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The Influence of Discovery Learning Model on Physics Learning Motivation and Critical Thinking Skills of Senior High School Students

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ABSTRACT

Physics learning in the 21st century requires students to develop not only conceptual understanding but also motivation and critical thinking skills needed to solve scientific problems. However, teacher-centered learning practices often limit students' opportunities to actively explore and construct knowledge. This study aimed to analyze the effect of the discovery learning model on students' physics learning motivation and critical thinking skills at SMA Negeri 1 Soyo Jaya. This research used a quantitative approach with a randomized pretest-posttest control group design involving 28 eleventh-grade students. Data were collected through observation, motivation questionnaires, critical thinking tests, and documentation. Data analysis was conducted using descriptive statistics and inferential analysis through normality tests, homogeneity tests, and independent sample t-tests. The results showed that the experimental class experienced higher improvement than the control class, with motivation scores increasing from 60.43 to 84.67 and critical thinking scores increasing from 50.25 to 64.25. The hypothesis test obtained a significance value of 0.000 < 0.05, indicating a significant effect of discovery learning. These findings show that discovery learning encourages active involvement, independent exploration, and analytical thinking. Therefore, discovery learning can be an effective instructional model to improve students' motivation and critical thinking skills in physics learning.

Keywords : *Critical Thinking Skills, Discovery Learning, Learning Motivation, Physics Learning, Student Engagement.*

INTRODUCTION

Twenty-first-century education requires a learning process that is not only oriented toward mastering learning materials but also toward developing students' abilities in critical thinking, problem-solving, collaboration, and independent knowledge construction. The changing demands of these competencies encourage the transformation of learning from teacher-centered approaches toward learning processes that provide greater opportunities for students to actively explore concepts because active involvement in learning can help students develop critical thinking skills through analysis and problem-solving processes (Palinussa et al., 2023). In the context of science learning, especially physics, students need to be involved in the process of discovering relationships between scientific concepts and real phenomena in their surrounding environment. Physics learning that only focuses on information delivery and formula application tends to provide limited opportunities for students to develop analytical abilities and scientific reasoning, therefore, learning processes that can build critical thinking skills through

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exploration activities and concept discovery are needed (Ruhana et al., 2023). Physics learning processes need to be directed toward activities that can encourage student involvement to increase learning motivation while developing higher-order thinking skills required to face the development of science and technology. Learning that provides opportunities for students to participate actively has been proven to play an important role in improving learning motivation and critical thinking skills as essential competencies in twenty-first-century education (Rizki et al., 2024).

Current science learning conditions still face challenges in improving the quality of students' thinking abilities and learning engagement. The results of the Programme for International Student Assessment (PISA) in 2022 showed that Indonesian students' science ability obtained an average score of 383 points, which was still below the OECD average of 485 points (Organisation for Economic Co-operation & Development, 2023). This achievement indicates that students' abilities to use scientific knowledge, analyze information, and apply science concepts to various problems still require attention, especially through the implementation of learning approaches that can continuously train critical thinking processes (UBM et al., 2024). In addition to thinking ability, learning motivation is also an important factor because it acts as an internal drive that influences students' engagement, persistence, and success in understanding learning materials. Good learning motivation can increase student participation in the learning process because students are encouraged to explore, understand concepts, and solve given problems (Salim & Ridlo, 2023). Low active involvement of students in physics learning can cause students to become less accustomed to developing curiosity, expressing opinions, and carrying out critical thinking processes in solving scientific problems. This condition shows that learning motivation has an important relationship with critical thinking skills because strong learning motivation can help students become more active in analyzing and constructing an understanding of the concepts being studied (Rohmawati & Zevender, 2022).

Various previous studies have proven that the implementation of the discovery learning model is associated with improving the quality of students' learning processes and outcomes. Firdaus et al. (Firdaus et al., 2022) showed that the implementation of discovery learning was able to develop critical thinking skills and increase students' learning motivation through a learning process that provided opportunities for students to actively discover concepts. Kadir et al. (2023) found that the guided discovery method had a positive effect on improving students' motivation and learning outcomes because students gained direct learning experiences through the discovery process. Hidayatullah and Gusemanto (2024) revealed that the discovery learning model assisted by multimedia could improve students' critical thinking skills in physics learning through analysis and problem-solving activities. Elfianawati et al. (2024) proved that discovery learning influenced students' critical thinking abilities, while learning motivation played an important role in supporting the effectiveness of the learning process.

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Although various previous studies have demonstrated the effectiveness of discovery learning in improving learning motivation and critical thinking skills, studies that integrate these two aspects simultaneously in physics learning at the senior high school level still need further development, particularly in the context of different student characteristics and learning environments. In addition, most previous studies have focused more on measuring only one aspect of students' abilities or have been conducted in learning fields other than physics, making it necessary to conduct research that simultaneously analyzes the influence of discovery learning on affective aspects represented by learning motivation and cognitive aspects represented by critical thinking skills. Based on this gap, this study aims to analyze the effect of the discovery learning model on students' physics learning motivation and critical thinking skills at SMA Negeri 1 Soyo Jaya. The results of this study are expected to contribute to the development of physics learning strategies that are more active, innovative, and oriented toward improving students' higher-order thinking skills.

LITERATURE REVIEW

Discovery Learning Model

The discovery learning model is a student-centered learning approach that emphasizes students' active involvement in constructing knowledge through exploration, investigation, and problem-solving activities. This model encourages students to discover concepts independently rather than only receiving information directly from teachers, allowing them to develop deeper conceptual understanding and scientific reasoning skills. In science learning, discovery learning provides opportunities for students to observe phenomena, identify problems, collect information, analyze findings, and formulate conclusions based on their learning experiences. The implementation of discovery learning can improve students' ability to process information and develop higher-order thinking because students are actively involved in meaningful learning activities (Akhir et al., 2023). Furthermore, Manurung and Pappachan (2025) explained that discovery learning plays an important role in developing students' critical thinking abilities because the learning process trains students to investigate problems and construct their own understanding.

The effectiveness of discovery learning is closely related to the learning stages that require students to participate actively in scientific inquiry activities. Through stimulation, problem identification, data collection, data processing, verification, and conclusion-making, students are encouraged to think systematically and independently. This learning process helps students not only understand theoretical concepts but also apply their knowledge to solve contextual problems. Arifianto and Koeswanti (Arifianto & Koeswanti, 2022) stated that discovery learning has a positive influence on students' critical thinking skills because students become more active in analyzing information and evaluating solutions.

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Similarly, Ayu et al. (Ayu et al., 2025) reported that discovery learning supports students' thinking development by providing opportunities to explore learning materials through investigation and reflection.

In physics education, discovery learning is considered relevant because physics requires students to understand concepts, analyze phenomena, and connect theories with real-world situations. Learning activities based on discovery encourage students to move beyond memorizing formulas and develop scientific reasoning through direct experiences. This approach also creates an interactive classroom environment where students can discuss, question, and evaluate scientific concepts collaboratively. Hidayatullah and Gusemanto (2024) found that discovery learning supported by multimedia modules effectively improved students' critical thinking skills in physics learning by facilitating concept exploration. In addition, Gunawan et al. (2023) revealed that discovery learning assisted by learning media enhanced students' analytical abilities because media integration strengthened students' engagement in the discovery process.

Learning Motivation and Critical Thinking Skills

Learning motivation is an important psychological factor that influences students' involvement, persistence, and success in the learning process. Students with high learning motivation tend to participate actively, show curiosity, and have a stronger willingness to understand complex concepts. In physics learning, motivation plays an essential role because students are required to analyze abstract concepts and solve scientific problems. Kadir et al. (2023) showed that discovery-based learning methods increased students' motivation because students obtained direct experiences during the learning process. Aldalur and Perez (2023) also emphasized that learning approaches involving discovery activities can improve student motivation by creating interactive and engaging learning environments.

Critical thinking skills are one of the essential competencies required in 21st-century education because they enable students to evaluate information, analyze problems, and make logical decisions. In physics learning, critical thinking helps students understand scientific relationships and apply concepts to solve various problems. Therefore, learning strategies should provide opportunities for students to develop reasoning and analytical abilities. Asri et al. (2023) stated that developing critical thinking instruments and learning activities in physics is important to measure and strengthen students' higher-order thinking skills. Bakri et al. (2024) also explained that students' critical thinking skills can improve when learning activities encourage reflection, analysis, and problem-solving processes.

Learning motivation and critical thinking skills are interconnected aspects that influence students' success in understanding scientific concepts. High motivation encourages students to participate actively in learning activities, while active involvement provides more opportunities to develop critical thinking abilities. Learning models that combine exploration, discussion, and independent

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investigation can support both cognitive and affective aspects of students. Elfianawati et al. (2024) found that motivation plays an important role in strengthening the effectiveness of discovery learning toward students' critical thinking abilities. Furthermore, Fajriah and Amir (2024) stated that discovery learning supports students' independent learning processes, which contribute to the improvement of analytical and critical thinking skills.

Previous Studes

Previous studies have demonstrated that discovery learning contributes positively to improving students' motivation, learning outcomes, and critical thinking skills in various educational contexts. Firdaus et al. (2022) found that the implementation of discovery learning improved students' critical thinking skills and learning motivation because students were actively involved in constructing knowledge. Cholifah and Fada (2022) also reported that guided discovery learning supported the development of students' critical thinking skills through problem-solving activities and active exploration during the learning process.

Several studies have also integrated discovery learning with different learning media and strategies to enhance its effectiveness. Hatiningsih and Hanik (2023) showed that discovery learning assisted by audiovisual media increased student involvement because learning activities became more interactive and meaningful. Martir et al. (2024) found that the implementation of discovery learning improved students' critical thinking abilities because students gained direct experiences in identifying and solving problems. In addition, Mitasari et al. (2024) emphasized that science learning should encourage active learning activities to strengthen students' scientific literacy and higher-order thinking abilities.

Although previous studies have confirmed the effectiveness of discovery learning, most research has focused on either learning motivation or critical thinking skills separately and has been conducted in different subjects or educational contexts. Limited studies have examined the simultaneous influence of discovery learning on both physics learning motivation and critical thinking skills, especially among senior high school students. Therefore, this study provides novelty by analyzing the effect of the discovery learning model on two important learning aspects, namely affective aspects through learning motivation and cognitive aspects through critical thinking skills in physics education. This research expands previous findings by providing empirical evidence regarding the role of discovery learning in improving students' engagement and higher-order thinking abilities in the context of physics learning at SMA Negeri 1 Soyo Jaya.

METHODS

This study used a quantitative approach with an experimental research design aimed at analyzing the effect of the discovery learning model on students' physics learning motivation and critical thinking skills. The research design used

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was the Randomized Pretest-Posttest Control Group Design involving two research groups, namely the experimental class and the control class. The experimental class was treated using the discovery learning model, while the control class was treated using the cooperative learning model. Before the implementation of the learning process, both groups were given an initial test (pretest) to determine the initial conditions of students' learning motivation and critical thinking skills. After the learning process was completed, a final test (posttest) was administered to determine changes in students' abilities after the treatment.

This research was conducted at SMA Negeri 1 Soyo Jaya involving 28 eleventh-grade students as research subjects. The sampling technique used was purposive sampling, which refers to the selection of samples based on certain considerations and characteristics relevant to the needs of the study. Data collection techniques were carried out through observation, tests, questionnaires, and documentation. The test instrument was used to measure students' critical thinking skills through 15 essay questions, while the questionnaire instrument was used to measure students' physics learning motivation through 30 statement items. Data collection was conducted by administering a pretest before the treatment and a posttest after the entire learning process had been completed.

The data obtained in this study were analyzed using descriptive statistical analysis and inferential statistical analysis. Descriptive analysis was used to describe the improvement of students' learning motivation and critical thinking skills based on the average pretest and posttest scores in both the experimental and control classes. Inferential statistical analysis was carried out through several testing stages, including a normality test to determine data distribution, a homogeneity test to determine the equality of data variance, and hypothesis testing using the Independent Sample t-Test at a significance level of 0.05. All data analysis processes were performed using IBM SPSS Statistics version 25 software to obtain accurate statistical testing results.

RESULTS AND DISCUSSION

Results

The research results were obtained through descriptive analysis and inferential analysis to determine the effect of the discovery learning model on students' physics learning motivation and critical thinking skills in the experimental and control classes.

Table 1. Descriptive Analysis Results of Students' Critical Thinking Skills

Variable	Class	Average Pretest	Average Posttest	Improvement	Percentage (%)
Critical Thinking Skills	Experimental	50.25	64.25	14.00	28.20%
Critical	Control	50.07	58.07	8.00	16.00%

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Thinking Skills					

Based on Table 1, the descriptive analysis results show an improvement in students' critical thinking skills after the treatment was given to each class. The experimental class using the discovery learning model obtained an average pretest score of 50.25, which increased to 64.25 in the posttest with an improvement of 14 points or 28.20%. Meanwhile, the control class using cooperative learning obtained an average pretest score of 50.07, which increased to 58.07 in the posttest with an improvement of 8 points or 16.00%. These results indicate that the improvement in students' critical thinking skills in the experimental class was higher than in the control class.

Table 2. Descriptive Analysis Results of Students' Learning Motivation

Variable	Class	Average Pretest	Average Posttest	Improvement	Percentage (%)
Learning Motivation	Experimental	60.43	84.67	24.24	40.11%
Learning Motivation	Control	59.14	65.18	6.04	10.21%

Based on Table 2, the descriptive analysis results show that students' learning motivation increased after receiving the treatment. In the experimental class, the average pretest score of learning motivation was 60.43 and increased to 84.67 in the posttest, with an improvement of 24.24 points or 40.11%. Meanwhile, in the control class, the average pretest score was 59.14 and increased to 65.18, with an improvement of 6.04 points or 10.21%. The difference in improvement indicates that the implementation of the discovery learning model resulted in greater changes in learning motivation compared to the learning process applied in the control class.

Table 3. Results of Normality and Homogeneity Tests of Research Data

Statistical Test	Variable	Class	Sig. Value	Significance Level	Description
Normality (Shapiro-Wilk)	Learning Motivation	Experimental	0.125	0.05	Normal
Normality (Shapiro-Wilk)	Learning Motivation	Control	0.214	0.05	Normal
Normality (Shapiro-Wilk)	Critical Thinking Skills	Experimental	0.183	0.05	Normal
Normality (Shapiro-	Critical Thinking	Control	0.197	0.05	Normal

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Wilk)	Skills				
Homogeneity (Levene Test)	Learning Motivation	Experimental-Control	0.236	0.05	Homogeneous
Homogeneity (Levene Test)	Critical Thinking Skills	Experimental-Control	0.318	0.05	Homogeneous

Based on Table 3, the results of the normality test using Shapiro-Wilk show that all data on learning motivation and critical thinking skills in both the experimental and control classes obtained significance values greater than 0.05, indicating that the data were normally distributed. Furthermore, the results of the homogeneity test using Levene Test showed a significance value of 0.236 for learning motivation and 0.318 for critical thinking skills, which were greater than the significance level of 0.05. These results indicate that the research data had homogeneous variance and met the requirements for hypothesis testing using the Independent Sample t-Test.

Table 4. Results of Independent Sample t-Test

Variable	Statistical Test	Sig. (2-tailed)	Significance Level	Decision
Learning Motivation	Independent Sample t-Test	0.000	0.05	H_0 rejected and H_1 accepted
Critical Thinking Skills	Independent Sample t-Test	0.000	0.05	H_0 rejected and H_1 accepted

Based on Table 4, the results of hypothesis testing using the Independent Sample t-Test show that learning motivation obtained a Sig. (2-tailed) value of 0.000 < 0.05, indicating that H_0 was rejected and H_1 was accepted. Similar results were also obtained for critical thinking skills, with a Sig. (2-tailed) value of 0.000 < 0.05, indicating a significant difference between the experimental class and the control class. Therefore, the implementation of the discovery learning model had a significant effect on improving physics learning motivation and critical thinking skills among eleventh-grade students at SMA Negeri 1 Soyo Jaya.

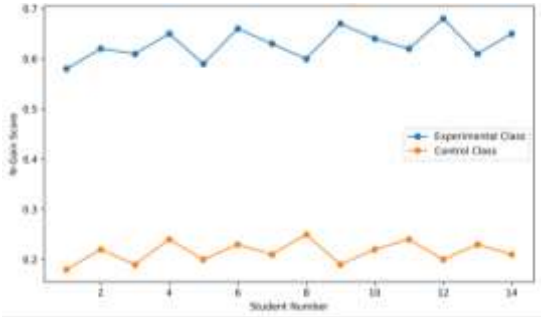

Figure 1. N-Gain of Students' Learning Motivation

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Based on Figure 1, the results of the N-Gain analysis of learning motivation show that students in the experimental class obtained a higher improvement compared to students in the control class. The N-Gain values of the experimental class tended to be in the moderate category, while the control class showed lower improvement among most students. The difference in improvement indicates that the implementation of the discovery learning model was able to provide a more optimal influence on students' physics learning motivation. This occurred because students in the experimental class had opportunities to actively participate in learning activities through observation, exploration, discussion, and independent concept discovery processes, thereby encouraging curiosity, activeness, and interest in participating in physics learning.

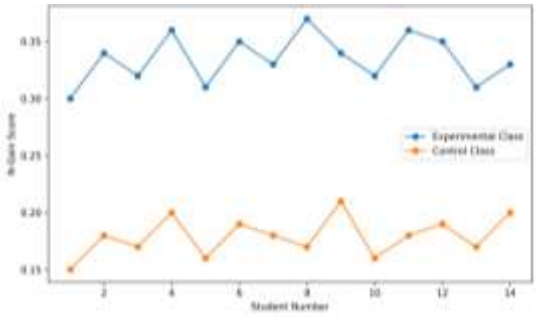

Figure 2. N-Gain of Students' Critical Thinking Skills

Based on Figure 2, the results of the N-Gain analysis of critical thinking skills show that the improvement of students' critical thinking skills in the experimental class was higher than that in the control class. Students who received learning using the discovery learning model showed more consistent improvement because the learning process provided opportunities for students to identify problems, collect information, analyze data, and draw conclusions based on discovery results. Meanwhile, improvement in the control class was relatively lower because students' involvement in the concept discovery process was still limited. These results indicate that the implementation of discovery learning can help students develop logical, analytical, and critical thinking abilities in solving physics problems.

Discussion

The results of this study indicate that the implementation of the discovery learning model has a significant effect on improving students' physics learning motivation and critical thinking skills at SMA Negeri 1 Soyo Jaya. The descriptive analysis results showed that the experimental class experienced higher improvement than the control class, both in terms of learning motivation and critical thinking skills. This condition indicates that learning that provides opportunities for students to discover concepts independently can create a more meaningful learning process. Through the stages of discovery learning, students do not only receive information directly from the teacher but also carry out problem identification, information collection, data analysis, and conclusion formulation activities. The

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results of this study are in line with Firdaus et al. (2022) who showed that the implementation of discovery learning was able to train critical thinking skills while increasing students' learning motivation because the learning process provided opportunities for students to actively construct understanding based on learning experiences.

The improvement of learning motivation in the experimental class indicates that the discovery learning model can create a more interesting learning atmosphere and encourage student involvement. Students who previously received more information from teachers became more active in asking questions, discussing, and finding solutions to given problems. The process of discovering concepts independently provides learning experiences that can increase students' curiosity and confidence in understanding physics materials. This finding is supported by Kadir et al. (Kadir et al., 2023) who found that the guided discovery method had a positive effect on students' motivation and learning outcomes because students were directly involved in the process of acquiring knowledge. In addition, Aldalur and Perez (2023) also explained that the integration of discovery learning principles could increase student motivation and engagement because learning becomes more interactive and provides opportunities for students to participate actively.

In addition to influencing learning motivation, the implementation of discovery learning has also been proven to improve students' critical thinking skills. This improvement occurs because each learning stage requires students to perform higher-order thinking activities such as analyzing phenomena, evaluating information, and drawing conclusions based on the evidence obtained. In physics learning, these activities are important because students are not only required to understand formulas but also need to explain the relationship between concepts and real phenomena. The results of this study are in line with Akhir et al. (2023) who showed that the discovery learning model was effective in improving critical thinking skills because students were directed to conduct exploration and solve problems independently. Similar findings were also reported by Arifianto and Koeswanti (2022) who stated that discovery learning had a positive impact on students' critical thinking skills through learning activities that placed students as the center of the learning process.

The improvement of students' critical thinking skills after the implementation of discovery learning is also related to the learning process involving scientific investigation activities. During the learning process, students are directed to identify problems, propose hypotheses, seek supporting information, conduct investigations, and formulate conclusions based on analysis results. These activities help students develop systematic and logical thinking patterns needed to understand physics concepts. This finding supports the research of Asri et al. (2023) who stated that physics learning needs to be directed toward developing critical thinking skills because these abilities are an important part of solving scientific problems. In addition, Bakri et al. (2024) showed that critical thinking skills in

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physics learning can improve when students are given opportunities to use thinking strategies that require analysis and reflection on a problem.

The success of the discovery learning model in improving critical thinking skills can also be seen from the improvement of students' ability to understand relationships between concepts and apply these concepts to new situations. This model provides different learning experiences because students are not directed to memorize information but to discover principles or concepts independently through learning activities. The results of this study are in line with Ayu et al. (2025) who showed that the implementation of discovery learning made a positive contribution to critical thinking skills because students were trained to actively engage in the process of searching and processing information. Bachtiar et al. (2025) also found that discovery learning could develop students' critical thinking skills because discovery-based learning improved independence, self-confidence, and students' ability to solve problems rationally.

The influence of the discovery learning model on improving critical thinking skills is also closely related to the characteristics of learning that provide opportunities for students to participate actively. Learning that involves an exploration process makes students more accustomed to asking questions, providing reasons for their opinions, and evaluating information before making decisions. This condition shows that critical thinking skills can develop through learning experiences that position students as the main subjects in the learning process. The results of this study are supported by Cholifah and Fada (2022) who showed that the implementation of guided discovery learning was able to improve critical thinking skills because students were directed to actively engage in the process of finding solutions. In addition, Elfianawati et al. (2024) found that discovery learning had an influence on students' critical thinking skills, and learning motivation became one of the factors supporting the successful implementation of this model.

The implementation of the discovery learning model also helps students develop independent learning abilities because students are given opportunities to organize their thinking processes and understand concepts through direct experiences. In the experimental class, students did not only receive materials from the teacher but also conducted discussions and analyses, allowing the process of knowledge construction to occur. This type of learning helps students connect new information with previous knowledge so that conceptual understanding becomes stronger. This finding is in line with Fajriah and Amir (2024) who stated that the implementation of discovery learning could improve mathematical critical thinking skills because students were encouraged to manage their learning processes independently. Gunawan et al. (2023) also found that the use of discovery learning models assisted by learning media could improve critical thinking skills because media supported students' exploration and analysis processes during learning activities.

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The results of this study further strengthen the idea that discovery-based learning can be applied as an alternative approach to overcome students' low critical thinking skills in science learning. Through concept discovery activities, students learn to understand the reasons behind a phenomenon, meaning that learning is not only oriented toward final outcomes. In physics learning, this ability is very important because students need to understand the scientific processes that occur before applying certain concepts or equations. This result is consistent with Handayani (2022) who proved that the implementation of discovery learning could improve students' critical thinking skills because learning was carried out through activities requiring involvement and problem-solving. Furthermore, Hidayatullah and Gusemanto (2024) showed that discovery learning assisted by multimedia modules could improve critical thinking skills in physics learning because students were able to explore abstract concepts more easily.

The effectiveness of the discovery learning model can also be seen from its ability to create learning that is more interesting and suitable for students' needs. The use of discovery activities makes students more active in interacting, collaborating, and communicating their ideas with peers and teachers. This active learning environment can improve the quality of learning because students gain more meaningful learning experiences. This finding is supported by Hatiningsih and Hanik (2023) who stated that the implementation of discovery learning assisted by audiovisual media could increase student involvement because the presentation of learning became more attractive. Manurung and Pappachan (2025) also explained that discovery learning played an important role in developing critical thinking skills because it provided opportunities for students to conduct investigations and construct understanding independently. Furthermore, Martir et al. (2024) proved that the implementation of discovery learning could improve critical thinking skills because the learning process provided direct experiences in discovering and solving problems. Strengthening active learning is also in line with Mitasari et al. (2024) who explained that science learning needs to be directed toward activities that can improve students' thinking skills and scientific literacy.

Although the results of this study indicate that the discovery learning model has a significant effect on students' physics learning motivation and critical thinking skills, this study still has several limitations. First, the number of research samples was limited to eleventh-grade students at SMA Negeri 1 Soyo Jaya, meaning that the research findings cannot yet be widely generalized to all educational levels or different school characteristics. Second, this study only focused on physics learning, so the effectiveness of the discovery learning model in other subjects still requires further investigation. In addition, this study only measured two variables, namely learning motivation and critical thinking skills, while other factors such as creativity, collaboration, problem-solving ability, and the use of learning technology have not been analyzed in depth. Therefore, future studies are recommended to involve larger sample sizes, more diverse learning contexts, and additional variables so that

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the effectiveness of the discovery learning model can be examined more comprehensively.

CONCLUSION

Based on the results and discussion, it can be concluded that the discovery learning model has a significant effect on improving students' physics learning motivation and critical thinking skills at SMA Negeri 1 Soyo Jaya. Students who learned through discovery learning showed higher improvement compared to students who received cooperative learning because they were actively involved in observing, exploring, discussing, analyzing information, and discovering concepts independently. The implementation of discovery learning provides implications for physics education by encouraging teachers to develop more student-centered learning strategies that support active participation and higher-order thinking skills. This model can be used as an alternative instructional approach to create meaningful learning experiences and strengthen students' ability to understand scientific concepts.

Although this study provides empirical evidence regarding the effectiveness of discovery learning, several limitations need to be considered. This research was conducted with a limited number of participants and focused only on eleventh-grade students at one school, which may limit the generalization of the findings to broader educational contexts. In addition, the study only examined physics learning motivation and critical thinking skills without considering other variables such as creativity, collaboration, problem-solving ability, or technology integration. Future researchers are recommended to involve larger samples, different educational levels, and additional learning variables to provide a more comprehensive understanding of the effectiveness of discovery learning in various learning environments.

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