class IX electricity material at 3th Junior High School5 Medan TP 2021/2022 and increased N-gain learning outcomes in class and experimental control classes, respectively. -each in the medium category. The increase in problem solving N-gain in the experimental class is in the medium category and the control class is in the low category.

Based on the results and conclusions that have been put forward, the researchers provide suggestions: For further researchers who want to examine the PhET-Colorado-assisted problem-based learning model more deeply in order to use time efficiently in order to achieve effective results and to be more careful in compiling the test instrument used and presenting questions that support the problem of base learning and are often encountered in everyday life, in order to get a more satisfactory increase in N-gain, it is necessary to be careful in compiling and using the instrument and the use of PhET simulation assistance can be done on In the investigation phase in the problem based learning model, it is better to use other technological media and look for problems that can be understood by students.

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