The Implementation of Guided Inquiry Learning Model Using PhET Simulation to Improve Student Learning Outcomes

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Abstract. This study aims to determine the improvement of learning outcomes using the guided inquiry learning model by using PhET simulations. A quasi-experiment method with a non-equivalent pre-test - post-test control group design was used. Purposive sampling techniques were used to collect samples. The guided inquiry learning model was used to teach the experimental class using PhET simulations, while conventional learning was used to teach the control class. The instrument used is a multiple-choice test with 20 validated items. The findings revealed that using the guided inquiry learning model with PhET simulations improved learning outcomes over conventional learning methods.

Keywords: Guided Inquiry Learning Model, PhET Simulation, Student Learning Outcomes

1 Introduction

Education is an effort to guide people toward intellectual, social, and moral maturity. As a result, education not only develops intellectuals but also encompasses all of the potential that students possess. As a result, interaction in learning must be fully implemented. Learning activities are the most dominant and important activities throughout the educational process. The interaction between a person and the learning environment can result in the teaching and learning process. The learning process that a person is going through determines whether or not educational goals are met [1].

One of the issues confronting the world of education is the issue of a poor learning process. Students lack motivation to develop thinking skills in the classroom, and their brains are forced to remember and hoard a variety of information without being required to understand it and connect it to everyday life, so their thinking stops until learning is complete. Meanwhile, the main issue in Indonesian education is the low learning outcomes of students in various subjects. Physics is one of the subjects that has poor learning outcomes.

Physics is a branch of science that studies the symptoms of nature and natural events, both visible and abstract. In this case, the teacher must act as a mediator and facilitator, designing appropriate learning so that students can comprehend natural phenomena and events. One of the physics materials studied by MAN 2 Tanjung Pura students, especially class X, is Momentum and Impulse, and the sub-materials covered in it, namely Momentum, The Law of Conservation momentum, collisions, and impulses are quite difficult and complex materials, and require a

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good understanding of basic physics concepts. As a result, the majority of students struggle to grasp this concept.

Based on the findings of research conducted at MAN 2 Tanjung Pura by conducting interviews with physics teachers. It was discovered that teachers used a conventional learning model with a lecture method. This method is considered less effective when used in physics lessons, particularly when discussing Momentum and Impulse. The learning process, which is limited to the teacher delivering material and providing question exercises, results in low student motivation. Students' learning outcomes are also quite low and fall short of the school's Minimum Completion Criteria target of 70. Furthermore, when it comes to the use of learning media, teachers are extremely rare. In the learning process, teachers only use simple media, such as a blackboard. Use of technology-based learning media or other supporting media is never recommended. According to some of the issues discovered, many students have a poor understanding of concepts and problem-solving abilities. This is what leads to poor learning outcomes in students.

To resolve these concerns, efforts must be made to improve educational quality. These efforts can begin by correcting the learning process that is not appropriate in the classroom teaching and learning process. Students' potential should be developed by directing the learning and learning environment, which means that the educational process must be student-centered (student active learning). Students can learn directly and understand the concepts instilled in the learning process when they are actively involved, which improves their learning outcomes.

Using a learning model is one effort that can help students improve their learning outcomes. The guided inquiry learning model is one of the learning models that works well in classroom settings where students' abilities vary. The guided inquiry learning model teaches students to question and investigate in order for them to learn to be mentally and physically active. As a result, the teacher's role is only that of a facilitator, assisting students in discovering their own understanding so that students can maximize their understanding of concepts and improve their learning outcomes [2], [3], [4]. Another thing that can help students improve their learning outcomes is to use the appropriate learning media for the times.

Teachers can aid students' learning by using appropriate learning media. The learning process is simplified by providing students with material [5]. Learning materials must be properly packaged in order to entice users to feel at ease while learning. The most important aspect of media use is its relationship to the level of advancement of educational technology. The higher the level of educational technology, the more media is required to arouse and motivate students to learn better. If the media used strongly supports students' interests and desires, it will be easier for them to learn effectively and efficiently [6].

Technological advancements have encouraged more appealing and effective learning approaches. Educational innovation has resulted in more creative developments for interactive technology in various forms, such as computer-based learning media [7]. Simulation PhET is a technology science product that can be used as a learning medium. PhET (Physics Education Technology) is included in the software, which contains simulations of moving images designed to be played by students to learn [8].

Because the delivery of the material requires understanding basic concepts that are undoubtedly interrelated with events or facts discovered by students, it is hoped that combining the guided inquiry model with PhEt Simulation in momentum and impulse materials will synergize physics learning and create active, creative, and effective learning.

2 Methods

For the study, a quasi-experimental design was used. This research was carried out at MAN 2 Tanjung Pura. This study included all students in class X at MAN 2 Tanjung Pura during the academic year 2021/2022. Purposive sampling was used to select samples: 30 students for the experiment group taught using the guided inquiry learning model using PhET simulations and 30 students for the control group taught using conventional learning. A learning outcomes test with 20 multiple choice questions was used to collect data. The data was descriptively analyzed using the average value. The N-gain was calculated as the difference between pre-test and post-test increases. The data was then analyzed for hypothesis testing using an independent sample t-test.

3 Result and Discussion

The data obtained in this study show that guided inquiry learning models using PhET simulations improve learning outcomes when compared to conventional learning. The average scores in both classes show an improvement in learning outcomes from the experimental and control classes, as shown in Table 1. The difference in the average value of the pre-test and post-test results in improved learning outcomes (N-gain). Table 2 shows the average score of improved learning outcomes.

Table 1. Data from the pre-test and post-test

Class	Average Value		Standard Deviation	
	Pre-test	Post-test	Pre-test	Post-test
Experiment	51.83	81.67	13.98	8.94
Control	50.67	66.67	11.65	10.19

Table 2. N-Gain Difference

Class	Average Value	Standard Deviation
Experiment	0.64	0.02
Control	0.33	0.98

According to Table 2, the improvement in student learning outcomes in the experiment group taught using the guided inquiry learning model using PhET simulations is greater than the improvement in student learning outcomes in control classes taught using conventional learning. Figure 1 describes the improvement in student learning outcomes in both classes.

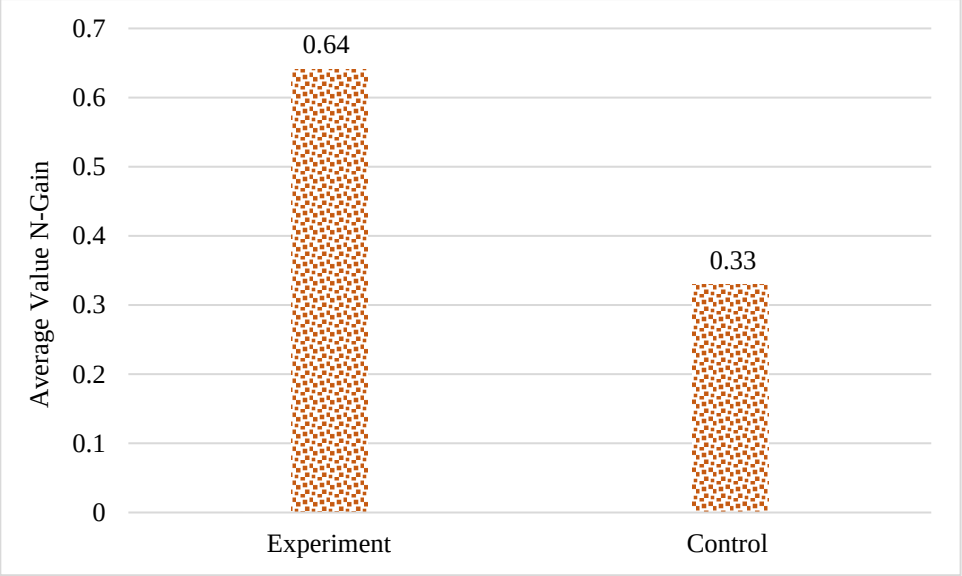

Fig. 1. Average improvement in student learning outcomes graph

According to Figure 1, the average N-gain value of the experiment class is greater than the average post-test value of the control class. It can be concluded that guided inquiry learning models using PhET simulations improve student learning outcomes more than conventional learning.

The two samples are normally distributed and homogeneous data from the distribution table of the improvement of learning outcomes (N-gain), so hypothesis testing is performed. Hypothesis testing is carried out using independent sample T-tests to determine differences in student learning outcomes caused by the influence of treatment, specifically in the experiment group taught using the guided inquiry learning model using PhET simulations and the control classes taught using conventional learning.

Table 3. SPSS Hypothesis Testing

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2 Tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post-Test	Equal variances assumed	.728	.397	6.058	58	.000	15.000	2.476	10.044	19.956
	Equal variances not assumed			6.058	57.018	.000	15.000	2.476	10.042	19.958

Based on the results of testing the hypotheses described in Table 3, sig (0.000) < α (0.05) is obtained, and H_0 is rejected while H_a is accepted. As a result, the guided inquiry learning model using PhET simulations can improve learning outcomes in momentum and impulse subject matter.

This is supported by the findings of studies conducted by Sianturi and Motlan [9], Susilawati et al [10], Ramadhaniyah & Supardi [11], Doyan [12], and Rasyidah et al [13], all of which concluded that guided inquiry learning models based on PhET can improve student learning outcomes. Molla's [14] research also demonstrates the effectiveness of guided inquiry methods for learning physics in terms of improving student learning outcomes. According to Mulyana et al. [15], guided inquiry learning has a significant impact on student learning outcomes. Furthermore, Nefrita [16] claims that using PHET-based information technology simulation media in physics learning can improve learning activeness and learning outcomes in SMA 4 Pekanbaru class XI students.

4 Conclusion

Based on the data analysis results, it is reasonable to conclude that the guided inquiry learning model with PhET simulations improved learning outcomes.

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