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The Effect of Discovery Learning Model Assisted by E-Module on Students' Physics Learning Outcomes

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Abstract—*This study aimed to determine the effect of the Discovery Learning model assisted by e-modules on students' physics learning outcomes. This study employed a quasi-experimental design with a nonequivalent control group design. The population consisted of all students of class XI A at SMAN 1 Kediri in the 2025/2026 academic year. Saturated sampling was used, with class XI A2 as the experimental class consisting of 20 students and class XI A1 as the control class consisting of 21 students. The research instrument was a multiple-choice test consisting of 25 items that had been tested for validity, reliability, item difficulty level, and discrimination index. Data analysis techniques included normality testing, homogeneity testing, and hypothesis testing using the t-test. The results showed that the implementation of the Discovery Learning model assisted by e-modules significantly affected students' physics learning outcomes. This learning model increased students' engagement in the learning process and encouraged them to actively discover concepts independently. These findings indicate that Discovery Learning assisted by e-modules not only improves students' physics learning outcomes but also promotes active engagement, independent learning, and conceptual understanding in digital learning environments.*

Keywords— Discovery Learning, E-Module, Learning Outcomes.
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1. Introduction

Twenty-first century education requires students to possess critical thinking, creativity, collaboration, and communication skills in order to face the rapid development of science and technology. Effective learning is necessary to support the development of these skills, including in physics learning. Physics is a branch of natural science that studies natural phenomena through scientific processes such as observation, experimentation, and analysis. However, physics learning is often considered difficult by most students due to abstract concepts and mathematical calculations. In addition, teacher-centered learning processes cause students to become less active and less interested in learning activities.

Based on observations and interviews with physics teachers at SMAN 1 Kediri, students' learning outcomes were still relatively low and many students had not achieved the Minimum Mastery Criteria (KKM). The learning process still relied on lecture methods and conventional textbooks, causing students to be passive during learning activities. One solution that can be implemented to improve students' learning outcomes is the application of the Discovery Learning model assisted by e-modules.

The Discovery Learning model is a learning approach designed to improve learning outcomes and develop active learning processes in students, enabling them to discover concepts independently so that the acquired knowledge is more meaningful and easier to remember. Discovery Learning emphasizes students' active involvement in discovering concepts through investigation and problem-solving activities. Learning media also play an important role in supporting the learning process. One learning medium that can be used is the e-module because it provides concise material summaries and can improve students' learning outcomes. The use of e-modules as learning media is expected to help students understand physics concepts in a more interesting and interactive way. Several previous studies have shown that the Discovery Learning model assisted by e-modules can improve students' motivation and learning outcomes. Several previous studies have reported that Discovery Learning and e-modules can improve students' learning outcomes. However, most studies focus on general science subjects or investigate the effectiveness of Discovery Learning and e-modules separately. Research examining the integration of Discovery Learning assisted by e-modules

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in physics learning at the senior high school level remains limited. Therefore, this study attempts to fill this gap by investigating the effect of Discovery Learning assisted by e-modules on students' physics learning outcomes. Therefore, this study aims to determine the effect of the Discovery Learning model assisted by e-modules on students' physics learning outcomes.

According to Bruner, Discovery Learning is a constructivist learning approach that encourages students to actively construct knowledge through exploration and problem-solving activities. The model consists of six learning phases, namely stimulation, problem statement, data collection, data processing, verification, and generalization. Through these stages, students are encouraged to investigate learning problems independently and develop a deeper conceptual understanding.

2. Method

This study employed a quasi-experimental design using a nonequivalent control group design. The study involved two classes, namely the experimental class and the control class. The experimental class received treatment using the Discovery Learning model assisted by e-modules, while the control class received conventional learning. The study was conducted at SMAN 1 Kediri during the even semester of the 2025/2026 academic year. The research sample consisted of class XI A2 as the experimental class with 20 students and class XI A1 as the control class with 21 students. The research instrument was a multiple-choice learning outcome test consisting of 25 items. Before being used, the instrument was tested for validity, reliability, item difficulty level, and discrimination index.

The prerequisites for data analysis consisted of a normality test using the Chi-Square test to determine the distribution of test result data from both classes, and a homogeneity test using the F-test to obtain the assumption that both classes had the same initial sample characteristics. Furthermore, hypothesis testing using the t-test was conducted to determine whether there were differences in students' learning outcomes between the two classes after the treatment was administered. The research data were obtained from a learning outcomes test in the form of multiple-choice questions that had undergone validity and reliability testing processes. Based on the validity test results of 25 test items, 20 items were found to be valid and 5 items were invalid because their calculated correlation coefficients were lower than the critical value at the 5% significance level. The reliability value was calculated using the KR-20 formula at a significance level of 5%, with the criterion that if $r_{11} \geq r_{tabel}$, the items were considered reliable. Based on the reliability test results of the 25 test items, all 25 items were declared reliable. The test items were developed based on the cognitive domain, which consists of six aspects: C1 (remembering), C2 (understanding), C3 (applying), C4 (analyzing), C5 (evaluating), and C6 (creating). The data were analyzed descriptively and inferentially and presented in the form of graphs and tables illustrating the Pretest and Posttest results. Hypothesis testing was conducted to determine whether there was a significant difference between the experimental class, which applied the discovery learning model assisted by an e-module, and the control class, which implemented conventional learning.

The e-module used in this study was developed based on the topic of sound waves. The module consisted of learning objectives, concept explanations, illustrations, learning videos, practice questions, and evaluation activities. The e-module was designed to support students in exploring concepts independently and facilitate active learning during the implementation of the Discovery Learning model. The learning process in the experimental class was conducted through the phases of Discovery Learning. During the stimulation phase, students were introduced to contextual phenomena related to sound waves. In the problem statement phase, students formulated learning problems. During data collection and data processing, students explored information through the e-module and group discussions. Verification activities were conducted to examine the accuracy of the obtained concepts, while generalization activities were carried out to formulate conclusions based on the learning findings.

3. Result and Discussion

The results of the instrument testing indicated that the research instrument was suitable for use in the study. Out of 25 test items administered, 20 items were declared valid, and all items were found to be reliable. Data collection was conducted through the administration of a pretest and a posttest to two sample groups, namely the experimental class, which received instruction using the Discovery Learning model assisted by an e-module, and the control class, which received conventional instruction. The pretest results are presented in Table 1, while the posttest results are shown in Table 2. The average scores of the pretest and posttest for students' physics learning outcomes are presented in Table 3.

Table 1. Pretest Data of Students' Physics Learning Outcomes

Score Data	Eksperimental Class Pretest	Control Class Pretest
Highest Score	50	55
Lowest Score	15	10
Normality Test	Normally Distributed	
Homogeneity Test	Homogeneous	

Table 2. Posttest Data of Students' Physics Learning Outcomes

Score Data	Experimental Class Posttest	Control Class Posttest
Highest Score	95	85
Lowest Score	70	60
Normality Test	Normally Distributed	

Homogeneity Test	Homogeneous

Table 3. Average Data of Pretest and Posttest Score on Students' Physics Learning Outcomes

Class	Number of Data	Pretest Mean Score	Posttest Mean Score	Improvement in Mean Score	Standard Deviation	Variance
Experimental	20	28,50	81,25	52,75	6, 86	47,03
Control	21	32,14	71,42	39,28	6,73	45,35

The observational data on learning outcomes indicated that both the experimental class and the control class experienced an increase in scores from the Pretest to the Posttest. However, the improvement observed in the experimental class was considerably more significant, with a higher average score in learning outcomes.

The prerequisite tests conducted on the Pretest and Posttest data in both classes showed that the data were normally distributed. In the Pretest, at a significance level of 5%, the calculated Chi-Square value (X^2calculated) for the experimental class was 8.96 with df = 5, while the control class obtained a value of 4.49 with df = 5. Meanwhile, the Chi-Square critical values (X^2table) at the same significance level were 12.59 for the experimental class and 11.07 for the control class. For the Posttest, at a significance level of 5%, the calculated Chi-Square value (X^2calculated) for the experimental class was 2.02 with df = 5, while the control class obtained a value of 0.38 with df = 5. Meanwhile, the Chi-Square critical value (X^2table) at the same significance level was 11.07. These results indicate that the data were normally distributed.

Furthermore, the data were found to have homogeneous variances. In the Pretest, the calculated F-value (Fcalculated) was smaller than the critical F-value (Ftable), namely $1.37 \leq 2.16$, with numerator degrees of freedom df = 20 and denominator degrees of freedom df = 19 at a significance level of 5%. Similarly, in the Posttest, the calculated F-value was smaller than the critical F-value, namely $1.01 \leq 2.12$, with numerator degrees of freedom df = 19 and denominator degrees of freedom df = 20 at a significance level of 5%. These findings indicate that the variances of both groups were homogeneous.

Table 4. Hypothesis Testing Data on Students' Physics Learning Outcomes

Class	Number of Data	Mean	Variance (S^2)	T_{count}	t_{table}
Experimental	20	81, 3	47, 04	4, 67	2,023
Control	21	71, 4	45, 35		

Based on the results of data analysis using the t-test, it was found that the Discovery Learning model assisted by an e-module had a significant effect on students' physics learning outcomes. As presented in Table 4, the calculated t-value (tcount = 4.67) was higher than the critical t-value (ttable = 2.023) at a significance level of 5%. Therefore, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_a) was accepted. This finding indicates that the implementation of the Discovery Learning model assisted by an e-module significantly improved students' physics learning outcomes compared to conventional instruction.

The implementation of the Discovery Learning model assisted by an e-module in the experimental class had a positive impact on students' learning outcomes. Students became more actively engaged in the learning process as they were directly involved in discovering concepts through discussions, observations, and investigative activities. The use of e-modules also helped students understand abstract physics concepts through visual displays, learning materials, and interactive activities. Consequently, the learning process became more meaningful and engaging, which increased students' motivation and participation during instruction.

The findings of this study are consistent with the research conducted by Raharjo (2024), which demonstrated that Discovery Learning assisted by e-modules could improve students' motivation and learning outcomes. Similarly, Dari and Sudatha (2022) reported that e-modules oriented toward Discovery Learning were effective in increasing students' enthusiasm for learning and facilitating a more active learning process.

The improvement in students' learning outcomes can be explained through the characteristics of Discovery Learning and the support provided by the e-module. Discovery Learning encourages students to actively construct knowledge through observation, investigation, experimentation, and problem-solving activities. Through these learning experiences, students are not merely recipients of information but actively participate in the process of concept formation. Meanwhile, the e-module provides interactive learning resources that enable students to access learning materials independently, review concepts repeatedly, and visualize abstract physics phenomena. This combination promotes meaningful learning experiences and strengthens students' conceptual understanding, which ultimately contributes to higher learning outcomes.

To strengthen the interpretation of the effectiveness of the treatment, an effect size analysis was conducted using Cohen's d. The analysis yielded a Cohen's d value of 1.45, which falls into the very large effect category. This result indicates that the Discovery Learning model assisted by e-modules had a substantial impact on improving students' physics learning outcomes. Therefore, the observed difference between the experimental and control groups was not only statistically significant but also educationally meaningful.

The average improvement achieved by both the experimental and control classes from the Pretest to the Posttest is

presented in the form of a histogram, as shown in Figure 1.

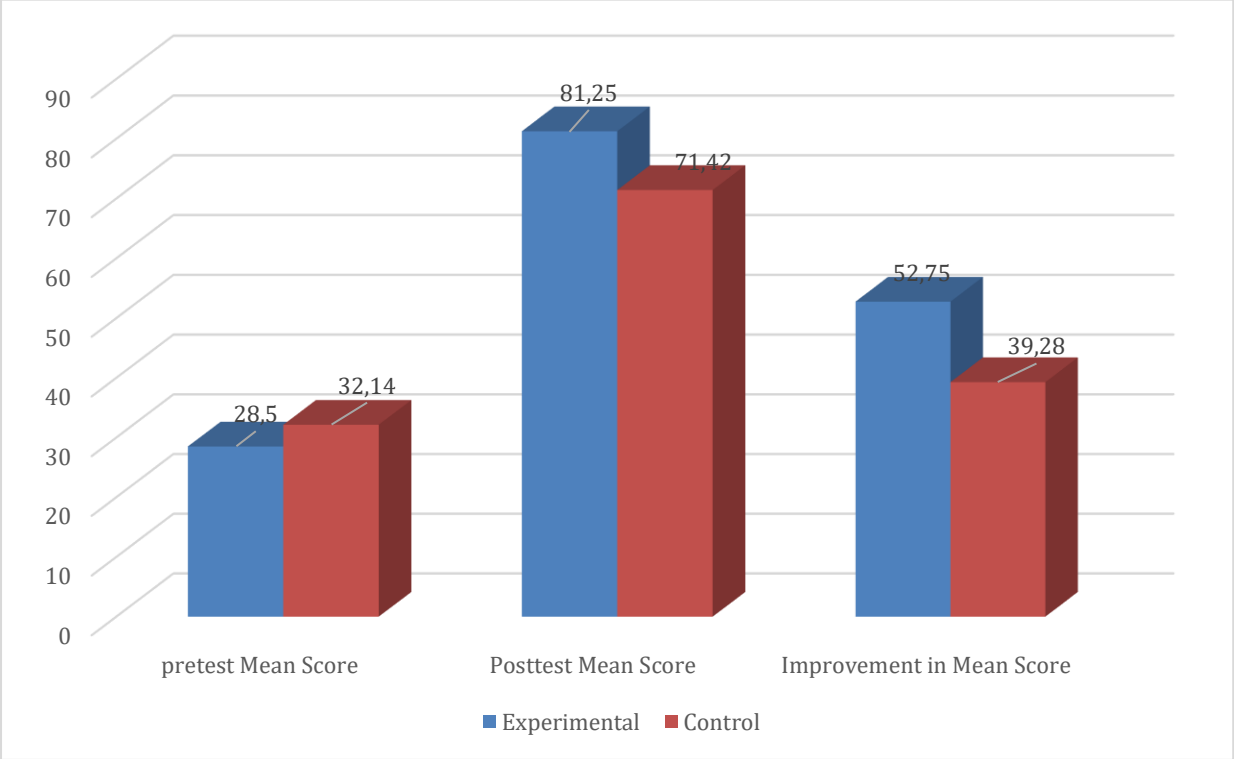

Figure 1. Comparison of the Improvement in the Average Scores of Physics Learning Outcomes

Figure 1 shows that both the experimental and control classes experienced an improvement in learning outcomes after the learning process. However, the increase in the experimental class was greater than that of the control class. This finding further supports the effectiveness of the Discovery Learning model assisted by an e-module in improving students' physics learning outcomes.

4. Conclusion

Based on the findings of this study, it can be concluded that the Discovery Learning model assisted by e-modules significantly improves students' physics learning outcomes on the topic of sound waves at SMAN 1 Kediri. The implementation of Discovery Learning encourages students to actively construct knowledge, while the e-module facilitates independent learning and conceptual understanding through interactive learning resources. Therefore, this learning approach can be considered an effective alternative for physics instruction in the digital learning era. Future studies are recommended to investigate its influence on students' critical thinking skills, problem-solving abilities, and learning motivation using larger and more diverse samples.

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