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The Influence of the Problem Based Learning (PBL) Learning Model Assisted by PhET Simulation Media to Increase HOTS of Class 6 Elementary School Students in Electrical Circuits

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Abstract: The research aims to examine the influence of the PBL Model assisted by PhET Simulation on students' HOTS. The research was carried out at SDN 2 Gantung on class VI students. The sampling technique uses a purposive area sampling method. The research used a quasi-experimental design with data collection techniques through post-tests in the form of multiple choice questions and descriptions, observation, documentation and interviews. The data obtained was analyzed using statistical tests which included normality tests, data analysis using Paired Samples t-Test. Based the validity test, the results show r = 0.81>α (0.05) and the reliability value α> 0.738, the value is valid and reliable. Then results of the normality test value of learning outcomes are 0.416>α (0.05) which exceeds the significant value, so The variable values are normally distributed, followed by using the Paired Samples t-Test, the results of the t-test are learning results at a sig value of 0.00 < α (0.05), then reject H0. So it can be concluded that there is an influence of the Problem Based Learning (PBL) learning model assisted by PhET Simulation on HOTS of 6th grade elementary school students on electrical circuit material.

Keywords: Circuits; Electrical; HOTS; PBL; PhET simulation

Introduction

High level thinking (HOTS), especially elementary school. students, should be used to it because it can make things easier and help students when taking part in learning at the next level of education. Training students to think at a higher level aims to familiarize students with making decisions and providing correct problem solutions. High Older Thinking Skills (HOTS) is the use of the mind in a broader way to obtain new challenges. HOTS is also defined as the ability to connect, manipulate and transform knowledge and experience (Rofiah et al., 2013). HOTS is classified as a comprehension skill and is able to identify necessary and unnecessary material. If related to Bloom's revised HOTS taxonomy, it includes analysis (C4), evaluation (C5), creating or creativity (C6). The HOTS problem from previous research conducted by Aspini (2020) that students still have difficulty understanding the questions, students are not yet skilled in doing new things that have not been demonstrated by the teacher, and the initial value students in working on HOTS questions (analysis question category) with a class average score of 63.89. Apart from that, the problem related to HOTS ability in research conducted by (Kiromiah et al., 2021) Gugus VIII Elementary School, Sukasada sub-district was that 50 students whose grades were incomplete reached 50 people or 52% of the total number of students of 96 students. This affects students' HOTS abilities during the science learning process. The low HOTS ability of students is due to the fact that the delivery of theories tends to be direct and students become passive in participating in learning.

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Based on the results of observations made at SDN 2 Gantung, the same problem was found in HOTS in class VI. In science learning, especially electricity material, creative and innovative learning models should be applied. The use of inappropriate learning models and media, especially in electrical material, has a significant impact on the process of learning activities. The learning model used is still teacher-centered, causing students to become passive and less able to trigger students to think at a higher level in understanding electrical material. Apart from that, learning media also plays an important role because it can attract students' interest in learning and can help students create the process of making electrical circuits using high-level thinking.

HOTS skills training can be given to elementary school students, especially those in high grades. Grade VI elementary school students are able to have a critical and thorough mindset in solving real problems. However, SDN 2 Gantung class students are still rarely given HOTS skills training. Therefore, students still experience difficulties in analyzing and evaluating questions related to electricity. Based on test results related to the HOTS abilities of class VI students in elementary school, it shows that the number of students who did not complete was 57% out of 22 students. From the test results, it can be seen that the HOTS abilities of class VI students at SDN 2 Gantung Elementary School are still relatively low.

From the problems encountered at SDN 2 Gantung Elementary School, the solution that can be taken to improve HOTS thinking skills in class VI students at SDN 2 Gantung is to apply the Problem Based Learning (PBL) model assisted by the PhET application. The Problem Based Learning (PBL) model is a learning model that challenges students, working in groups to find solutions to real world problems. Problems are given to students before students learn the concept or material relating to the problem that must be solved, thereby triggering curiosity about the learning in question (Syawaly et al., 2020). The Problem Based Learning model is a learning model that is ideally applied in science learning. Through a fairly broad science topic and the design of assignments or sub-topics that lead to scientific method activities, it is hoped that students and their groups can contribute to each other based on daily experiences. The syntax of Problem Based Learning according to Riadi (2016) isorienting students towards a problem, orienting students to learn, guiding individual or group investigations, develop and present work results, analyze and evaluate problem solving.

Apart from using innovative learning models, it should also be supported by the use of learning media. One learning media that can be used is the PhET application media. PhET simulations emphasize the relationship between real-life phenomena and the underlying science, support interactive and constructivist approaches, provide feedback, and provide a creative workplace (Perkins et al., 2006). PhET simulations make learning more interesting because they can provide students with both learning and playing experiences. Learning activities using PhET simulations make students interested and enthusiastic about doing practicums, thereby completing student learning outcomes (Anjarsari et al., 2023; Saheb et al., 2018). The use of PhET simulations in learning often leads to questions that train students' higher-order thinking skills (Rizaldi et al., 2020). The PhET simulation design can be used to test students' ideas in the activity of making series and parallel electrical circuits. Apart from that, PhET simulation media also reduces misconceptions about electrical circuit material because the characteristics of PhET simulations can present phenomena that are similar in nature. Microscopic and abstract into real form rather than using props (Rosalina et al., 2020).

According to the explanation above, there are several problems encountered at SDN 2 Gantung Elementary School. The solution that can be done to improve HOTS thinking skills in class VI students at SDN 2 Gantung is to apply the Problem Based Learning (PBL) model assisted by the PhET application. The Problem Based Learning (PBL) model is a learning model that challenges students. Because with this model students can solve various problems that will be solved both individually and in groups. Apart from using innovative learning models, it should also be supported by the use of learning media. One learning media that can be used is the PhET application media. By doing virtual practicum and solving the problems that will be given, it will make students think critically so that it will increase students' HOTS.

Based on this description, the application of the Problem Based Learning (PBL) model assisted by the PhET application media in electricity material is assumed to have an influence on the HOTS of class VI elementary school students. Thus, a research will be carried out with the title The Effect of the Problem Based Learning (PBL) Learning Model Assisted by Phet Simulation on HOTS of Grade 6 Elementary School Students on Electrical Circuits.

Method

The research was carried out at SDN SDN 2 Gantung on class VI students on solar system material in the even semester of the 2022/2023 academic year. The sample selection used the purposive area sampling method, namely determining the sample based on specific criteria for the object that the researcher hoped for Marginingsih (2017). The criteria addressed are that

the sample used must be homogeneous and have recommendations from the teacher. Researchers used two classes as samples, namely the control class (X2) and the experimental class (X1). The experimental class was given learning treatment using the Problem Based Learning (PBL) model assisted by Phet Simulation, while the control class was not given learning treatment (but used conventional learning).

The quasi-experimental research design is that the researcher does not carry out randomization in determining research group subjects (Yusuf et al., 2020). The researcher used two classes as samples and the design used was a post-test only control design, where the post-test was held after learning was carried out to determine the effect of the treatment. The post-test only control design research design can be seen in Table 1.

Table 1. Post-test Only Control Design Research Design

Class	Treatment	Posttest
Experiment	X1	O1
Control	X2	O2

The data collection technique uses a multiple choice test containing 10 questions. Apart from that, observations take the form of sheets given to observers to make observations during the learning process, documentation related to photos of activities during the research, as well as interviews with science teachers at the school regarding learning activities, methods, models and media commonly used during learning. Data analysis techniques use measurement of learning outcomes, especially in the cognitive or knowledge domain. After obtaining the results, they are then categorized into the percentage of completeness in accordance with the K13 guidelines which have been adjusted to the minimum completeness criteria (KKM) at the school, namely 70. The percentage of completeness is shown in Table 2.

Table 2. Percentage of Completeness

Score	Completeness
≥ 70	Complete
< 70	Not Complete

Furthermore, the post-test results data that has been obtained will be analyzed using the paired sample t test to determine whether learning after using the PBL model assisted by Phet Simulation media has an influence on student learning outcomes or not. The data must be tested for normality first before carrying out the t-test to decide which test will be use next. Furthermore, the post-test data that has been obtained will be analyzed using the paired sample t test to determine whether or not learning after using interactive media has an influence on student learning outcomes. The data must be tested for normality first before carrying out the t-test to decide which test will be used next. The following is the research flow:

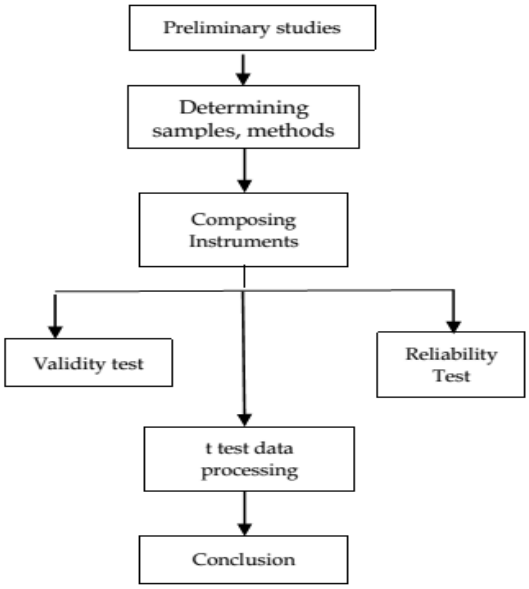

Figure 1. Research flow

Results and Discussion

The method used in this article is quantitative research. The examination model used is a pre-test and post-test using a likert scale estimate. The population in this logic work is class VI students at SDN 2 Gantung, totaling 50 students, by taking samples using a purposive examination procedure so that the number of tests is 25 students from class VI C and 25 class A. This concentration is for one purpose only class to be given inspirational treatment. Information collection uses 10 question items to measure student learning outcomes. Formed into an inspirational testing instrument that is estimated using a likert scale. This exam was directed to SDN 2 Gantung by the researchers using a purposive examination procedure. The sample used was 25 students from a student population of 25 students taken from class VI at SDN 2 Gantung. The implementation was carried out during 1 meeting. Before learning begins, a pre-test is given and after treatment, a post-test is given.

Data Processing

Descriptive Analysis the data is analyzed using SPSS, so that data that has been tabulated in Excel can be directly transferred to the t-test statistical formula. Sudjana (2013) said that to create a list of frequency distribution tables with the same class length, first carry out the following processing.

In this research, students' learning outcomes were measured before and after learning, namely Pre-test and

Post-Test. Data analysis uses descriptive analysis techniques. The results of the analysis are shown in Table 1. Measurement of student learning outcomes aims to test the effectiveness of the PBL model assisted by PhET Simulation media that has been used during learning. The measurement data were analyzed using descriptive statistics. The average pretest score for the control class was 32.36, while the average post-test score for the control class was 66.24. For the experimental class the pretest score was 34.32 while the average post-test score was 84.48 which shows an increase. So, it can be concluded that there are differences in learning outcomes before and after in the experimental class and the control class. According to the results above, the highest score was obtained in the experimental class. This means that learning using the PBL model assisted by PhET simulation media is more effective than using Power Point media.

Table 3. Descriptive Analysis

Analysis data	Minimum	Maximum	Average ($\bar{x}$)	Standard Deviation
Pre Exp	16	63	34.32	13.009
Post Exp	70	95	84.48	6.212
Pre-Con	10	57	32.36	12.315
Post Con	59	74	66.24	54.166

Validity and Reliability Test

Validity test uses the Pearson Correlation method. Question items are said to be valid if the Pearson coefficient is more than the r-table. Apart from that, it can be seen from the significance value, if the significance value is less than α (0.05) then the question item is considered valid. Following are the results of the validity test for each question item for all variables (Riduwan, 2012). The validity test is intended to find out whether the instrument used really measures what it is supposed to measure. Validity is tested through Confirmatory Factor analysis. If Rcount > 0.50 the question item is valid (Ghozali et al., 2019). Validity testing is carried out using the product moment correlation formula. The calculated r is obtained from the SPPS version 26 output results, this value is then compared with the table r value from the statistics book. Complete validity testing can be seen in Table 4 which shows that everything used to measure the items used in this research has a correlation coefficient that is greater than the r-table, where for a sample of 25 students at SDN 2 Gantung class VI B with using different classes with 10 questions, the r-table value is 0.396 with a significance level of 0.05 or 5%. The resulting calculated r-value is presented in Table 4. These results show that all of these indicators are valid. Pearson Correlation Table Question Items Description.

Based on the table above, all question items have valid items because R count >R Table. This means that the instrument is able to measure what is desired and is able to reveal the data studied accurately.

Table 4. Pre-Test Validity Test Results Critical Thinking Skills

Question Items	R_{table}	Person Correlation	Description
1	0.396	0,81	Valid
2	0.396	0,73	Valid
3	0.396	0,78	Valid
4	0.396	0,85	Valid
5	0.396	0,45	Valid
6	0.396	0,79	Valid
7	0.396	0,43	Valid
8	0.396	0,49	Valid
9	0.396	0,63	Valid
10	0.396	0,65	Valid

Table 5. Post-Test Validity Test Results for Critical Thinking Skills

Question Items	R_{tabble}	Person Correlation	Description
1	0.396	0.67	Valid
2	0.396	0.85	Valid
3	0.396	0.64	Valid
4	0.396	0.69	Valid
5	0.396	0.73	Valid
6	0.396	0,74	Valid
7	0.396	0.58	Valid
8	0.396	0.59	Valid
9	0.396	0.63	Valid
10	0.396	0.71	Valid

Based on the table above, all question items have valid items because Rcount > RTable. This means that the instrument is able to measure what is desired and is able to reveal the data studied accurately. Based on Table 5, the results of the validity test on all learning outcome variable items with a total of 10 items each show that the Pearson coefficient value is more than the r-table (0.396) and the significance value is less than α (0.05). So all question items in the questionnaire to represent all variables in this research are valid. Then proceed with the reliability test, namely the reliability or consistency or trustworthiness value of a measuring instrument. Researchers used the Cronbach's Alpha method to test the reliability value of each item from all variables. A variable is said to be reliable if it provides a Cronbach's Alpha value > 0.70. Following are the results of the reliability test.

Table 6. Pre-Test Reliability Test Results

Reliability Statistics	
Cronbach's Alpha	N of Items
.756	10

Based on Table 6, the results of the Pre-Test reliability test can be seen that the Cronbach's Alpha value for all variables is more than 0.70. So it can be concluded that all question items from all variables are reliable or consistent. Because all items for each variable are valid and reliable.

Table 7. Post-Test Reliability Test Results

Reliability Statistics	
Cronbach's Alpha	N of Items
.762	10

Based on Table 7, the results of the post-Test reliability test can be seen that the Cronbach's Alpha value for all variables is more than 0.70. So it can be concluded that all question items from all variables are reliable or consistent. Because all items for each variable are valid and reliable, the next analysis can be continued.

Normality Test

The researcher tested normality using the Shapiro Wilk test, because the sample in the study was less than 30. The hypothesis underlying the data normality test was:

H0: Data is normally distributed

H1: Data is not normally distributed

Following are the results of the normality test of the HOTS variable.

Table 8. Data Normality Test Results

Variable	Class	Shapiro Wilk test statistics	Sig Value.
Learning Results	Experiment	0,960	0.416
	Control	0,951	0.269

Based on Table 8, it shows that changes in learning outcomes have a significance value of more than α (0.05), so the decision to accept H0 is obtained. Can be concluded that learning outcome variables are normally distributed. Then the analysis can be continued using the t-test.

T-test

In this section we will review whether there are significant differences in the two tests. After applying the PBL models asistend phet simulation, the analysis uses statistical testing, namely the Paired Samples t-Test, where the aim is to compare the values of samples that are not paired with each other. Paired sample t-test t-test is used to test whether the mean of a variable is statistically significantly different when compared with the known mean value as an assumed or hypothesized value. In this study, we wanted to find out whether the average learning outcome scores were different or not.

The hypothesis in this research is:

H_0 = There is an influence of the Problem Based Learning (PBL) learning model assisted by Phet Simulation media to increase the HOTS of grade 6 elementary school students in the Electrical Circuit material.

H_1 = There is no influence of the Problem Based Learning (PBL) learning model assisted by Phet Simulation media to increase the HOTS of 6th grade elementary school students in the Electrical Circuit material.

The following are the results of the paired sample t-test t-test analysis.

Table 9. Paired Sample t-Test Result

Variable	t-statistics	Sig Value
Learning Results	17.928	0.000

Based on Table 9, the results of the t-test on learning cshow a significance value of less than 0.05, so reject H0. Based on the test results in the equal variances assumed section, it appears that the value of Sig. (2-tailed) < α is 0.001 < 0.05. So, the decision taken is to reject *H*0 and the final conclusion is that there is an influence of the Problem Based Learning model assisted by Phet simulation on students' HOTS.

Discussion

From the description of this research, researchers used pre-test and post-test learning outcomes in the experimental class and control class. The aim of learning using the PBL model assisted by phet simulation is to help train students' HOTS skills. Before researchers carry out research, researchers first validate the research instruments needed during learning. From the validator's opinions and suggestions, it can be concluded that the entire research instrument prepared by the researcher has reached the valid validation category. Then test the validation of the questions and reliability. The results of the items tested were valid and reliable. The results obtained from the data above are that there is an influence of the Problem Based Learning (PBL) learning model assisted by Phet Simulation media to increase the HOTS of grade 6 elementary school students in electrical circuits. After testing the hypothesis using the t test of 0.001. After testing the hypothesis, there is an influence between the two variables with the coefficient determination of model influence Problem Based Learning (PBL) learning assisted by Phet Simulation media to increase HOTS of 6th grade elementary school students on Electric Circuit material. Based on the results of data processing, graphic results of student learning outcomes can be seen before and after learning.

Based on figure 2, it can be seen that learning outcomes increased before using the PBL model assisted by Phet simulation. The measurement data were analyzed using descriptive statistics. The average pretest score for the control class was 32.36, while the average

post-test score for the control class was 66.24. For the experimental class the pretest score was 34.32 while the average post-test score was 84.48 which shows an increase. So, it can be concluded that there are differences in learning outcomes before and after in the experimental class and the control class. According to the results above, the highest score was obtained in the experimental class. This means that learning using the PBL model assisted by phet simulation is more effective than using conventional learning.

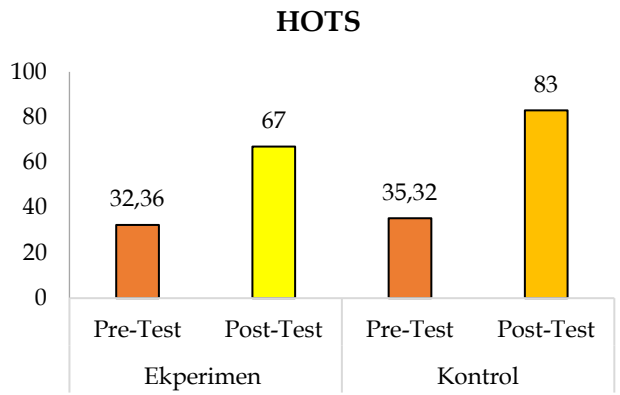

Figure 2. Learning outcomes graph (Source: Excel 2023 data processing)

So, it can be concluded that there are differences in students' HOTS before and after learning using the PBL model assisted by phet simulation. The results of the Validity Test show the results r = 0.81 < (0.05) so that everything shows valid results so from the dependability test if the value is > 0.70, the value is reliable, to be precise 0.81, from the consequences of the legitimacy test and unwavering quality, all factors are solid/predictable because everything matters for each variable.

Then a normality test was carried out before solving using the t-test, the regularity test results for the inspiration value were 0.416> value (0.05). This value shows that the independent factor is more important than the large value, so the variable value is usually adjusted. then use the t-test. Based on the test results in the equal variances assumed section, it appears that the Sig (2-tailed) < α value is 0.001 < 0.05. So, the decision taken is to reject *H*0 and the final conclusion is that there is an influence of the Problem Based Learning (PBL) learning model assisted by Phet Simulation media to increase the HOTS of 6th grade elementary school students in the Electrical Circuit material.

The conclusion is that there is a significant difference in the average HOTS score of students between the two classes. Because the score obtained by the experimental class was higher than the control class, it was concluded that learning used the Problem Based Learning (PBL) learning model assisted by Phet Simulation media to increase the HOTS of 6th grade elementary school students in the Electrical Circuit material. Based on the post-test scores and statistical test results obtained, it can be said that learning using the Problem Based Learning (PBL) learning model assisted by Phet Simulation media has proven to be efficient and has an effect on students' HOTS.

This is relevant to previous investigations (Apriani et al., 2016) which proved that there was an influence of the problematic PhET learning activity model on the physics learning outcomes of class control class (57.60). Then research Yuafi (2015) shows that there is an influence of applying a direct learning model with Physics Education Technology (PhET) Simulation learning materials on the HOTD of class X TITL students on competency standards for applying electrical circuits at SMKN 7 Surabaya. The average learning score for the experimental class is 87.58 and the average score for the control class is 79.17. The results obtained from the paired sample t test were t count experimental class -42.13 < 1.67 and t count control class -28.48 < -1.67; (2) from the results of student responses to all aspects of the questionnaire sheet, student responses were categorized as positive. Because it can be seen from all aspects in the average response of students who answered very well, 56.40%, good, 43.30%, and quite good, 0.30%. (Zahara et al. (2022) shows that activities using PhET (Physics Education Technology) can improve students' physics learning outcomes because learning using PhET media can involve students in learning activities that require higher cognitive skills, Diani et al. (2019) shows the results Student learning taught using the demonstration method assisted by PhET software animation media is better than student learning outcomes using conventional methods, Jauhari (2016) showed that the increase in the average score of the experimental class with the problem-based learning model assisted by PhET media was greater than the increase in the average score of the control class with the conventional learning model. According to Nyoman et al. (2021) the advantages of the PBL learning model are that students are trained to have problem solving abilities in everyday life and are able to build their knowledge through learning activities so that student learning outcomes increase.

By using the PBL model assisted by phet simulation, students become more active in asking, answering and solving problems shown in the animated video. Even though they both follow in learning, it can be seen from the student learning results (post-test) obtained by the experimental class which was given learning treatment using the PBL model assisted by phet simulation, which got a much higher score when compared to the control class which only used

conventional learning normal. This is because students are more enthusiastic about participating in learning because of the use of the PBL model assisted by Phet simulation which makes them feel more interested.

Conclusion

Based on the results of the research and data processing that has been carried out, it can be concluded that there is an influence of the Problem Based Learning (PBL) learning model assisted by Phet Simulation media to increase the HOTS of grade 6 elementary school students in the Electrical Circuit material. Based on the test results in the equal variances assumed section, it appears that the value of Sig. (2-tailed) < α is 0.001 < 0.05. So, the decision taken is to reject $H0$ and the final conclusion is that there is an influence of the Problem Based Learning (PBL) learning model assisted by Phet Simulation media to increase the HOTS of grade 6 elementary school students in the Electrical Circuit material.

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Author Contributions
Hafizah Isbah, Conceptualized the research ide, designed of methodology, analyzed data, management and coordination responsibility. Banu, Literatur review and provided critical feedback the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest. The funders had no role in the design of the study.

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