

The Effect of Science Process Application on Students' Scientific Thinking Skill on the Material of Ecosystem in High School

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ABSTRACT : This study aimed to analyze the effect of the application of science process skills on students' scientific thinking skills in ecosystem learning at SMA Negeri 1 Kutabaro. This study employed a quantitative approach with a quasi-experimental design in the form of a one-group pretest-posttest. The research subjects were Grade X science students selected through purposive sampling. An observation sheet was used as a data collection instrument, which included indicators of observing, classifying, predicting, and communicating. The data were analyzed with descriptive quantitative and inferential analysis to assess changes before and after the treatment. The results showed a significant increase in students' scientific thinking skills, as indicated by an increase in the high category from 3.70% to 59.26%, while the low category decreased from 44.45% to 7.40%. This indicates that students' active involvement in scientific activities can enhance scientific thinking skills and promote a deeper understanding of concepts. Thus, the application of science process skills is effective in improving students' scientific thinking skills in ecosystem learning. The results are expected to provide an alternative, innovative learning strategy for improving the quality of biology instruction in schools.

KEYWORDS: science thinking skills, ecosystem learning, quasi-experiments, active learning.

I. INTRODUCTION

The demands of 21st-century education require students not only to master concepts but also to develop critical, creative, and scientific thinking skills to understand various natural phenomena. In biology learning, particularly ecosystem topics, students are expected to analyze the complex interactions between biotic and abiotic components through a systematic scientific approach. However, learning practices in schools still tend to be teacher-centered (*teacher-centered learning*), which limit students' active involvement in the learning process.. This condition contributes to the low level of students' scientific thinking skills and science process skills (Turiman et al., 2012).

Science process skills (SPS) refer to a set of skills used to acquire knowledge through scientific methods, such as observing, classifying, predicting, and communicating results. These skills are crucial for developing a scientific mindset and enhancing in-depth conceptual understanding. According to Aktamis and Ergin (2008), science process skills are significantly associated with students' critical thinking skills and therefore need to be systematically developed through classroom learning. However, various studies have shown that students' science process skills remain still relatively low. This is mainly due to the limited implementation of learning activities that provides students with direct experience in scientific investigations. Learning that focuses solely on content delivery without actively involving students may hinder the development of their scientific thinking skills (Abungu et al., 2014). Therefore, learning strategies that integrate authentic scientific activities into the learning process are needed.

One approach that can be applied is the integration of science process skills into classroom learning. This approach emphasizes students' active involvement in discovering concepts through observation, experimentation, and data analysis. Learning based on science process skills has been shown to significantly improve students' conceptual understanding and scientific thinking skills (Ergül et al., 2011). In addition, this approach can also enhance students' learning motivation and their ability to solve problems systematically. Ecosystem is a highly relevant topic for the application of the science process skills approach because they are closely related to students' everyday environment. Experiential learning allows students to observe and analyze real-world phenomena, making the concepts learned more meaningful and easier to understand. However, based on preliminary observations conducted at SMA Negeri 1 Kutabaro, ecosystem learning has not fully incorporated the science process skills approach, which makes the students' learning outcomes suboptimal. Based on the above consideration, the current study aims to analyze the effect of applying

science process skills on improving students' scientific thinking skills in ecosystem learning at SMA Negeri 1 Kutabaro. This research is expected to contribute to the development of more innovative, effective, and 21st-century skills-oriented biology learning strategies.

II. RESEARCH METHODS

Types and Design of Research : This research used a quantitative approach using a quasi-experimental design. The design adopted was a one-group pretest-posttest design, which aimed to determine the effect of the application of science process skills on improving students' science process skills before and after treatment. The design of this study can be described as follows:

Table 1. One Group Pretest-Posttest Research Design.

Group	Pretest	Treatment	Posttest
Experiment	T ₁	X	T ₂

Where:

T₁ = Pretest (before treatment)

X = Application of science process skills

T₂ = Posttest (after treatment)

Research Location and Duration : This research was conducted at SMA Negeri 1 Kutabaro, Aceh Besar Regency, during the second semester of the 2023/2024 academic year, from May to June 2024.

Population and Sample : The population of this study consisted of all Grade 10 science students at SMA Negeri 1 Kutabaro. The sample was selected using a purposive sampling technique, whereby one class was chosen based on its representativeness of the population characteristics. The sample consisted of approximately 25 science students from Grade 10.

Research Variables

The variables examined in this study were as follows:

1. Independent variable: application of science process skills in learning.
2. Dependent variable: students' science process skills.

Research Instruments : The instrument used in this study was a science process skills observation sheet developed based on the following science process skills indicators: observing, classifying, predicting, and communicating results. The instrument used a rating scale of 1-4 (very poor to excellent). Prior to its implementation, the instrument was subjected to content validity assessment by experts and reliability testing to ensure its appropriateness and consistency.

Data Collection Techniques : The current study used several data collection techniques: observation, pretest, and posttest. Observation was employed to collect data regarding students' science process skills during learning, while pretest and posttest were used to measure the improvement in students' science process skills before and after treatment.

Data Analysis Techniques : The collected data were then analyzed using both quantitative descriptive and inferential analysis, with the following steps:

1. Descriptive-Analysis

Science process skills data was analyzed in percentage form using the following formula:

$$P = \frac{f}{N} \times 100\%$$

Where:

P = Percentage

f = Frequency

N = Number of respondents

2. Gain Test (N-Gain)

To determine the improvement in students' scientific thinking skills, the following N-gain formula was used:

$$N - Gain = \frac{Posttest\ scores - Pretest\ scores}{Maximum\ score - Pretest\ score}$$

3. N-Gain Criteria:

- High ($g > 0.7$)
- Medium ($0.3 \leq g \leq 0.7$)
- Low ($g < 0.3$)

4. Statistical Test

To determine the significance of the differences between pretest and posttest scores, a paired sample t-test was conducted at a significance level of 0.05.

Research Procedures

This study was conducted through the following stages:

1. Preparation stage, involving preparation of instruments, validation of instruments, and research permits.
2. Implementation stage, including pretest administration, implementation of science process skills-based learning, and posttest administration.
3. Final stage, involving data processing, data analysis, and drawing conclusions.

III. RESULTS AND DISCUSSION

RESULTS : The results of the students' scientific thinking skills before and after the implementation of science process skills-based learning are presented in Table 1.

Table 1. Students' Science Process Skills Before and After the Implementation of Science Process Skills-based Learning.

Categories	Before Treatment (%)	After Treatment (%)
High	3.70	59.26
Currently	51.85	33.34
Low	44.45	7.40

Table 1 shows that, prior to the implementation of science process skills-based learning, the majority of students were categorized as having medium (51.85%) and low (44.45%) levels of scientific thinking skills, while only 3.70% were in the high category. However, after the implementation of science process skills-based learning, the percentage of students in the high category increased significantly to 59.26%, while the percentage in the low category decreased to 7.40%. These findings indicate a positive shift in the distribution of students' scientific thinking skills toward improvement. Overall, the students demonstrated improved skills in the Science Process Skills indicators, including observing, classifying, predicting, and communicating results. This suggests that activity-based learning is able to optimally develop science process skills.

IV. DISCUSSION

The results of the study indicate that the application of science process skills in ecosystem learning had a positive effect on students' science process skills. This improvement was reflected in the significant increase in the percentage of students classified in the high category after the treatment. Theoretically, science process skills constitute an important component in science learning because they are closely related to the application of the scientific method. Through observation, classification, and communication, students are trained to think systematically and logically. This is in line with Ergül et al. (2011), who reported that inquiry-based learning can significantly improve students' science process skills. The improvement in this study can also be attributed to students' active participation during the learning process. Rather than passively receiving information, the students were directly involved in scientific activities, including environmental observation and data analysis. Such active involvement has been shown to improve both conceptual understanding and scientific skills. This finding is supported by Abungu et al. (2014), who found that the science process skills approach can improve learning outcomes and scientific skills through student-centered learning activities. Furthermore, the development of science process skills was also facilitated by repeated practices during learning. The more frequently students engaged in scientific investigations, the more their skills improved. This finding aligns with Turiman et al. (2012), who emphasized the importance of developing 21st-century skills through science process skills and scientific literacy. In terms of specific indicators, observation and classification skills showed

significant improvement because students interacted directly with the learning objects. Prediction and communication skills also improved because the students were encouraged to think critically and communicated their observation results systematically. These findings indicate that science process skills-based learning not only improves cognitive aspects but also scientific communication skills. The findings further suggest that ecosystem topics are highly suitable for the application of a science process skills approach because they are contextual and closely related to students' daily lives. Environmental-based learning provides hands-on experiences that can foster deeper and more meaningful conceptual understanding. However, this study has several limitations, such as the absence of a control class for comparison and the limited science process skill indicators used. Therefore, future research is recommended to employ more rigorous experimental designs and examine a broader range of science process skill indicators more comprehensively.

V. CONCLUSION

Based on the results and discussion, it can be concluded that the application of science process skills in ecosystem learning had a positive effect on the improvement of students' science process skills at SMA Negeri 1 Kutabaro. This was reflected by a significant increase in the percentage of students in the high category, from 3.70% before the treatment and 59.26% after the treatment, while the percentage in the low category decreased from 44.45% to 7.40%. The findings indicate that students' active participation in scientific activities, such as observing, classifying, predicting, and communicating results, can enhance their scientific thinking skills and deepen their conceptual understanding. Thus, the application of science process skills has proven to be an effective learning strategy for improving the quality of biology learning. The implication of this study highlights the importance of consistency in integrating science process skills into classroom learning, particularly in contextual topics such as ecosystems. Future studies are recommended to use more comprehensive experimental designs involving a control class and a broader range of science process skill indicators to achieve more robust findings.

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