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The Effect of Guided Inquiry Learning Model Assisted by PhET Simulations on Students' Physics Learning Outcomes

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Abstract

The purpose of this study was to determine the effect of the guided inquiry learning model assisted by PhET Simulations on students' physics learning outcomes. This study used an experimental research design with a pretest-posttest control group. The sampling technique used the Cluster Random Sampling method, and 27 students from class XI MIPA 2 served as the experimental class and 27 students from class XI MIPA 3 served as the control class. The experimental class was given the guided inquiry learning model assisted by

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PhET Simulations, while the control class used conventional learning. The instrument used to measure student learning outcomes was an objective test consisting of 25 multiple-choice questions. The learning outcome test instrument used has been tested for validity, reliability, difficulty level, and discrimination power. The data analysis technique was carried out using the polled variance t-test. Based on the results of the t-test, it was obtained that the average value for the experimental class was 79.704 and the control class was 75.111. If t_{count} is greater than t_{table} or 2.172 > 1.676 at a significance level of 5%, then H_0 is rejected and H_a is accepted. Thus, it can be concluded that there is an influence of the guided inquiry learning model assisted by PhET Simulations on students' physics learning outcomes

Keywords
Guided Inquiry, PhET Simulations, Learning Outcomes, Physics

I. Introduction

1.1 Introduce the Problem

Education is the process of imparting knowledge, skills, and habits to a group of people, passed down from one generation to the next through systematic teaching, training, and research. High-quality education can support a nation's progress, as it produces high-quality human resources. The quality of education must also be continuously improved through reforms that are accountable to the public, so that it can prepare the nation's future generations from an early age to achieve a competitive edge in both the national and global spheres (Priscilla and Yudhyarta, 2021).

PhET Simulations are simulations developed by the University of Colorado that include physics, biology, and chemistry learning simulations for classroom instruction or individual study. PhET Simulations emphasize the relationship between real-life phenomena and the underlying science, support interactive and constructivist approaches, provide feedback, and offer a creative workspace. In addition to being applied within learning models, PhET Simulations can also be used in the development research conducted by Sumarauw et al. (2017)—specifically, the development of guided inquiry-based learning tools supported by PhET Simulations for physics instruction.

The guided inquiry learning model is an alternative solution to address these issues. The guided inquiry learning model is a learning model that encourages students to actively participate in acquiring scientific knowledge by conducting investigations to find answers to the problems presented (Seranica et al., 2018). The inquiry and decision-making model related to daily life is a science literacy-based learning concept. Learning begins with a scientific problem, followed by formulating a tentative answer and conducting an investigation to solve the problem through literature and laboratory activities; subsequently, the understanding gained from the problem-solving process is used to make decisions in daily life.

According to Lewa et al. (2017), the inquiry model best suited for teaching physics concepts to students is the guided inquiry model, as this model emphasizes student engagement in learning activities. Guided inquiry encourages students to seek answers to problems through experiments conducted under the guidance of an educator. Through guided inquiry learning, students actively participate in the learning process by identifying problems, formulating hypotheses, and collecting and analyzing data. Students who understand the material can transform various forms of representation into other forms and interpret research tables as data presentations. Conceptual understanding equips students to adapt to various situations encountered in daily life. Forms of conceptual understanding that facilitate adaptation to the environment and daily life include the ability to interpret, explain, compare, provide examples, and draw conclusions.

The following are relevant studies on the implementation of the guided inquiry learning model that have been conducted and have had a positive impact on students. Research conducted by Ramadhanti & Agustini (2021) indicates that the implementation of the guided inquiry model is capable of improving students' critical thinking skills across all indicators.

Physics is a branch of the natural sciences and is the discipline that studies natural phenomena through a series of scientific processes. Physics is viewed as both a process and a product; therefore, in teaching, educators must consider effective and efficient learning strategies and methods (Hikmawati, 2023). According to Rizaldi et al. (2020), learning physics involves practicing the understanding of concepts, solving problems related to observed phenomena, and constructing reasoning to grasp concepts through experimental activities or discovery processes to verify the theories being studied. According to Ministry of Education and Culture Regulation No. 22 of 2016, physics instruction should provide learning experiences that foster curiosity and enhance skills in observation, analysis, and communication; by implementing these principles, the quality of learning can be improved.

One educational resource that has been available since the 21st century—PhET Simulations—suggests that the guided inquiry learning model can serve as an alternative approach to teaching physics in the classroom and is most effective when implemented with the aid of PhET Simulations. By using PhET Simulations, teachers can easily answer students' questions, explain abstract physics concepts, and demonstrate phenomena that are difficult to observe in real-world laboratory experiments, ensuring that students do not merely memorize what they have learned (Agustina, 2020).

Based on this background, the researcher was interested in examining the effect of Guided Inquiry supported by PhET Simulations on students' physics learning outcomes at SMAN 1 Soromandi during the 2025/2026 academic year. Initial observations conducted at SMAN 1 Soromandi revealed that students' physics learning outcomes were still suboptimal. Data from the learning evaluation showed that the average physics score for 11th-grade students was 71.48, which was still below the Learning Objective Achievement Criteria (KKTP) set by the school, namely 75. Of the 27 students, 15 (55.56%) have not met the KKTP, while only 12 (44.44%) have met it. Interviews with physics teachers revealed that students still struggle to understand abstract physics concepts because instruction tends to be teacher-centered and makes insufficient use of interactive learning media. In addition, students tend to be passive during learning activities, are not sufficiently engaged in scientific discussions, and exhibit relatively low interest and motivation to learn. The use of educational technologies, such as virtual simulations, has also not been optimally utilized in the physics learning process. These conditions highlight the need to implement a learning model capable of increasing student engagement in independently discovering concepts and visualizing physical phenomena—one such approach being the guided inquiry learning model supported by PhET Simulations.

II. Method

This study is an experiment using a non-equivalent control group design. The study involved two classes: an experimental class and a control class. The experimental class received the treatment—instruction using the guided inquiry model aided by PhET Simulations with virtual laboratory activities—while the control class received no treatment and used the conventional teaching model. This study was conducted at SMAN 1 Soromandi, Bajo Village, Soromandi Subdistrict, Bima Regency, West Nusa Tenggara Province, ZIP Code 84163, during the odd semester of the 2025/2026 academic year.

An independent variable is a variable that influences or causes changes in or the occurrence of a dependent variable (Sugiyono, 2016). The independent variable in this study is the guided inquiry learning model supported by PhET Simulations. A dependent variable is a variable that is influenced or results from the presence of an independent variable (Sugiyono, 2016). The dependent variable in this study is student learning outcomes. Control variables: Variables that are controlled or kept constant so that the relationship between the independent and dependent variables is not influenced by external factors not under investigation (Sugiyono, 2016). The control variables in this study are the instructional material, learning objectives, the teaching teacher, the instruments used, time allocation, and the assessment method.

The population in this study is the generalizable population consisting of objects/subjects with specific qualities and characteristics determined by the researcher for study, from which conclusions are subsequently drawn (Sugiyono, 2016). In this study, the population consists of all 120 students in the 11th-grade Science (MIPA) program at SMAN 1 Soromandi, divided into 4 classes. The sample in this study consists of a number of small groups representative of the population, which serve as the objects of the study (Setyosari, 2016). The technique used for sampling in this study is cluster random sampling. Cluster random sampling is a type of sampling technique in which a researcher divides the population into several separate groups called clusters. From these groups, which have been divided into several clusters, samples were drawn; in this study, these were Class XI MIPA 2 and 3.

The instrument used in this study was a physics achievement test consisting of multiple-choice questions. A test instrument is a tool designed to measure the attainment of previously planned learning competencies. The learning outcome test used in this study is an objective multiple-choice test designed to measure the cognitive domains: (C1) knowing, (C2) understanding, (C3) applying, (C4) analyzing, (C5) evaluating, and (C6) creating. This pilot test aims to determine whether the test to be used can be considered valid; therefore, an item analysis must be conducted, which includes the following:

According to Arikunto (2019), a measurement instrument is a tool used in assessment that can be employed to verify the absence of discrepancies between the data obtained by the researcher and what actually occurs in the research subject. In this case, a problem-solving ability instrument means that the instrument is truly capable of measuring students' problem-solving abilities.

Reliability testing is used to determine how accurate a measurement tool will be. A test can be considered reliable if the measurement results from the test group show consistency. This refers to the ability of an instrument or test to produce scores that are approximately the same for each individual when the test is administered repeatedly to the same or different individuals (Sundayana, 2016). The technique used to test the reliability of the research instrument was the Spearman-Brown method.

Difficulty level refers to whether a test item is considered difficult, moderate, or easy to answer. A good test item is one that is neither too easy nor too difficult (Arikunto, 2019). The results of the difficulty level calculation for the 30 test items revealed that 3 items fell into the easy category, 24 into the moderate category, and 3 into the difficult category.

According to Arikunto (2019), discriminating power is the ability of a test item to distinguish between high-ability students and low-ability students.

Data on students' physics learning outcomes were obtained through tests. Research data in the form of students' physics learning outcomes in the cognitive domain in the control class of this study were collected using multiple-choice tests. These tests were administered to the experimental class before the intervention (pretest) and after the intervention (posttest). Meanwhile, data on students' physics learning outcomes in the affective and psychomotor domains were collected using observation sheets during each learning activity.

Data analysis is the process that takes place after data from all respondents or other data sources have been collected. The learning outcome data (post-test) were first subjected to a normality test, a homogeneity test, and a hypothesis test. According to Sugiyono (2016), the normality test is used to determine whether the data being analyzed follows a normal distribution. The normality test used in this study is the chi-square test. The homogeneity test is conducted on the students' initial data, specifically their first-semester exam results. This aims to determine whether the two samples taken are homogeneous or heterogeneous. Additionally, in the analysis of this study, the homogeneity test was also used to process the posttest data. The posttest homogeneity test aims to determine the appropriate follow-up test for comparing differences (t-test) to be used (Sugiyono, 2019).

After the data were confirmed to be normally distributed and homogeneous, a hypothesis test was conducted using the t-test. The test was designed to determine whether the guided inquiry learning model had a significant effect on the physics learning outcomes of 11th-grade students at SMAN 1 Soromandi regarding the topics of temperature and heat. Parametric statistics were used to test the research hypothesis.

Parametric statistics were used to test the two-sample hypothesis when the data were interval or ratio scaled, using the t-test. The t-test is a statistical technique used to test the significance of the difference between two means derived from two distributions.

III. Result and Discussion

Research Results

The instrument pilot test was conducted during the odd semester of the 2025/2026 academic year in Class XII MIPA 2 at SMAN 1 Soromandi. The instrument tested in this study was a test of students' learning outcomes in the cognitive domain. The tests conducted included validity testing, reliability testing, difficulty level testing, and discriminant power testing.

To test the validity of the test items, this study used the product-moment correlation equation with raw scores (Arikunto, 2019). Based on the results of the instrument pilot test, 25 valid items and 5 invalid items were identified out of the 30 items tested. The following table presents the results of the instrument validity test.

Table 1: Validity Test Results

Total PD	Level Sig	Valid	Invalid
30	5%	25	5

The reliability test for the items in this study was conducted using the Spearman-Brown formula (Sundayana, 2016). The results of the reliability test were as follows: r_{11} 0.828, whereas r_{table} 0.707. Based on the calculation results, it can be seen that $r_{11} > r_{table}$, therefore, the 30 items are considered reliable.

Table 2: Reliability Test Results

Total PD	Level Sig	r_{table}	r_{11}	details
30	5%	0,707	0,828	Reliabel

Based on the results of the difficulty level assessment of the 30 test items, 3 items were classified as easy, 24 as moderate, and 3 as difficult.

Table 3: Test Item Difficulty Assessment Results

Number of questions	Total SM	Total SS	Total SS
30 questions	3 questions	24 questions	3 questions

The results of the item discrimination test on the 30 test items showed that 10 items were rated "good," 12 items "fair," 4 items "poor," 1 item "very poor," and 3 items "very good."

Table 4: Item Discrimination Test Results

Total SJ	Total STB	Total SB	Total SC	Total SBS
1 questions	4 questions	10 questions	12 questions	3 questions

The description of student learning outcome data pertains solely to the cognitive domain. The data on student learning outcomes in the cognitive domain obtained in this study consist of the results of the pre-test and post-test. Based on the research findings, the mean score on the pre-test for physics learning outcomes among students in the experimental class was 36.741, while the mean score on the pre-test for the control class was 33.333. Meanwhile, for the final physics achievement tests, the average scores for the experimental and control classes were 79.704 and 75.111, respectively.

Table 5: Initial and Final Test Results

	Preliminary Test		Final Exam	
Component	Experimental Class	Control Class	Experimental Class	Control Class
Total PD	27	27	27	27

Highest Score	64	56	92	84
Lowest Value	20	16	68	60
Average	36,741	33,333	79,704	75,111

Based on Table 5, the initial test results show that there was no significant difference in the initial abilities of students between the experimental and control classes, so they can be categorized as similar. It can be concluded that there was an improvement in students' physics learning outcomes in both the experimental and control classes. This is indicated by an increase in students' average scores after the intervention was administered. The experimental class showed an increase of 42.963, while the control class showed an increase of 41.778. The improvement in students' learning outcomes is illustrated in the graph in Figure 1.

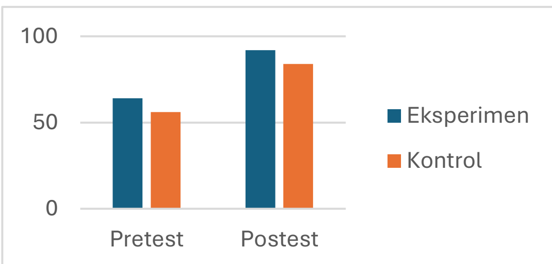

Figure 1: Comparison of Learning Outcomes

Homogeneity and normality tests were conducted to determine whether the study sample was homogeneous and normally distributed. The homogeneity test was calculated using the analysis of variance (F-test), and the normality test was conducted using the chi-square test. The homogeneity test of the pretest data was used to determine the variance in the initial ability of students in the experimental and control classes before the intervention was administered. The results of the homogeneity test for the initial test data in both classes are shown in Table 6 below.

Table 6: Results of the Homogeneity Test for Initial Test Data

Class	F_{count}	F_{table}	α	details
Eksperimental	1,077	1,929		Homogen
Control				

Table 6 shows that the value $F_{count} < F_{table}$, or with 1,077 < 1,929 $db_{numerator}$ = 26 and $db_{denominator}$ = 26 at a 5% significance level. From this information, it can be concluded that the two samples are homogeneous at a 5% significance level, meaning that before the treatment was administered, the experimental and control classes had the same initial ability.

The normality test conducted on the pretest data was intended to determine whether the data were normally distributed or not. The results of the normality test at a 5% significance level were x^2_{count} an experimental class size of 4,653 with df = 4 and x^2_{count} The control class had a value of 3.861 with df = 4. Meanwhile, at a 5% significance level and with df = 4, the value obtained was x^2_{table} 9,488. This indicates that the initial test data for students in both classes are normally distributed. The results of the normality test are shown in Table 7 below.

Table 7: Results of the Normality Test for Initial Test Data

Class	x^2_{count}	x^2_{table}	α	details
Eksperimental	4,653	9,488	0,05	**Normally Distributed**
Control	3,861			

The normality plots for the initial test data from the experimental and control classes are shown in the following figure.

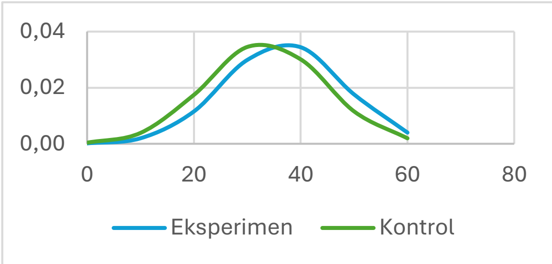

Figure 2: Normality Curve of the Pre-Test Data

The homogeneity test for the post-test data was used to determine which hypothesis test (t-test) to use next. The results of the homogeneity test for the students' physics learning outcomes on the post-test are shown in Table 8 below.

Table 8: Results of the Homogeneity Test for the Post-Test Data

Class	F_{count}	F_{table}	α	details
Eksperimental	1,192	1,929	0,05	**Homogen**
Control				

Table 9 shows that $F_{count} < F_{table}$, or 1,192 < 1,929 with $db_{numerator}$ = 26 and $db_{denominator}$ = 26 at a 5% significance level. From this information, it can be concluded that both samples are homogeneous at a 5% significance level.

The normality test of the final test data aims to determine whether the final learning outcome data for both classes are normally distributed and to identify the statistical test used to test the hypothesis. The results of the normality test for the physics learning outcome data in both classes at a 5% significance level are as follows: x^2_{count} an experimental class size of 7,377 with df = 5 and x^2_{count} the control class had a value of 6.806 with df = 5. Meanwhile, at a 5% significance level and with df = 5, the value obtained was x^2_{table} 11,070. This indicates that the physics learning outcome data for students in both classes are normally distributed. The results of the normality test are shown in Table 9 below.

Table 9: Results of the Normality Test for Final Test Data

Class	x^2_{count}	x^2_{table}		details
Eksperimental	7,377	11,070	0,05	**Normal**
Control	6,806			

The normality plots for the final test data from the experimental and control classes are shown in the following figure.

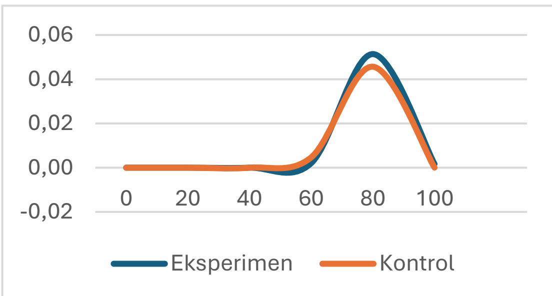

Figure 3: Normality Curve of Final Test Data

The hypothesis test aims to determine whether the hypothesis proposed in this study is accepted or rejected, taking into account the results of the homogeneity and normality tests that have been conducted. Based on the results of the homogeneity and normality tests of the final exam data, it was found that the data from both classes were homogeneous and normally distributed. Therefore, the hypothesis test used was a parametric statistical test with the t-test for pooled variances. The results of the hypothesis test can be seen in Table 10 below.

Table: 10 Results of the Hypothesis Test on Physics Learning Outcomes

Class	Total PD	Average	Varians (s^2)	t_{count}	t_{table}
Eksperimental	27	79,704	65,727	2,172	**1,676**
Control	27	75,111	55,125		

Based on Table 11 above, it can be seen that the value t_{count} > t_{table}, namely 2.172 > 1.676 at a 5% significance level with 52 degrees of freedom (df), so H_0 can be rejected. This means that the guided inquiry learning model, supported by PhET Simulations, has an effect on students' physics learning outcomes.

Discussion

This study aims to determine the effect of the guided inquiry learning model assisted by PhET Simulations on the physics learning outcomes of students at SMAN 1 Soromandi on the topics of temperature and heat, at SMAN 1 Soromandi, Soromandi Subdistrict, Bima Regency. In this study, there were two sample groups: Class XI MIPA 2 as the experimental class and Class XI MIPA 3 as the control class, each consisting of 27 students. The experimental class was taught using the guided inquiry model supported by PhET Simulations, while the control class received conventional instruction.

A pilot test of the instrument was conducted at SMAN 1 Soromandi with Class XII MIPA 2, consisting of 30 students. The pilot test was carried out prior to the main study. The purpose of the pilot test was to determine the instrument's validity, reliability, difficulty level, and discriminative power. The test instrument consisted of 30 multiple-choice questions.

The results of the instrument analysis showed that, of the 30 test items that were pilot-tested, 25 were valid and 5 were invalid. Consequently, the researcher concluded that these 25 items should be administered to students during data collection for the initial (pretest) and final (posttest) assessments. The reliability test revealed that all multiple-choice items fell into the reliable category because the values r_{11} the result is greater than the value r_{tabel} or 0.828 > 0.707. The difficulty levels of the test items were determined as follows: 3 items were classified as easy, 24 as moderate, and 3 as difficult. The discriminative power of the test items showed that 10 items were classified as good, 12 as adequate, 4 as poor, 1 as very poor, and 3 as excellent.

This study was conducted over five sessions in each class, with a time allocation of 90 minutes (2 class periods). The first session was used for the pre-test; the second, third, and fourth sessions were used for presenting the material; and the fifth session was used for the post-test. All activities in this study were conducted in person. Students in the experimental and control classes were first given a pre-test to determine their initial abilities before receiving the treatment, and the post-test was designed to assess the impact of the instruction on students' physics learning outcomes after the treatment was administered.

The initial test results show that the average score of the 27 students in the experimental class was 36.741, with a highest score of 64.00 and a lowest score of 20.00, while the average score for the control class, consisting of 27 students, was 33.333, with a highest score of 56.00 and a lowest score of 16.00. After both classes received the treatment, the researcher administered a final learning achievement test, which revealed that the average learning achievement score for students in the experimental class was 79.704, with a highest score of 92.00 and a lowest score of 68.00, while the average score for the control class was 75.111, with a highest score of 84.00 and a lowest score of 60.00. The average final test score indicates that there was an improvement in students' physics learning outcomes compared to their previous scores.

The homogeneity test on the pre-test was intended to determine whether the students' initial abilities were at the same level or not. Meanwhile, the homogeneity test on the post-test was used to test the hypothesis. The homogeneity test used the F-test or variance test formula. Based on the results of the homogeneity test analysis of the pre-test using a 5% significance level, the value obtained was F_{count} 1,077 with F_{table} 1,929. Value $F_{count} < F_{table}$, which means that the data are classified as homogeneous and that both classes have the same initial ability. The homogeneity test on the final exam yielded a value of F_{count} namely 1.192 with F_{table} 1,929. Value $F_{count} < F_{table,}$ this means that the data is classified as homogeneous; therefore, once the homogeneity test confirms that the final test data is homogeneous, we can proceed to the parametric hypothesis test (t-test) to be used.

The normality test is the second requirement, following the homogeneity test, for conducting a hypothesis test. The normality test aims to determine whether the data being tested is normally distributed or not. The normality test used is the chi-square test. Based on the results of the normality test analysis of the preliminary test in the experimental and control classes, the following values were obtained x^2_{count} 4,653 and 3,861, respectively, with x^2_{table} 9,488. Value x^2_{count} In both classes, the values are smaller than x^2_{table} and thus classified as normally distributed. Meanwhile, the results of the normality test analysis for the final test in the experimental and control classes yielded a value of x^2_{count} 7,377 and 6,806, respectively, with x^2_{table} 11,070. Value x^2_{count} In both classes, the values are smaller than x^2_{table} and thus classified as normally distributed. Once the pre-test and post-test results were classified as homogeneous and normally distributed, the study proceeded to parametric hypothesis testing.

The hypothesis test used is a two-tailed t-test with the pooled variance formula. This formula can be used when the data are homogeneous and normally distributed. This is why the prerequisite tests were conducted first. The significance level used in these calculations is 5% with df = $(n_1 + n_2) - 2$. Comparison criteria between t_{count} with t_{table} is if $t_{count} > t_{table}$ so H_o rejected and H_a accepted, whereas if $t_{count} < t_{table}$ so H_o accepted and H_a rejected.

Based on the hypothesis test, it was found that t_{count} 2,172 and t_{table} 1,676. When compared, the result is $t_{count} > t_{table}$ which means H_a accepted, Thus, the guided inquiry learning model supported by PhET Simulations has an effect on students' physics learning outcomes.

The results of the study indicate that final learning outcomes differ from initial abilities. Both the experimental and control classes showed improvement. Several factors influenced these results, including the fact that in the experimental class, which used PhET Simulations, the guided inquiry learning model supported by PhET Simulations made students more enthusiastic about participating in the learning process. The method of presenting the material differed from conventional teaching. Learning was conducted by linking students' prior experiences to the material being taught. Students were presented with questions related to the material and connected to everyday situations they had previously observed or experienced. The answers provided by the students were then linked to the concepts covered in the lesson. This process of connecting concepts to prior knowledge utilized PhET Simulations to help students more easily grasp the intended meaning of the material presented. In addition, the use of PhET Simulations also sparked students' interest in the learning process, leading to increased student engagement and motivation. A solid conceptual understanding and heightened interest in learning will support improvements in students' learning outcomes.

The results of this study and the data analysis indicate that students' final performance improved in both classes compared to their initial performance. However, the improvement in learning outcomes in the experimental class was greater than that in the control class. This demonstrates that the guided inquiry learning model supported by PhET Simulations has a significant effect on students' physics learning outcomes. The research results show that the average score for the experimental class was 79.704 and for the control class was 75.111; thus, it can be concluded that the experimental and demonstration methods have significantly different effects on students' physics learning achievement.

This is consistent with research conducted

by Aeni et al. (2017), which found that the guided inquiry model makes students more active compared to previous learning activities that used the direct instruction model. After using the guided inquiry model, students were able to conduct experiments that directly engaged them in exploring information they did not yet know, rather than merely receiving information from the teacher. Based on the analysis of the data, it was found that physics instruction using the guided inquiry model supported by PhET Simulations is effective in improving the critical thinking skills of physics students.

Puspita (2018) found that the critical thinking skills of students at SMAN 2 Sidoarjo were categorized as moderate after using guided inquiry. Additionally, Azizah (2016) reported that guided inquiry is capable of improving students' thinking skills. The guided inquiry model supported by PhET Simulations significantly increased students' critical thinking skills by 5%. The guided inquiry model involves analytical, critical, and systematic learning activities. This indicates that the inquiry-based learning model using simulation media has a more positive impact compared to conventional learning models (Hayati et al., 2017).

The experimental class, which was treated with the application of a guided inquiry learning model aided by virtual simulations, had an effect on students' mastery of physics concepts (Fadholi et al., 2025). This study is also consistent with research conducted by Hikmawati et al. (2023), which found that PhET simulation software can serve as an alternative learning tool to help students master various physics concepts.

IV. Conclusion

Conclusion

Based on the research question, the research findings, and the discussion, it can be concluded that the guided inquiry learning model aided by PhET Simulations is effective in improving students' physics learning outcomes on the topic of temperature and heat for 11th-grade MIPA students at SMAN 1 Soromandi.

Recommendations

Based on the research findings, the researcher offers several recommendations: teachers can utilize the guided inquiry model supported by PhET Simulations as an alternative to improve students' physics learning outcomes. Future researchers are encouraged to take into account time estimates to ensure the success of the learning process and to be more creative in designing student worksheets (LKPD). These worksheets should be relevant to students' daily lives so that they can connect what they learn to real-world situations.

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