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Improving Science Process Skills through the Discovery Learning model

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Abstract

This study examines the effectiveness of implementing the Discovery Learning model on students' science process skills. The research method used is a quasi-experiment with a Pretest-Posttest Control Group Design, involving two groups: an experimental class (n = 16) using Discovery Learning and a control class (n = 15) using the lecture method. The research instruments include achievement tests, observation sheets, and interviews with teachers and students. The results indicate that students who learned through Discovery Learning experienced a significant improvement in science process skills, particularly in observing, classifying, predicting, and communicating learning outcomes. Statistical analysis using the t-test showed a significant difference between the experimental and control groups, with $t_{calculated}$=3.17 = 3.17 greater than t_{table}=2.045 at a significance level of p<0.0. These findings highlight the importance of inquiry-based learning strategies in improving the quality of science education. The study was conducted over eight weeks, allowing for a comprehensive assessment of student progress.

Keywords: Discovery Learning, Science Process Skills, Inquiry-Based Learning, Science Education.

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INTRODUCTION

Science education plays a crucial role in developing critical thinking, problem-solving, and evidence-based decision-making skills. To improve the quality of science learning, various teaching approaches and models have been developed, one of which is Discovery Learning. This model is rooted in constructivist theory, emphasizing independent exploration and active student engagement in discovering scientific concepts (Fitriasari et al., 2018; Manyasi, 2024). Discovery Learning has been recognized as an effective instructional model for enhancing students' conceptual understanding and science process skills.

Discovery Learning has long been studied as an effective instructional model for improving science process skills. (Bahtiar & Dukomalamo, 2019; Firdaus & Hunaepi, 2016; Hunaepi et al., 2021) emphasized that this model enables active student engagement in experimental activities, fostering deeper understanding through self-discovery. (Nirmala & Darmawati, 2021) demonstrated that virtual laboratory experiences based on Discovery Learning significantly enhance science process skills by helping students construct meaningful knowledge and gain practical understanding. (Yandri et al., 2022) also reported that Discovery Learning effectively fosters inquiry skills, which are crucial for the development of scientific thinking.

Although numerous studies have proven the effectiveness of Discovery Learning, there are gaps in previous research that need to be addressed. Most studies have focused on the application of Discovery Learning in classroom settings or virtual laboratories, but few have specifically examined how this model enhances key indicators of science process skills, such as observing, classifying, predicting, and communicating learning outcomes. This study aims to fill this gap by analyzing the impact of Discovery Learning on each of these science process skill indicators in high school students.

Despite its proven effectiveness, the implementation of Discovery Learning still faces various challenges. Research indicates that many teachers continue to rely on lecture-based methods as their primary instructional strategy in science education (Istrate, 2018). This method is less effective in developing critical thinking and problem-solving skills, as students passively receive information without opportunities to explore and construct their own understanding. Consequently, student motivation and engagement in science learning remain low, affecting their learning outcomes.

Furthermore, a lack of teachers' understanding of Discovery Learning implementation strategies poses a major obstacle. Many educators struggle to design inquiry-based learning activities and guide students in discovering concepts independently. Therefore, an approach is needed that not only emphasizes the application of Discovery Learning but also ensures that teachers possess the necessary knowledge and skills to effectively manage inquiry-based learning (Fitri et al., 2020). Found that students taught using Discovery Learning showed a greater improvement in science process skills compared to those taught using traditional techniques (Ferdiansah et al., 2020). This finding is supported by (Hasmawati et al., 2023), who reported that classes employing Discovery Learning achieved higher average science process skill scores than those using other instructional strategies.

Based on the identified challenges and research gaps, this study aims to analyze the effectiveness of Discovery Learning in enhancing the science process skills of high school students. This study is expected to provide significant contributions to the development of more innovative and effective instructional strategies. By examining the impact of this model on students' science process skills and identifying the challenges encountered in its implementation, this research aims to offer valuable insights for educators seeking to improve the quality of science education. Additionally, the findings of this study are anticipated to serve as a reference for teachers, researchers, and policymakers in developing more inquiry-based and participatory teaching methods.

METHOD

This study employed a quasi-experimental method with a Pretest-Posttest Control Group Design. This design involved two groups: an experimental class that received instruction using the Discovery Learning model and a control class that was taught using the lecture method. The selection of this design was based on its suitability for evaluating the causal effects of Discovery Learning on students' science process skills by comparing learning outcomes before and after treatment. This design was considered appropriate as it allows researchers to assess the effectiveness of Discovery Learning while controlling for potential confounding variables that may influence the research outcomes.

The population of this study consisted of all 11th-grade science students at SMA Negeri 1 Janapria during the 2019/2020 academic year. The sampling technique used was purposive sampling, selecting two classes as the research sample. One class was assigned as the experimental group, while the other was designated as the control group. The experimental group consisted of 16 students, and the control group consisted of 15 students. Although the sample size was relatively small, it was selected based on feasibility constraints and participant availability. Consequently, the findings of this study are exploratory and may not be fully generalizable to a larger population.

Research Instrument

The instrument used in this study was the science process skills observation sheet, which was utilized to assess students' skills in observing, classifying, predicting, and communicating experimental results. To ensure the quality of the instrument, validity and reliability tests were conducted. The validity of the test items was assessed using correlation analysis, with validity scores for test items 1 to 7 being 0.702, 0.841, 0.705, 0.787, 0.789, 0.777, and 0.589, respectively. Since these values exceeded the critical r-value of 0.388 at a 5% significance level, all test items were deemed valid and suitable for use in the study. Subsequently, the reliability of the science process skills instrument was analyzed using

Cronbach's Alpha formula, yielding a reliability coefficient of 0.9. This value falls within the very high reliability category (0.79 – 1.00), indicating that the instrument has a high level of consistency.

Data Analysis Techniques

The data were analyzed using the following statistical techniques:

a. Normality Test using the Kolmogorov-Smirnov test to ensure that the data followed a normal distribution.
b. Homogeneity Test using Levene's Test to verify that the variances between groups were homogeneous.
c. t-test (Independent Sample t-test) to determine differences in learning outcomes and science process skills between the experimental and control classes.

RESULTS AND DISCUSSION

Discovery Learning is an innovative student-centered instructional model that encourages learners to actively explore, discover concepts, and construct their own understanding of the subject matter. This study aimed to compare the effectiveness of the Discovery Learning model with the lecture method in improving students' learning outcomes and science process skills. The analysis results indicate that students who learned using the Discovery Learning model achieved higher learning outcomes compared to those taught using the lecture method. Additionally, the smaller standard deviation in the experimental group suggests that the learning outcomes were more homogeneous, indicating that this model helped students achieve a more even understanding of the material.

Beyond improvements in learning outcomes, the Discovery Learning model also proved to be effective in enhancing students' science process skills. The findings show that the experimental class scored higher in observation, classification, prediction, and communication skills compared to the control class. This suggests that students who engaged in Discovery Learning were better able to conduct detailed observations, systematically categorize information, and effectively communicate their learning results. Thus, the implementation of the Discovery Learning model in science education can serve as an effective alternative for enhancing students' understanding as well as their critical thinking and problem-solving skills.

The detailed analysis results are presented in Table 1 and Table 2, which demonstrate that Discovery Learning significantly improves students' science process skills compared to conventional methods.

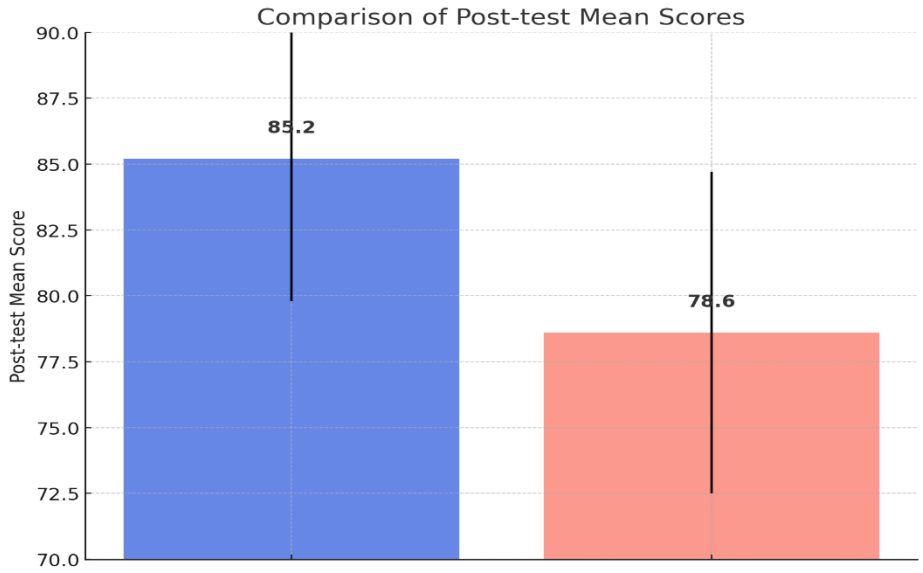

Figure 1. graph Independent Sample t-Test Results

This study aimed to compare the effectiveness of the Discovery Learning model with the lecture method in improving students' learning outcomes. The results of the independent sample t-test showed that the experimental group, which used the Discovery Learning model, had an average post-test score of 85.2 with a standard deviation of 5.4. Meanwhile, the control group, which used the lecture method, obtained an average post-test score of 78.6 with a standard deviation of 6.1.

From this data, it is evident that the post-test average score of students taught using the Discovery Learning model was higher compared to those taught using the lecture method. The smaller standard deviation in the experimental group indicates that students' learning outcomes were more homogeneous compared to the control group. This suggests that Discovery Learning helps students understand the material more effectively and evenly.

The difference in mean scores between the two groups suggests a potential positive impact of the Discovery Learning method on students' learning outcomes. This model allows students to be more actively involved in exploring and discovering concepts on their own, leading to a deeper understanding of the material. In contrast, the lecture method, which is more teacher-centered, appears to be less effective in optimizing learning outcomes. Thus, the findings of this study can serve as a consideration for educators in selecting more suitable teaching strategies to enhance students' comprehension.

Hypothesis Testing

The data analysis results show that the calculated t-value $t_{calculated}$ was 3.17, while the critical t-value t_{table} at 29 degrees of freedom (df) with a 0.05 significance level was 2.045. Since $t_{calculated} > t_{table}$, the null hypothesis ($H_o$) is rejected, and the alternative hypothesis (H_a) is accepted. This indicates a significant effect of the Discovery Learning model on students' science process skills. Thus, it can be concluded that the implementation of this learning model significantly improves students' science process skills compared to conventional methods. The student-centered Discovery Learning model encourages them to actively explore, identify problems, and find solutions through direct experience. With active engagement in the learning process, students gain a deeper understanding and develop critical thinking and problem-solving skills.

Table 2. Average Scores of Science Process Skills Indicators

Science Process Skills Indicator	Experimental Group (Discovery Learning)	Control Group (Lecture Method)	Difference
Observing	88.4	80.2	+8.2
Classifying	82.1	76.3	+5.8
Predicting	84.7	77.5	+7.2
Communicating	90.2	81.7	+8.5

This study examines the effectiveness of the Discovery Learning model on students' science process skills by comparing the results between the experimental and control classes. The analysis results show that the experimental class scored higher on all indicators of science process skills compared to the control class. The highest-rated indicator was Communicating, with a score of 90.2 in the experimental class and 81.7 in the control class, indicating that students who learned through the Discovery Learning model were better able to effectively convey their learning outcomes.

Additionally, the Observing indicator also showed a significant difference, with a score of 88.4 in the experimental class and 80.2 in the control class, indicating that this model helps students conduct more precise observations of the phenomena studied. The Predicting indicator scored 84.7 in the experimental class and 77.5 in the control class, suggesting an improvement in students' ability to anticipate results based on patterns or data obtained.

However, the lowest-scoring indicator was Classifying, with a score of 82.1 in the experimental class and 76.3 in the control class. This finding suggests that students still face difficulties in systematically categorizing information despite using the Discovery Learning model. Nevertheless, the score difference of 5.8 still indicates that this method positively impacts students' classification skills.

The experimental class demonstrated better improvement compared to the control class across all science process skills indicators. This confirms that the Discovery Learning model is effective in enhancing students' ability to observe, classify, predict, and communicate information in science learning. Therefore, this learning model can be considered a strategy to improve students' science process skills in the classroom.

This study reveals that implementing the Discovery Learning model framework significantly impacts the enhancement of students' science process skills. These findings align with various studies emphasizing that constructivist-based approaches, such as Discovery Learning, can enhance critical thinking skills, problem-solving abilities, and students' scientific concept comprehension (Ocak & Hocaoğlu, 2021; Şenler, 2022). In the context of science learning, Discovery Learning is a relevant model as it emphasizes active exploration and independent investigation by students, ultimately improving their conceptual understanding and scientific skills (Festiawan & Khurrohman, 2021).

From the data analysis results, it is evident that students taught with Discovery Learning achieved higher learning outcomes compared to those taught using the lecture method. This indicates that inquiry-based learning models are more effective in creating meaningful learning experiences (Matamay et al., 2023; Firdaus et al., 2023). The lecture method, although still commonly used, often fails to actively engage students and primarily focuses on one-way knowledge transfer (Rafiqa et al., 2023). Conversely, Discovery Learning involves students in problem-solving, concept exploration, and deeper reflection, resulting in improved higher-order thinking skills (Priyanka & Selamat, 2021).

This study also demonstrates that Discovery Learning not only enhances learning outcomes but also improves students' science process skills, including the ability to observe, classify, predict, and systematically communicate information. Based on the obtained data, the Communicating indicator had the highest score in the experimental class (90.2), indicating that this model significantly enhances students' ability to effectively convey their learning outcomes. This aligns with previous research stating that constructivist-based learning strategies promote more active interaction and better communication in the classroom (Ojelade et al., 2022).

The Observing indicator also showed a substantial improvement, with a score of 88.4 in the experimental class compared to 80.2 in the control class. This indicates that students taught with Discovery Learning were better able to conduct precise observations of the studied phenomena, as also noted in the research by Yaz & Yerlikaya (2021), which emphasized that direct experience in science learning enhances students' conceptual understanding.

Furthermore, the Classifying indicator had the lowest score among all indicators, although it still showed improvement compared to the lecture method. This suggests that while Discovery Learning aids in deeper conceptual understanding, students still require guidance in systematically organizing information. Therefore, additional strategies such as scaffolding or the use of visual aids like diagrams and charts are needed to help students classify information more effectively (Setiawaty et al., 2024).

The enhancement of science process skills is also consistent with the concept of Science Process Skills (SPS), which includes various skills necessary for conducting scientific investigations, such as observing, classifying, predicting, and communicating results. Firdaus et al. (2023) stated that these skills are essential in science learning as they help students develop a deeper conceptual understanding and enhance their critical thinking skills.

A t-test conducted in this study revealed a significant difference between the experimental and control classes, with a t-value of 3.17, which was greater than the t-table value of 2.045. This finding reinforces the conclusion that Discovery Learning is significantly more effective than the lecture method in improving students' science process skills. Previous studies also indicated that inquiry-based learning models, such as Discovery Learning, positively impact students' learning outcomes and scientific skills compared to traditional methods (Salam et al., 2023).

Furthermore, this study showed that the experimental class had a smaller standard deviation compared to the control class, meaning that Discovery Learning helps students achieve a more even understanding. This finding is consistent with (Junus, 2021), who stated that discovery-based learning

provides a more equitable opportunity for all students to comprehend the material in their own way, thereby reducing gaps in understanding among students.

CONCLUSION

Based on the research findings, it can be concluded that the implementation of the Discovery Learning model significantly enhances students' science process skills compared to the lecture method. Statistical analysis results indicate a significant difference between the experimental and control groups, with students in the experimental group showing greater improvements in observing, classifying, predicting, and communicating learning outcomes. These findings confirm that Discovery Learning fosters active student engagement in exploration and concept discovery, thereby strengthening conceptual understanding, critical thinking, and problem-solving skills. Additionally, the study results show that students in the experimental group had a more even distribution of learning outcomes, suggesting that this approach can help reduce learning disparities among students. Thus, the Discovery Learning model is recommended for broader implementation in science education, particularly in enhancing students' science process skills. Intensive training for teachers is necessary to ensure optimal implementation, along with institutional support in providing resources that facilitate inquiry-based learning.

RECOMMENDATIONS

Based on the research findings, it is recommended that the Discovery Learning model be widely implemented in science education due to its proven effectiveness in enhancing students' science process skills. This model fosters active learning, critical thinking, and deeper conceptual understanding, making it a valuable approach in modern science teaching. To ensure successful implementation, teachers should receive intensive training on designing and facilitating inquiry-based learning activities. Professional development programs, workshops, and peer collaboration should be encouraged to improve teachers' pedagogical skills and confidence in using this model effectively.

Educational institutions should integrate Discovery Learning into the science curriculum, ensuring that lesson plans emphasize students' abilities to observe, classify, predict, and communicate scientific findings. Additionally, schools must provide adequate support in terms of laboratory equipment, digital tools, and interactive learning resources to facilitate hands-on and inquiry-based learning experiences. Access to well-structured instructional materials will further enhance the effectiveness of Discovery Learning in improving students' scientific competencies.

Furthermore, considering the relatively small sample size in this study, further research is needed with larger and more diverse samples to validate and generalize the findings. Future studies could also explore the long-term impact of Discovery Learning on students' scientific reasoning and problem-solving skills. By implementing these recommendations, educators and policymakers can maximize the benefits of Discovery Learning, ultimately improving the quality of science education and preparing students with essential scientific competencies for the future.

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AUTHOR CONTRIBUTIONS

Sri Rofida Azis contributed to research conceptualization, methodology design, and data analysis. Baiq Fatmawati played a role in data collection and coordination with research participants. Indra Himayatul Asri supervised the study, provided academic feedback, and performed final manuscript editing. All authors collaborated throughout all research phases, from planning and execution to reporting and publication preparation.

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