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The Influence of Problem Based Learning (PBL) Model on Students Learning Outcome

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Abstract: This study aims to determine the effect of problem based learning models assisted by PhET simulations on student learning outcomes in wave material. This research is a type of quasi-experimental research with nonequivalent control group design. The population in this study were all students of class XI MAN 1 Mataram. The research samples were students in class XI MIPA 3 with a total of 31 people as the control class and students in class XI MIPA 4 with a total of 29 students as the experimental class. The test instrument used is in the form of multiple choice questions. The results of the analysis show that the average score of physics learning outcomes in the psychomotor domain in the experimental class is 3.43, while for the control class the average value is 3.06. Analysis of physics learning outcomes in the affective domain of the experimental class was 3.34, while for the control class the average value was 3.13. The results of the questionnaire analysis of student responses in the experimental class obtained an average of 63.63. The results of testing the hypothesis using the t-test obtained a t_{count} of 6.45 and a t_{table} of 2.00. Thus the value of t_{count} is greater than t_{table} then H_a is accepted and H_0 is rejected. This means that there is an influence of the problem-based learning model assisted by PhET simulations on student learning outcomes in wave material.

Keywords: Affective; PhET; Problem based learning; Psychomotor; Response questionnaire

Introduction

In the 21st century, educational institutions are required to prepare students to have 4C competencies, namely creativity thinking and innovation, critical thinking and problem solving, communication, and collaborations. In addition, education is demanded in order to prepare students to have skills in using and utilizing information technology and media (Dewantara, 2021).

Life in the 21st century demands student mastery of various skills so that in the future they will become successful and active generations. The active involvement of students in the learning process is the main thing, but in reality the learning implemented in schools is still teacher-centered. Teacher-centered learning cannot equip students to solve problems in everyday life and cannot encourage students to think critically (Susilawati et al., 2022). So that in order to cultivate skills in the 21st century and be able to move students themselves to foster a sense of curiosity and want to play an active role in learning activities, a suitable learning model is needed (Doyan et al., 2023).

Based on observations at MAN 1 Mataram, especially class XI MIPA and interviews with physics teachers, it is known that the learning implemented at the school is still using the note-taking method accompanied by power point media. Learning patterns like that result in students tending to get bored quickly in learning, so to overcome this we need a learning model that is suitable for learning physics. One learning model that can be applied is the Problem Based Learning (PBL) model or problem-based learning (Kartini et al., 2022; Ulfani et al., 2022; Zaidah et al., 2022).

The Problem Based Learning (PBL) model is a classroom learning model that has the characteristics that in classroom learning activities there are real problems to be used as a reference for students to be able

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to think creatively and critically in order to find solutions to problems given by the teacher through group discussions which allows students to take an active and creative role in learning activities (Budiman et al., 2019; Hasanah et al., 2021). The Problem Based Learning model is a learning model that requires students' mental activity to understand a learning concept through situations and problems presented at the beginning of learning with the aim of training students to solve problems with a problem solving approach (Agustina, 2018; Anggraini et al., 2020; Pamungkas et al., 2019).

According to Supatminingsih et al. (2020) students will get a significant advantage if they learn by using media that are in accordance with the characteristics of their type or learning style. Students who choose the type of visual learning will benefit more when learning uses visual media, such as pictures, diagrams, videos, or films (Doyan et al., 2022; Susilawati, Rahmana, et al., 2022). Meanwhile students who choose the auditive learning type will have more difficulty learning with audio media, such as radio, sound recordings, or teacher lectures (Nurfadhillah, 2021; Sumiharsono et al., 2017).

Through the use of information and communication technology media, educators can deliver learning materials more practically and efficiently (Doyan et al., 2022; Susilawati et al., 2023). As it is known that physics is a subject in which there are many abstract concepts such as material about waves and electromagnetics. With media based on information and communication technology, such as visualization, which can describe things that are abstract in nature, information and communication technology will easily visualize in the form of moving images (animation) that will be easier to understand (Huda et al., 2021). One of the media learning that can be used to assist teachers in explaining abstract physics concepts and can attract students' interest in participating in the learning process is PhET (Physics Education Technology) media (Moore et al., 2018; Price et al., 2019).

PhET is a website developed by the University of Colorado that provides various simulations for learning both in class and individually. By using PhET simulation, learning becomes more interesting, challenging and fun (Fauzia et al., 2021). The advantage of this PhET virtual laboratory is that it can minimize errors in carrying out practicum activities such as damaging tools, doing things that cause danger and so on (Defianti et al., 2021).

Based on the problems above, the researcher is interested in using PhET media as an experimental medium. Therefore, researchers are interested in conducting research with the title "The Effect of the PhET-Assisted Problem Based Learning Model on Student Learning Outcomes in Wave Material".

Method

This study aims to determine the effect of the Problem Based Learning model assisted by PhET simulation on student learning outcomes in wave material. The research design used in this study is the Nonquivalent Control Group Design. This study used two classes, namely class XI MIPA 4 as the experimental class and class XI MIPA 3 as the control class. Class XI MIPA 4 was given treatment using a problem-based learning model assisted by PhET simulations while class XI MIPA 3 used conventional models without the help of PhET simulations. Before being given treatment, students are given a pretest first which aims to determine the initial abilities of students. Then given a posttest to find out the increase in student learning outcomes after being given treatment. The test given is in the form of multiple choices. Student response data to learning using PhET obtained from the questionnaire were then analyzed based on the categories in Table 1. The post-test results data will be tested using a hypothesis test which aims to aim to find out whether the Problem Based Learning model assisted by PhET simulation has an effect on physics learning outcomes students of MAN 1 Mataram.

Table 1. Student Response Criteria (Riduwan, 2019)

Score	Information
0% - 20%	Very less
21% - 40%	Not enough
41% - 60%	Enough
61 – 80%	Good
81% - 100%	Very good

Result and Discussion

This study aims to determine the effect of the PhET simulation-assisted Problem Based Learning model on student learning outcomes. This research was conducted in 3 meetings. The material for each meeting consists of traveling waves (first meeting), free end stationary waves (second meeting) and bound end stationary waves (third meeting). At each of these meetings, students conducted experiments using the PhET virtual laboratory program. Then choose "Wave on a String" in the Physics simulation.

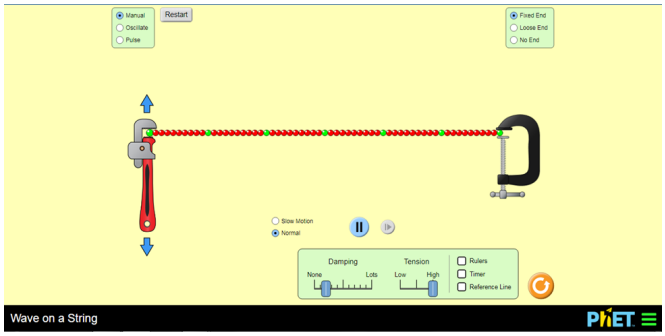

Figure 1. Wave on a string

The data from the results of the assessment analysis on the affective domain of students can be seen in Table 2. The affective abilities of students are measured through several aspects which include attitudes in working together, opinions, and responsibility. Assessment is carried out when students carry out learning activities in class.

Table 2. Recapitulation of Affective Domain Learning Outcomes

Class	Average	Criteria
Experiment	3.34	Very good
Control	3.13	good

Based on Table 2 it can be seen that the learning outcomes of students in the affective domain in the experimental class are higher than the control class. The effect of the learning treatment given shows that there is also an influence on the affective and psychomotor domains of students, aspects that are assessed for the affective domain include responsibility, opinion, and cooperation. The average affective assessment results obtained for the experimental class were 3.34 in the very good category while the average affective assessment for the control class was 3.13 in the good category. The practicum method makes students responsible for what is assigned by the teacher in completing practicum activities. In addition, the presence of practicum activities will increase cooperation between students when completing a series of practicum activities which will improve student learning outcomes.

In addition to increasing learning outcomes in the affective domain, the influence of the learning treatment given also shows an influence on the psychomotor domain of students. Data on the results of the analysis on the psychomotor domain can be seen in Table 3.

Table 3. Recapitulation of Psychomotor Learning Outcomes

Class	Average	Criteria
Experiment	3.43	Very good
Control	3.06	good

The average score in the psychomotor domain for the experimental class was 3.43 (very good category) while the average psychomotor result for the control class was 3.06 (good category.) The increase in learning outcomes in the psychomotor domain of the experimental class was due to the skills students acquired in carrying out practicum activities with the learning experience gained during the learning process, compared to the control class which only received conventional learning without directly participating in doing the practicum. Comparison of the average scores of students' learning outcomes in the affective and psychomotor domains of the experimental class and the control class can be seen in Figure 2.

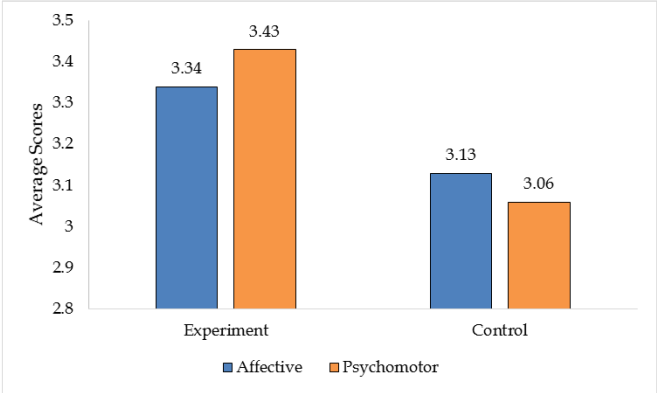

Figure 2. Comparison of the average scores of students' learning outcomes in the affective and psychomotor domains

The results of the student response questionnaire can be seen in Table 4. Based on Table 4 it can be seen that the average response value of the experimental class was 63.62%. This shows that students' responses to learning using PhET are in the "good" category. This is because the PhET Simulation provides interactive moving images (animation) and is created like a game where students can learn by exploring. In addition, PhET simulation also emphasizes the relationship between real-life phenomena and science which supports an interactive and constructivist approach, and provides a creative workplace. Learning physics using PhET can provide real experiences to students so that they can motivate students, explain and simplify complex and abstract concepts into simpler ones, so as to improve student learning outcomes. This is supported by the research of Susilawati et al. (2021) that using PhET media can help improve students' thinking skills. Increasing students' thinking will have a positive influence on student learning outcomes.

Table 4. Student Response Questionnaire Results

Number of Students	Score	Average	Category
29	1845	63.62	Good

The next analysis is hypothesis testing. Before carrying out the hypothesis test, the normality test and homogeneity test are carried out first, as a form of the requirements of the hypothesis test. The results of the prerequisite tests carried out included a homogeneity test which aimed to find out the variance of the initial ability of students in the experimental class and control class before being given treatment and the normality test aimed to find out whether the final test data on the learning outcomes of the two classes were normally distributed or not.

Based on the calculation results, it is known that the data for both classes are normally distributed and homogeneous, so the hypothesis test used based on the prerequisites is parametric statistics, namely t-test

polled variance. The results of hypothesis testing can be seen in Table 5.

Table 5. Hypothesis Test Results

Component	Experiment Class	Control Class
Number of Students	29	31
Average	79.65	69.77
Variance	35.73	35.64
t_{count}		6.45
t_{table}		2.00

Based on Table 5, it can be seen that the value of $t_{count} > t_{table}$ is 6.45 > 2.00. This is in accordance with the criteria for testing the hypothesis, namely $t_{count} > t_{table}$, then H_0 is rejected and H_a is accepted. Thus, from the results of the study it can be concluded that the Problem Based Learning model assisted by PhET simulation has an effect on student learning outcomes in the affective domain, psychomotor domain, and student responses to wave material. This is in accordance with research conducted by Hasanah et al. (2021), Umayrah et al. (2023), and Susilawati et al. (2022) that there is a positive and significant influence from the application of the problem based learning model on student learning outcomes.

Conclusion

Based on the results of the research that has been done, the average value of learning outcomes in the psychomotor domain of physics in the experimental class is 3.43, while for the control class the average value is 3.06. Analysis of physics learning outcomes in the affective domain of the experimental class was 3.34, while for the control class the average value was 3.13. The results of the questionnaire analysis of student responses in the experimental class obtained an average of 63.63. The results of testing the hypothesis using the t-test obtained a t_{count} of 6.45 and a t_{table} of 2.00. Thus the value of t_{count} is greater than t_{table} then Ha is accepted and H_0 is rejected. This means that there is an influence of the problem-based learning model assisted by PhET simulations on student learning outcomes in wave material.

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