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APPLICATION OF THE GUIDED INQUIRY LEARNING MODEL WITH THE ASSISTANCE OF PhET TO IMPROVE HIGH SCHOOL STUDENTS' LEARNING OUTCOMES ON MOMENTUM AND IMPULSE

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ABSTRACT

This study aims to find out how to improve student learning outcomes through the guided inquiry learning model with the help of PhET. The population in this study were class X students of SMA Negeri 7 Medan T.P 2022/2023 and the research samples were taken using a random sampling technique, namely class X MIPA 2 as the experimental class and X MIPA 5 as the control class. This research is a quasi-experimental research with Control Group Pretestt-Postestt Design. Data collection was carried out using the test method in the form of multiple choice tests which totaled 15 questions and student activity observation sheets. The results showed an increase in learning outcomes in the experimental class by 0.61 while in the control class it was 0.23. Student activity in the experimental class has increased and is stated with good (active) assessment criteria. So it can be concluded that the application of the guided inquiry learning model with the help of PhET can improve and have an influence on student learning outcomes on momentum and impulse material.

Keywords: *Guided inquiry, phet, learning outcomes.*

INTRODUCTION

Over time, the educational paradigm has shifted, especially for teachers and students in teaching and learning activities. Where initially learning only focused on the teacher, in other terms, teacher centered learning shifted to students who became the center of learning (student centered learning). In the learning process, the role of educators and students has an influence in determining the learning outcomes to be obtained. The tendency of the one-way learning process is one of the obstacles to students' interest in studying lessons, especially in physics lessons. In contrast to other subjects, physics contains science in the form of concepts that are embodied in writing or systematically. Not only to remember but also to understand concepts that emphasize knowledge through an experiment, presenting data systematically with certain rules.

Physics learning has a definition, namely a learning activity with a broad design in order to achieve the basic competencies in it including the formation of the psychic and physical that is involved from interactions between fellow students, educators with students, schools and other teaching resources in providing understanding skills through experience for students. This learning experience can be achieved by a variety of learning approaches that are student centered learning applied to teaching and learning activities in order to equip students with a series of knowledge and abilities to develop science

and technology that students need to master (Sutarto, Wardany, & Subiki, 2014).

Talking about learning physics, there are still many learning activities carried out in schools. Lack of students' understanding of physics concepts is one of the problems that is often encountered. This is because the learning process is still running in one direction or is teacher centered learning and there is no diversity of teaching models used. The learning process is limited to the teacher explaining the material, giving exercises and putting more emphasis on students memorizing, taking notes and listening. The teaching and learning process which is centered on the teacher causes students to fail to be active in order to receive their knowledge. The teacher's ability to teach plays an important role in determining the active involvement of students when learning.

Based on initial observations at the school where the research was conducted, namely SMAN 7 Medan, it was shown that teachers still apply a teacher-centered learning system. This can be seen from teachers who are still conventional in using their learning models. Teachers have not implemented innovation in learning such as supporting learning activities such as media which results in a lack of student involvement in learning. Therefore, the learning completeness of students is still in a below average position, in other words, they have not met the minimum completeness criteria (KKM).

Based on this, it is important for teachers to follow the paradigm shift by encouraging students to be actively involved in learning activities through the application of innovative learning models that are centered on students. Thus, the learning process is able to increase the value of learning and student activity through competency development and its application.

Of the many learning models, the guided inquiry model can be used as an innovative model that can be implemented in learning. This model is a model that makes students play an active role in solving problems independently or in groups and finding concepts or information on their own through guidance. Collaboration in the form of media support such as PhET can be used as a tool that will greatly support the learning process to help students solve their problems.

PhET is a virtual laboratory simulation environment developed by Katherin Perkins et al. developed by the University of Colorado, USA. As stated in (Wieman, Adams, Loeblein, & Perkins, 2015), PhET simulation media can be used to help students understand physics concepts visually through the use of dynamic graphs that reflect visual and visual concepts used by experienced physicists to be clear. animate the conceptual model.

Several previous studies have shown that the application of the guided inquiry model in the classroom has an impact. As has been researched by Hayati, (2017), learning model research using simulation media has an effect on student learning outcomes which can be seen from the acquisition of test scores for the experimental class which is superior to the control class. The same research was conducted by Gres Harlely Purba (2017), with the results of guided inquiry research with phet being able to increase student learning scores.

Based on the explanation of the background above, research was conducted which aims to improve student learning outcomes by implementing the guided inquiry learning model on Momentum and Impulse material for Class X Students at SMAN 7 Medan.

RESEARCH METHODS

The research location is at SMA Negeri 7 Medan. The school is located on Jl. Timor No. 36, Gaharu Village, East Medan District, Medan City, North Sumatra. This research will be carried out at the class level in the second semester of the 2022/2023 Academic Year on the topic of momentum and impulse.

The population in this study were all students of class X MIPA SMAN 7 Medan. The sample in this study consisted of two classes, namely class X MIPA 2 as an experimental class with a total of 33 students and class X MIPA 5 as a control class with a total of 35 students. The research sample was taken using cluster

random sampling technique. The two classes were given different treatment. In the experimental class, the guided inquiry model was used with the help of PhET, and in the control class, the conventional model, namely the direct instruction model, was used.

This type of research is quasi-experimental, namely research that aims to determine whether there is an influence or effect of a treatment imposed on the subject, namely students. The variables in this study consist of categories, namely the independent and dependent variables. In this study, the independent variables were the guided inquiry learning model and conventional learning, while the students' physics learning outcomes in the matter of momentum and impulses were the dependent variable. The design of this study was a control group pretestt-posttest design which can be seen in Table 1.

Table 1. *Two group pretest postest design*

Class	*Pre-test*	Treatment	*Post-tes*
Experimental	O_1	X_1	O_2
Control	O_1	X_2	O_2

Information:

O_1 = Initial test (pretestt)

O_2 = Final test (posttest)

X_1 = Treatment using the guided inquiry model with the help of phet in the experimental class

X_2 = Treatment uses conventional learning models in the control class

Data collection techniques used is by giving the pretest and posttest in the form of learning achievement test instruments. The two sample classes were given a pretest before learning was carried out. Furthermore, a posttest will be given after implementing guided inquiry learning in the experimental class and conventional learning in the control class. After the data is obtained, a prerequisite test is carried out, namely the normality test and homogeneity test. After the prerequisite test is fulfilled, the t test and gain test are carried out. The purpose of this data analysis is to determine the increase and influence of the guided inquiry learning model on student learning outcomes.

RESULT AND DISCUSSION

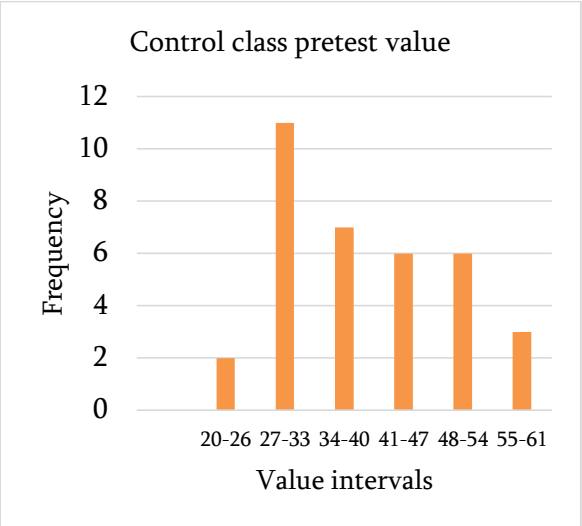
a. Research result

From the research results, it was obtained that the average pretest value of students in the experimental class before using the guided inquiry learning model with the help of phet was 36,36 with a standard deviation of 9,44 and the average pretest value of students in the control class was 40,76 with a standard deviation of 11 ,63. The results can be shown in Table 2.

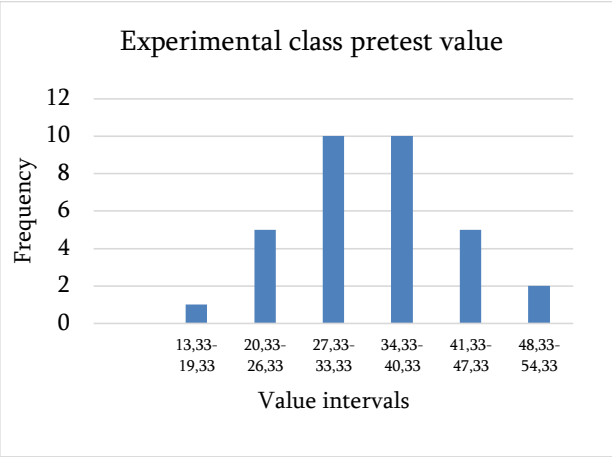
Table 2. Results of pretest control class and experimental class

Control class				**Experimental class**			
Value Intervals	F	$\bar{X}$	S	Value Intervals	f	$\bar{X}$	S
20-26	2	40,76	11,63	13,33-19,33	1	36,36	9,44
27-33	11			20,33-26,33	5		
34-40	7			27,33-33,33	10		
41-47	6			34,33-40,33	10		
48-54	6			41,33-47,33	5		
55-61	3			48,33-54,33	2		
Amount = 35				Amount = 33			

The results of the pretest of the two classes can be seen in the following bar chart.



Picture 1. Bar chart of control class pretest data



Picture 2. Bar chart of experimental class pretest data

Based on the calculation results of the normality test and homogeneity test, it shows that the pretest data is normally distributed and homogeneous. So that it fulfills the requirements for conducting a t-test to find out the similarity of students' initial abilities in both classes. Briefly presented in Table 3.

Table 3. Test the ability of the pretest hypothesis

Class	Average	t_{count}	t_{table}	Conclusion
Experimental	36,36	-1,705	1,998	Ho accepted
Control	40,76			Initial ability of students is the same

From the results of the two-party t test, it was found that tcount t_{hitung} = -1,705 with a significant level of $\alpha = 0{,}05$ dan dk = 66 diperoleh t_{Table} = 1,998. With the criteria if $-t_{(1-\frac{1}{2}\alpha)} < t < t_{(1-\frac{1}{2}\alpha)}$, then Ho accepted, namely (-1,998 < -1,705 < 1,998). Which means the initial ability of the two classes is the same or there is no significant effect.

Furthermore, the two classes were given different treatment, then the two classes were given a final test with the same questions as the initial test. Based on the research results, it was obtained that the average posttest score of students in the experimental class after using the guided inquiry learning model with the help of phet was 75,35 with a standard deviation of 8,89 and the average in the control class was 55,05 with a standard deviation of 10.88 . The results are shown in Table 4.

Table 4. Results of posttest control class and experimental class

Control class			Experimental class			
Interval Nilai	$\bar{X}$	S	Interval Nilai	F	$\bar{X}$	S
33,33-39,33	55,05	10,88	60-64	4	75,35	8,89
40,33-46,33			65-69	6		
47,33-53,33			70-74	6		
54,33-60,33			75-79	0		
61,33-67,33			80-84	10		
68,33-74,33			85-89	7		
Amount = 35			Amount = 33			

Based on the calculation results of the normality test and homogeneity test, it shows that the posttest data are normally distributed and homogeneous. So that it fulfills the requirements for conducting a t test to see whether there is an effect on student learning outcomes after being given different treatments. Briefly presented in Table 5.

Table 5. Summary of t test calculations for posttest data

Class	Average	t_{count}	t_{table}	Conclusion
Experimental	75,35	8,39	1,669	Ha accepted There is an influence of the guided inquiry learning model
Control	55,05			

Based on the results of the calculation of the average similarity test posttest experimental class and control class with a significance level of α = 0,05 diperoleh bahwa t_{hitung} = 8,39 and t_{Table} = 1,669. Jika $t_{hitung} > t_{Table}$ (8,39 > 1,669), reject Ho and accepted Ha, which means that the learning outcomes of experimental class students are greater than those of the control class. This means that the Guided Inquiry Learning Model with the Assistance of PhET has an impact on Student Learning Outcomes on the Main Topics of Momentum and Impulse.

The results of observing student activity are shown in the table below.

Table 6. Recapitulation of student activities

Meeting	Average	Criteria
I	1,927	Enough
II	2,388	Good
III	2,709	Good

Based on Table 6, it can be seen that the average activity of experimental class students during the three meetings has increased and is stated with good (active) assessment criteria.

b. Diacussion

Based on the results of the study, it was shown that there was an increase and a significant influence from the application of the guided inquiry learning model with the help of phet on student learning outcomes in the material of momentum and impulse in class X MIPA SMA Negeri 7 Medan. This is evidenced by the difference in the average value of student learning outcomes before and after being given treatment in the experimental class and control class. In the experimental class, the average pretest score was 36.36 and the posttest was 75.35. In the control class, the average pretest score was 40.76 and the posttest was 55.05. In this case, the experimental class has a higher increase than the control class.

Experimental class has a higher increase due to the application of the guided inquiry learning model which encourages students to be more active in the learning process. The guided inquiry model also provides space for students to absorb, understand and respond to parts of the material being studied. In addition, in the learning process students are given the opportunity to carry out investigations, collect information and data to solve problems so that they can train students to perform higher-order thinking skills. This can be seen during research, students are active in discussions and work together to solve problems given by researchers.

Strengthened by research that has been carried out by (Saptaputra, 2018) also shows an increase in student activity in learning which supports students in optimizing their abilities to be active, learning in a conducive and togetherness atmosphere which ultimately helps students achieve learning mastery on the material being studied. Other research that has been conducted by (Nurfarida, Bahtiar, & Ernita, 2019) shows that the guided inquiry model is able to invite students to be actively involved in learning activities and to seek answers to problems that arise through experimental activities with teacher guidance. In this case the teacher provides broad guidance to students, such as providing questions that direct students to determine concepts through inquiry activities so as to enable them to participate in learning properly. In contrast to the control class which did not carry out experimental or demonstration activities. Learning is only centered on the teacher who provides material using the lecture method and assignments which result in students being passive in the learning process and tend to only memorize the material provided by the teacher. Likewise, research conducted by (Lubis & Motlan, 2021) menyatakan bahwa meningkatnya hasil belajar states that the increase in student learning outcomes is due to the learning process which requires students to seek and find answers to the problems to be solved. Where it includes the guided inquiry learning process.

The results of the analysis of the data obtained in this study also prove the above statement. Testing the one-party hypothesis with a significant level $\alpha = 0{,}05$ and dk = 66, yields t_{hitung} = 8,39 dan t_{Table} = 1,669. According to the test standard, if $t_{hitung} > t_{Table}$ (8,39 > 1,669), or it can be said that the experimental class student learning outcomes have academic achievement rather than the control class, which means that there is an influence of the guided inquiry learning model with the help of phet on student learning outcomes on the subject matter of momentum and impulse in Class X SMAN 7 Medan. From the results of the N-gain test calculation, the N-gain value in the experimental class was 0,3 < g < 0,7, namely 0,61 in the medium category, while in the control class the N-gain value was 0,23 in the low category. Thus it can be concluded that the application of the guided inquiry learning model with the help of phet is able to improve the learning outcomes of class X students of

SMAN 7 Medan on the material of momentum and impulse.

This is reinforced by previous research (Hikmawati, 2017) which found that learning with guided inquiry and PhET can make students more active in learning and student scores increase, which can be seen from the average student physics learning outcomes, experimental class learning outcomes taught with guided type inquiry along with support in the form of PhET is higher than the control class taught by conventional learning models. This is also relevant to previous research by (Hayati, 2017), that in the experimental class the average score of student learning outcomes tests with a survey-based simulation model is higher than the comparison class with conventional learning models. Because in the experimental class students are used as subjects in the teaching and learning process and not as objects, so students are motivated to participate actively in the learning process under the guidance of the teacher. Students have the freedom to develop the concepts learned and work in groups to solve the problems they face. Where it can improve student learning outcomes.

With the application of the guided inquiry learning model with the help of phet, it can encourage students to be more active in class. This is evidenced by the observations of researchers on student activities in conducting experiments. Aspects observed included conducting experiments, using tools and materials, making experimental data on observation tables, discussing with groups and working together in groups. Student activity has increased in each meeting because the learning process is different than usual and is able to attract students to be actively involved in it. The results of this study are reinforced by (Nini, Sahara, & Sukariasih, 2019) who has conducted his research revealing that the learning activities of students who apply the guided inquiry learning model tend to increase and improve at every meeting. This is due to the application of the guided inquiry learning model which invites students to actively participate in conducting experiments. They will explore the knowledge gained by students themselves in order to solve the problems given either individually or in groups. As stated by (Tarigan, 2018) that the increase in learning outcomes is caused by guided inquiry which acts as a learning model that makes it easier for students to adapt, and the instructions and instructions given are easily understood by students so that learning becomes more interesting. The application of the "Guided Inquiry" learning model also promotes collaboration in groups, so that students gain a deeper understanding, because students are directly involved in finding answers to existing problems and conducting experiments that are directly related to the subject matter.

The application of the guided inquiry learning model with the help of PhET can improve learning outcomes and student activities, but during the learning process there are several obstacles. The obstacles encountered during the research were ineffective time allocation and less conducive class conditions such as some students who were not serious during the learning process. Another obstacle faced was the lack of experience of researchers in managing classes and the lack of observers in this study making it difficult for students to be supervised and controlled.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the research and the results of data analysis that has been carried out, it can be concluded that the application of the guided inquiry learning model with the help of phet is able to improve the learning outcomes of class X students of SMAN 7 Medan on the material of momentum and impulse and there is a significant influence from the application of the guided inquiry learning model with the help of phet on student learning outcomes of class X SMAN 7 Medan on the material momentum and impulse. The suggestions that can be conveyed by researchers are as follows:

1. For teachers and prospective teachers, especially physics teachers, it is hoped that they can use methods, models and

strategies that involve students actively in the learning process and encourage students to develop an understanding of the concepts being studied. One of them is the application of the guided inquiry learning model with the help of PhET.

2. For further researchers, who wish to conduct research using the guided inquiry learning model in the future, it is hoped that they will first master each syntax contained in the model so that the learning process can run efficiently and effectively, especially in allocating time.
3. For students, it is hoped that they can prepare themselves well to be active in their learning activities to get better results.

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