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Application of the PDEODE Learning Model Assisted by PhET Simulation to Improve the Cognitive Learning Outcomes of Physics Science for Class VIII Students

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A B S T R A C T

Based on the results of a needs analysis conducted by researchers on class VIII students at SMP Negeri 8 Pekanbaru regarding their perceptions of science learning at school, it is known that almost all class VIII students do not understand science lessons. This is due to the use of conventional teaching methods without the help of learning media. One of the facilities that is available and can be used is PhET Simulation. This research aims to determine the cognitive learning outcomes of physics science for class VIII students through the application of the PDEODE learning model assisted by PhET Simulation. This research uses a quantitative approach using experimental methods. The population of this research was class VIII students at SMP Negeri 8 Pekanbaru. Instruments and data collection techniques include posttest. Data analysis includes descriptive analysis with a focus on average student cognitive learning outcomes, as well as inferential analysis through normality tests, homogeneity tests, and hypothesis tests. The research results show that the application of the PDEODE learning model with the support of PhET Simulation causes an increase in students' cognitive learning outcomes in physics subjects.

1. Introduction

Education is considered a universal priority and is agreed upon in all countries. The quality of a nation's education is an important determinant in measuring its level of progress. In other words, the level of progress of a country is reflected in the superiority of the education system it implements. If the quality of education is low, this can cause the country to be underdeveloped and left behind (Kurniawati, 2022). The rapid development of Science and Technology (IPTEK) demands appropriate education. In accordance with Law No. 20 of 2003, students are

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expected to actively develop religious spiritual strength, self-control, personality, intelligence, good morals and skills that are beneficial to themselves, society and the country. Therefore, education is an important effort that is planned to create an effective learning environment for the smooth running of the learning process (Qolbi & Hamami, 2021).

Physics science education subjects have great potential to directly support the formation of student characteristics that are in line with national character. The characteristics of physics science education are actually similar to other subjects, because both aim to develop students' cognitive, affective and psychomotor abilities. The main difference lies in the emphasis on developing affective aspects which are the focus in science education (Harefa et al., 2020). Studying science involves more than just memorizing information, concepts, or principles, but is a process of exploration (Saridewiet et al., 2017). In addition, most teachers still use old methods, there is no flexibility in their teaching, and learning resources are rarely used. Teachers do not use learning models that encourage student participation, which makes learning seem passive, prevents students from wanting to learn, does not help students' attitudes grow during the process, and makes students reluctant to speak up and ask questions (Sudana et al., 2017). Teachers need to explore their creativity to apply various learning models in their teaching process in order to overcome these challenges.

Incompatibility in choosing learning models and media can cause low student learning achievement due to a lack of understanding of science conceptsThe success of learning hinges on how well the subject is crafted, rather than the tools employed to present it. Meanwhile, educators must be able to plan effective learning which is strengthened by the use of media and models that are appropriate to the subject matter (Gay et al., 2022). One of the materials in science learning that requires an understanding of concepts is material regarding vibrations and waves.

The results of observations at SMP Negeri 8 Pekanbaru showed that the average daily test scores, especially on vibration and wave material for class VIII, which consisted of 74 students, showed that many students scored below the KKM. Data from class VIII.C, totaling 37 students, shows that only 2 students succeeded in achieving completion, while 35 other students did not achieve completion. Meanwhile, class VIII.E, which also consisted of 37 students, showed that 11 students succeeded in achieving completion, while 26 other students did not achieve completion. From this information, it appears that students' cognitive learning abilities are still not optimal and they are less skilled in applying learning in real situations. Science subject teachers, especially in class VIII at SMP Negeri 8 Pekanbaru, do not encourage all students to play an active role and take responsibility for the material in progress when implementing learning in group discussions. Group discussions were not optimal due to the lack of interest in the learning carried out due to the lack of complete tools and materials and the science laboratory was rarely used for direct learning. The impact can be seen on students' cognitive learning outcomes.

Overcoming the various problems faced, it is necessary to apply an effective learning model to improve students' physics cognitive science learning outcomes. One of the suggested models is the PDEODE learning model. The learning model is a teaching strategy that includes learning objectives, learning activity steps, learning environment, and classroom management. The PDEODE learning model is an approach that can improve students' achievement of cognitive learning outcomes, especially in science and physics lessons, bringing learning outcomes to a more optimal level (Wijaya & Arismunandar, 2018).

The PDEODE learning model is a learning approach rooted in constructivism, where students are encouraged to build new knowledge through understanding the phenomena around them, apart from the knowledge they already have. This model emphasizes students' active participation in the learning process, which means students are directly involved in constructing their own knowledge, which allows them to expand and develop their own knowledge. At this stage, students are able to reason conceptually and logically using proportions and assumptions. They can also draw conclusions and use those conclusions to guide their judgment. Teachers encourage student learning activities during this time by acting as facilitators. Teachers accompany, guide and lead their students in interacting with the outside world and everyday life (Ma'rifah et al., 2019). The PDEODE learning model consists of six syntactic steps in the learning process, namely predict, discuss, explain, observe, discuss, and explain.

Activities in laboratories that have adequate facilities and infrastructure will ensure that operations run smoothly. Even so, schools still need a lot of supporting facilities and infrastructure. Therefore, steps have been taken to facilitate learning activities, such as using virtual labs. Physics Education Technology simulation media or known as PhET is an interesting example of a virtual lab that utilizes physics concepts in the physics science learning process (Zainuri et al., 2022). PhET Simulation is an example of a virtual lab that supports students in learning science (Muzana et al., 2021).

Students can relate real-life phenomena to their underlying scientific principles through the use of PhET Simulation. Because this application can be used in the classroom, it can increase students' motivation and encouragement to understand science (Ramadani & Nana, 2020). This learning media can simulate abstract concepts, making it easier for students to understand these concepts. Apart from that, PhET Simulation is an interactive and interesting learning media that allows students to explore the material (Nurdini et al., 2022). It is hoped that the combination of the PDEODE and PhET Simulation learning models can improve understanding of physics science concepts to make students better.

This study seeks to depict the cognitive learning achievements of students in physics, specifically concerning vibration and wave concepts, through the implementation of the PDEODE learning model supplemented by PhET Simulation. Additionally, it aims to ascertain disparities in students' cognitive learning outcomes in the mentioned physics subjects following the utilization of the PDEODE learning model along with PhET Simulation.

2. Methodology

This research uses a Quasi-Experimental approach using a Nonequivalent Posttest Only Control Group Design to determine differences in student cognitive learning outcomes between the control and experimental classes. The experimental group applied the PDEODE learning model with the help of PhET Simulation, while the control group followed conventional learning methods. Both groups underwent identical posttests, featuring identical question formats, time limits, and number of questions. The Nonequivalent Posttest Only Control Group Design can be seen in Table 1.

Table 1. Research Design

Class	**Treatment**	***Posttest***
Experimental Group	X	O_1
Control Group	-	O_2

(Sugiyono,2017)

Information:
X_1 = Treatment Using the PDEODE (Predict Discuss Explain Observe Discuss Explain) model assisted by PhET Simulation
O_1 = Posttest scores in the experimental class
O_2 = Posttest scores in the control class

Before conducting research, normality and homogeneity tests are carried out first on previous replicate data (work, energy and simple planes) to ensure that the prerequisites must be met. After testing was carried out, it was discovered that the data distribution was normal and homogeneous. The experimental and control classes were carried out using simple random sampling techniques, using the lottery method. So the result was that class VIII.C with 37 students was selected as the experimental class, while 37 students in class VIII.E were selected as the control class. Data obtained from research results are analyzed through data processing processes. Posttest data is processed in data analysis. In this research, the data analysis techniques used include inferential analysis and descriptive analysis.

3. Results and Discussion

This study employs descriptive analysis to elucidate the cognitive learning outcomes of students following a posttest on vibration and wave material, facilitated by the application of the PDEODE learning model with PhET Simulation. Additionally, inferential analysis is utilized to examine significant disparities in the cognitive learning outcomes of eighth-grade students at SMP Negeri 8 Pekanbaru between classes implementing the PDEODE learning model with PhET Simulation and those utilizing conventional learning approaches. The research outcomes are evaluated based on student absorption capacity scores categorized as very good, good, quite good, and not good. The final scores were

analyzed inferentially to determine significant differences in students' physics cognitive abilities between the experimental and control class groups.

Descriptive Analysis

The research results were obtained from students' absorption capacity after applying the PDEODE learning model with the help of PhET Simulation and conventional learning on vibration and wave material, as shown in Table 2.

Table 2. Student Cognitive Learning Outcomes

Cognitive Aspect	Experiment		Control	
	Score Average	Category	Score Average	Category
Remember	96	Very good	87,9	Very good
Comprehension	87,2	Very good	79,1	Good
Application	75,3	Good	63,1	Quite good
Analysis	67,2	Quite good	57,2	Quite good
Evaluation	64,9	Quite good	54,1	Quite good
Average (M)	76,2		65,9	
Standard Deviation	12,6		12,1	
Category	Good		Quite good	

Table 2 shows that students in the experimental class showed higher cognitive learning outcomes than students in the control class, indicating a disparity between the two groups of 10.3%. In addition, the results of cognitive learning regarding vibration and wave material show variations at various levels of the cognitive domain. The average score of the experimental and control classes categorized based on cognitive domain level is in the good and quite good range. From Table 2, it can be seen that the cognitive learning outcomes of students in the experimental class were higher than those in the control class, indicating that there was a difference between the two groups of 10.3%. Students' cognitive learning outcomes on vibration and wave material also vary for each level of the cognitive domain. It can be seen that the average scores of the experimental class and control class, based on the level of the cognitive domain, are in the good and quite good categories.

The remembering aspect (C1) yielded the highest average value in cognitive learning outcomes, whereas the analysis aspect (C4) recorded the lowest average value. Nonetheless, across every level of cognitive aspect, the experimental class consistently displayed a higher average score compared to the control class. To ascertain significant disparities in the cognitive learning outcomes of eighth-grade students at SMP Negeri 8 Pekanbaru between classes employing the PDEODE learning model with PhET Simulation and those utilizing conventional learning, inferential analysis was conducted.

Inferential Analysis

Before proceeding to hypothesis testing, the normality test and homogeneity test are important prerequisite steps. In data analysis using SPSS, the Kolmogorov-

Smirnov test was used to determine whether the data was normally distributed or not. Detailed SPSS analysis results can be found in Table 3.

Table 3. Details of SPSS Assisted Analysis Results

Tests carried out	Significant Value	
	Experimental Class	Control Class
Normality Test	0,178	0,147
Homogeneity Test	0,745	0,745
Hypothesis Test	0,001	0,001

In Table 3 provided, the posttest data from both the control and experimental classes demonstrate a normal distribution. The normality test, conducted using the Kolmogorov-Smirnov test, yielded significance values (Sig.) of 0.178 for the experimental class and 0.147 for the control class. Given that the latter significance value is ≥ 0.05, it can be inferred that the improvement in learning outcomes in both classes follows a normal distribution.

Following the homogeneity analysis conducted using the One-Way ANOVA method, a significance value of 0.745 was obtained. According to the homogeneity criteria, since the significance value (p) is 0.745 ($p \geq 0.05$), it can be concluded that the posttest data from both classes exhibit homogeneity or possess similar variances. Subsequently, after examining normality and homogeneity, a hypothesis test (t-test) was performed. In accordance with the established criteria, with a significance value (p) of 0.001 ($p < 0.05$), it can be deduced that the alternative hypothesis (Ha) is accepted while the null hypothesis (Ho) is rejected. This implies that there is a significant disparity between the posttest results of the two classes examined. As illustrated in Figure 1, it is evident that students approach the cognitive ability posttest with earnestness.

Figure 1. Students Carry Out the Posttest

Based on the results of research conducted by Ardillani & Sutama (2022), they argue that the PDEODE learning strategy has the advantage of developing students' abilities in self-confidence, critical thinking, creativity, and submitting

scientific reports. This is expected to increase students' understanding of the concepts studied. This leads to improved learning outcomes, because PDEODE learning facilitates students to relate learning to everyday events, thereby helping them gain a better understanding of concepts (Ernawati et al., 2019).

This shows that the use of the PDEODE learning model with the help of PhET Simulation produces better performance than classes that do not use these two approaches. These results are in line with research by Gay et al (2022) showing that there is an increase in student learning outcomes through PDEODE model learning and research conducted by Fatikasari et al (2020). The results of the research show that there is an increase in students' cognitive learning outcomes which uses PhET Simulation media.

4. Conclusion

The students in the experimental class, which utilized the PDEODE learning model with PhET Simulation, exhibited superior cognitive learning outcomes in physics science compared to the control class, which relied on conventional learning methods. This finding indicates that the average cognitive learning outcomes of students in the experimental class fall within the good category, whereas those in the control class are classified in the quite good category. Notably, there exists a significant difference in students' cognitive learning outcomes in physics science between the experimental and control classes following the implementation of the PDEODE learning model with PhET Simulation. Hence, it can be concluded that the utilization of the PDEODE learning model, supported by PhET Simulation, contributes to enhancing students' cognitive learning outcomes in physics science, specifically regarding vibration and wave material, among eighth-grade students at SMP Negeri 8 Pekanbaru.

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