THE EFFECT OF LOCAL WISDOM-BASED ECOPEDAGOGY LEARNING MODEL ON SCIENCE LEARNING IN ELEMENTARY SCHOOLS

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ARTICLE HISTORY
Received: 9 January 2026 **Revised:** 23 January 2026 **Published:** 8 February 2026

ABSTRACT
This study examines the effect of a local wisdom-based ecopedagogy learning model on elementary school students' science conceptual understanding and environmental awareness. Using a quantitative quasi-experimental design with a non-equivalent control group, the study involved 42 fifth-grade students of SDN 3 Samirejo, divided into an experimental group (21 students) and a control group (21 students). Data were collected through a science conceptual understanding test and an environmental awareness questionnaire, both of which were validated and proven reliable. The results revealed a significant difference between the two groups, with a calculated t-value of 4.23 exceeding the critical value of 2.02 ($\alpha = 0.05$). The experimental group also showed a higher increase in environmental awareness (18.7%) compared to the control group (6.5%). These findings indicate that local wisdom-based ecopedagogy effectively improves students' science understanding while fostering environmental awareness, making it a relevant approach for sustainable education in elementary schools.
Keywords: Ecopedagogy, Local Wisdom, Science Learning, Environmental Awareness, Elementary School

CITATION INFORMATION: Rahmawati, S., Sumarni, W., & Sarwi, S. (2026). The Effect of Local Wisdom-Based Ecopedagogy Learning Model on Science Learning in Elementary Schools. *Procedia of Multidisciplinary Research, 4*(2), 3.

INTRODUCTION

Science education in elementary schools plays an essential role in developing students' scientific knowledge while simultaneously fostering environmental awareness from an early age. However, science learning at the primary school level is often focused on memorizing concepts and lacks meaningful connections to students' real-life experiences. Consequently, students frequently experience difficulties in achieving deep conceptual understanding and tend to show low levels of environmental responsibility in their daily behavior (Sari & Mulyani, 2022; Rahmawati et al., 2020; Yuliana, 2019). Therefore, innovative learning models are needed to connect scientific knowledge with students' social and environmental contexts.

One learning approach that is relevant to this need is the ecopedagogy learning model, which emphasizes the relationship between humans and the environment within the framework of sustainable education. This approach not only aims to improve students' understanding of scientific concepts but also seeks to develop ecological awareness, critical thinking skills, and social responsibility (Hidayat & Nasir, 2021; Nurhayati, 2020; Tilbury, 2011). Through ecopedagogy, students are encouraged to reflect on environmental issues and critically examine human interactions with nature, making the learning process more meaningful and transformative.

The integration of local wisdom into ecopedagogy further enhances the relevance of science learning. Local wisdom embodies cultural values and traditional practices that promote harmony between humans and the natural environment and can serve as a contextual learning resource closely related to students' everyday lives (Wagiran, 2019; Mariani et al., 2021; Suastra, 2017). By combining ecopedagogy with local wisdom, students are able to understand science concepts more effectively while internalizing environmental conservation values that have long been upheld within their communities.

Previous studies have demonstrated that local wisdom-based learning positively influences students' conceptual understanding and environmental awareness. Mariani et al. (2021) reported that the integration of local wisdom into science learning significantly improved students' environmental literacy and critical thinking skills. Similar findings were also reported by Suastra (2017) and Wulandari et al. (2020), who found that students exposed to culturally contextualized learning showed better understanding of science concepts and more positive attitudes toward environmental sustainability.

Despite these promising findings, most existing studies on ecopedagogy and local wisdom-based education remain qualitative and descriptive in nature. Quantitative studies that empirically examine the effectiveness of local wisdom-based ecopedagogy on students' learning outcomes, particularly in elementary science education, are still limited (Hidayat & Nasir, 2021; Sari & Mulyani, 2022; Rahmawati et al., 2020). Therefore, empirical quantitative research is needed to provide measurable evidence of the effectiveness of this learning model.

Based on this research gap, the present study aims to examine the effect of a local wisdom-based ecopedagogy learning model on elementary school students' science conceptual understanding and environmental awareness. Using a quantitative approach, this study is expected to contribute empirical evidence that supports the development of contextual, character-based, and sustainable science learning strategies in elementary education (Tilbury, 2011; Wagiran, 2019; Mariani et al., 2021).

LITERATURE REVIEWS

Ecopedagogy and Its Role in Elementary Science Education

Ecopedagogy is an educational approach that emphasizes the interconnection between human learning processes and environmental sustainability. Rooted in critical pedagogy, ecopedagogy aims to develop students' ecological awareness, critical thinking, and ethical responsibility toward environmental issues through meaningful learning experiences (Misiaszek, 2021). In

elementary science education, ecopedagogy provides a pedagogical framework that integrates scientific concepts with real environmental contexts, enabling students to understand science as part of their everyday ecological interactions (Kahn & Hammad, 2022).

Recent international studies highlight that ecopedagogical approaches contribute positively to students' cognitive and affective learning outcomes. For instance, Kopnina (2021) emphasized that ecopedagogy supports sustainability-oriented science learning by encouraging reflective thinking and environmental problem-solving skills. Similarly, Rieckmann (2023) reported that ecopedagogy-based instruction strengthens students' systems thinking and responsibility toward environmental sustainability. These findings indicate that ecopedagogy is highly relevant for supporting sustainable science education at the elementary school level.

Local Wisdom in Science Learning

Local wisdom refers to indigenous knowledge systems, cultural values, and traditional practices developed through long-term interaction between communities and their natural environments. In educational contexts, local wisdom serves as a valuable learning resource that contextualizes scientific concepts within students' cultural and environmental experiences (Aikenhead & Elliott, 2022). Integrating local wisdom into science learning enables students to understand abstract concepts through culturally familiar phenomena, thereby enhancing learning relevance and engagement.

International research has demonstrated that culturally contextualized science learning improves students' conceptual understanding and environmental attitudes. McKinley et al. (2021) found that the incorporation of indigenous and local knowledge into science education promotes meaningful learning and strengthens students' environmental identity. Similarly, Ogunniyi and Hewson (2023) reported that local knowledge-based science instruction supports students' cognitive development and fosters respect for environmental sustainability. Therefore, local wisdom plays a crucial role in enriching elementary science learning within culturally diverse contexts.

Science Conceptual Understanding in Elementary Schools

Science conceptual understanding refers to students' ability to comprehend, integrate, and apply scientific concepts meaningfully rather than relying on rote memorization. Developing strong conceptual understanding at the elementary level is essential for building scientific literacy and problem-solving skills (Vosniadou, 2021). However, traditional teacher-centered instruction often limits students' opportunities to construct knowledge through meaningful and contextual learning experiences.

Recent studies suggest that contextual and inquiry-based learning models significantly enhance students' science conceptual understanding. According to Hmelo-Silver et al. (2022), learning environments that emphasize real-world contexts and active student engagement support deeper conceptual change. Additionally, Schneider et al. (2023) found that contextual science instruction improves students' conceptual coherence and long-term retention. These findings suggest that integrating ecopedagogy and local wisdom into science learning can effectively support conceptual understanding in elementary schools.

Environmental Awareness in Elementary Education

Environmental awareness encompasses students' knowledge, attitudes, and behaviors related to environmental protection and sustainability. Developing environmental awareness from an early age is critical for shaping environmentally responsible future citizens (UNESCO, 2022). Elementary education plays a strategic role in instilling environmental values through learning experiences that integrate ecological concepts with everyday practices.

Empirical studies indicate that value-based and contextual pedagogical approaches are effective in fostering students' environmental awareness. Ardoin et al. (2021) demonstrated that environmental education programs emphasizing experiential and contextual learning significantly enhance students' environmental attitudes and behaviors. Furthermore, Monroe

et al. (2023) reported that sustainability-oriented instruction in primary education strengthens students' environmental concern and pro-environmental intentions. These findings support the integration of ecopedagogy and local wisdom as effective strategies for developing environmental awareness among elementary school students.

Synthesis of Literature

The reviewed literature indicates that ecopedagogy and local wisdom-based science learning approaches are closely linked to improvements in science conceptual understanding and environmental awareness. Ecopedagogy provides a sustainability-oriented framework that contextualizes science learning within environmental realities, while local wisdom offers culturally meaningful learning contexts that enhance student engagement. Empirical evidence from recent international studies (2021-2025) supports the relevance of these approaches for elementary science education, thereby justifying the implementation of a local wisdom-based ecopedagogy learning model to improve students' learning outcomes.

Based on the reviewed literature, ecopedagogy and local wisdom have been widely recognized as effective approaches for enhancing meaningful science learning and promoting environmental sustainability in elementary education. Ecopedagogy provides a pedagogical framework that connects scientific concepts with real environmental contexts, while local wisdom offers culturally relevant learning resources that are closely related to students' everyday experiences. The integration of these two approaches is expected to create contextual learning environments that support both cognitive and affective learning outcomes.

In the context of this study, a local wisdom-based ecopedagogy learning model is proposed as an instructional strategy to improve students' science learning outcomes. Specifically, this model is assumed to influence students' science conceptual understanding and environmental awareness as key indicators of effective and sustainable science education. Therefore, a conceptual framework is developed to illustrate the relationship between the learning model and the expected learning outcomes, as presented in Figure 1.

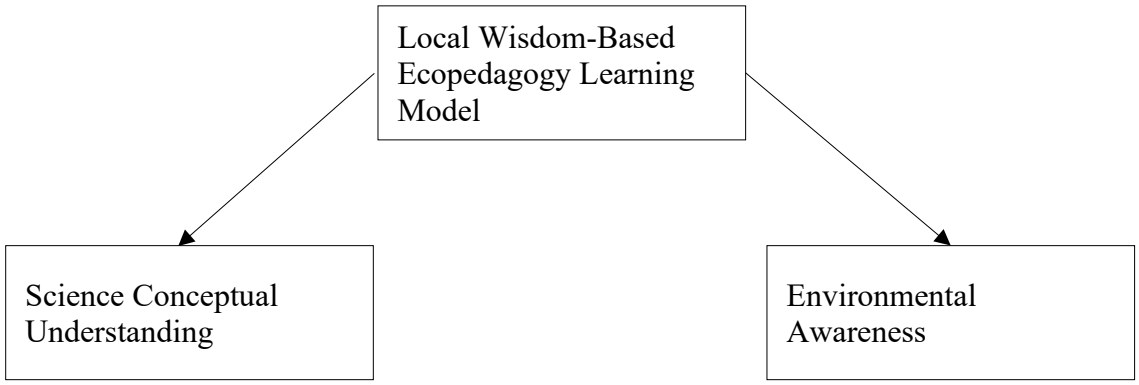

Figure 1 Conceptual Framework

RESEARCH METHODOLOGY

This study employed a quantitative research approach with a quasi-experimental design, specifically a non-equivalent control group design. This design was selected because the research was conducted using pre-existing classes, making random assignment of participants impractical. Quasi-experimental designs are commonly used in educational research to examine the effectiveness of instructional interventions in natural classroom settings (Creswell & Creswell, 2021; Cohen et al., 2018). The study aimed to examine the effect of a local wisdom-based ecopedagogy learning model on students' science conceptual understanding and environmental awareness.

The research subjects consisted of 42 fifth-grade students from SDN 3 Samirejo. The sample was divided into two groups: Class VA as the experimental group (21 students) and Class VB as the control group (21 students). The participants were selected using purposive sampling, considering the similarity of students' academic characteristics and learning conditions between the two classes. As intact classes were used, the study applied a non-equivalent control group design without random assignment (Fraenkel et al., 2019).

Two instruments were used to collect the research data. Students' science conceptual understanding was measured using a multiple-choice test designed to assess students' comprehension, interpretation, and application of science concepts related to the learning material. The test consisted of 20 multiple-choice items, each with four answer options. Multiple-choice tests are widely used in science education research to measure students' conceptual understanding objectively and efficiently (Doran et al., 2021).

Students' environmental awareness was measured using a questionnaire developed based on indicators of environmental knowledge, attitudes, and responsible behavior toward the environment. The questionnaire employed a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). Likert-scale questionnaires are commonly used to assess affective domains such as attitudes and awareness in educational research (Taherdoost, 2022).

The validity of the research instruments was examined through expert judgment, involving science education experts and elementary school practitioners. In addition, item analysis was conducted for the science conceptual understanding test to determine item difficulty and discrimination indices. The reliability of both instruments was tested using Cronbach's Alpha, and the results indicated that the instruments were reliable, with reliability coefficients exceeding 0.70, which is considered acceptable for educational research instruments (Taber, 2018).

The data collection procedure was carried out in three stages. First, a pre-test was administered to both the experimental and control groups to identify students' initial levels of science conceptual understanding and environmental awareness. Second, the experimental group was taught using the local wisdom-based ecopedagogy learning model, while the control group received conventional science instruction. Third, a post-test was administered to both groups to measure changes in students' learning outcomes after the learning intervention.

Data analysis was conducted using descriptive and inferential statistical techniques. Prior to hypothesis testing, normality tests and homogeneity tests were performed to ensure that the data met the assumptions for parametric analysis (Field, 2022). Differences between the experimental and control groups were analyzed using an independent samples t-test at a significance level of $\alpha = 0.05$, which is appropriate for comparing the means of two independent groups (Pallant, 2020).

To determine the improvement in students' learning outcomes, the normalized gain (N-gain) was calculated using the following formula (Hake, 1998):

$$\text{N-gain} = \frac{\text{Post-test score} - \text{Pre-test score}}{\text{Maximum score} - \text{Pre-test score}}$$

The N-gain values were interpreted using the following criteria: high ($g \geq 0.70$), medium ($0.30 \leq g < 0.70$), and low ($g < 0.30$).

RESEARCH RESULTS

Respondents' Profile

The respondents of this study consisted of 42 fifth-grade students from SDN 3 Samirejo. The participants were divided into two groups: 21 students in the experimental group (Class VA) and 21 students in the control group (Class VB). The composition of students in both groups was relatively balanced in terms of gender and academic background, as all participants were

drawn from the same grade level and school environment. This condition indicates that both groups were comparable prior to the implementation of the learning intervention.

Descriptive Statistics of Science Conceptual Understanding

Students' science conceptual understanding was measured using a multiple-choice test administered before and after the learning intervention. The descriptive statistics of pre-test and post-test scores for both groups are presented in Table 1. The pre-test results showed that the mean scores of the experimental group (M = 62.38, SD = 7.45) and the control group (M = 61.90, SD = 7.12) were relatively similar, indicating comparable initial science conceptual understanding. After the intervention, both groups experienced an improvement in post-test scores. However, the experimental group demonstrated a higher increase in mean score (M = 82.10, SD = 6.83) compared to the control group (M = 71.43, SD = 7.05).

Table 1 Descriptive Statistics of Science Conceptual Understanding Scores

Group	Test	Mean	Standard Deviation
Experimental	Pre-test	62.38	7.45
Experimental	Post-test	82.10	6.83
Control	Pre-test	61.90	7.12
Control	Post-test	71.43	7.05

Normalized Gain (N-Gain) Analysis of Science Conceptual Understanding

To examine the magnitude of improvement in students' science conceptual understanding, the normalized gain (N-gain) was calculated. The experimental group achieved an average N-gain score of 0.58, which falls into the medium category, while the control group achieved an average N-gain score of 0.26, categorized as low.

Table 2 N-Gain Analysis of Science Conceptual Understanding

Group	Mean N-Gain	Category
Experimental	0.58	Medium
Control	0.26	Low

These results indicate that the local wisdom-based ecopedagogy learning model was more effective in improving students' science conceptual understanding compared to conventional instruction.

Descriptive Statistics of Environmental Awareness

Students' environmental awareness was measured using a Likert-scale questionnaire administered before and after the learning intervention. The descriptive analysis revealed that the experimental group showed a greater improvement in environmental awareness compared to the control group. The experimental group's mean environmental awareness score increased from 71.20 to 84.52, representing an improvement of 18.7%. In contrast, the control group's mean score increased from 70.85 to 75.45, indicating an improvement of 6.5%.

Table 3 Environmental Awareness Scores Before and After the Intervention

Group	Pre-test Mean	Post-test Mean	Percentage Increase
Experimental	71.20	84.52	18.7%
Control	70.85	75.45	6.5%

Inferential Analysis of Science Conceptual Understanding

Before conducting inferential analysis, normality and homogeneity tests were performed and confirmed that the data met the assumptions for parametric testing. An independent samples t-test was then conducted to examine the difference in post-test science conceptual understanding

scores between the experimental and control groups. The results showed that the calculated t-value ($t = 4.23$) exceeded the critical t-value ($t_{0.05} = 2.02$), with a significance level of $p < 0.05$. This result indicates a statistically significant difference in science conceptual understanding between students taught using the local wisdom-based ecopedagogy learning model and those taught using conventional learning methods.

Summary of Research Findings

Overall, the results demonstrate that the local wisdom-based ecopedagogy learning model had a significant positive effect on students' science learning outcomes. Students in the experimental group achieved higher science conceptual understanding scores, greater normalized gains, and stronger improvements in environmental awareness compared to students in the control group. These findings provide empirical evidence supporting the effectiveness of integrating local wisdom and ecopedagogical principles into elementary science learning.

DISCUSSION & CONCLUSION

This study aimed to examine the effect of a local wisdom-based ecopedagogy learning model on students' science conceptual understanding and environmental awareness in elementary schools. The results of the study indicate that the implementation of the ecopedagogy learning model integrated with local wisdom significantly improved students' learning outcomes compared to conventional science instruction.

The findings showed that students in the experimental group achieved higher post-test scores and greater learning gains than those in the control group. This result confirms that science learning becomes more effective when students are actively involved in contextual learning experiences that are closely related to their daily lives and cultural environments. Contextual and culturally responsive learning approaches have been shown to support meaningful learning and deeper conceptual understanding in science education (Sari & Mulyani, 2022; Rahmawati et al., 2020).

The improvement in students' science conceptual understanding can be explained through the principles of ecopedagogy, which emphasize the integration of environmental issues into learning activities. Ecopedagogy encourages students to reflect critically on real environmental problems, enabling them to construct scientific knowledge through authentic contexts rather than memorization. Previous studies have reported that ecopedagogical approaches promote conceptual understanding and critical thinking skills in sustainability-oriented education (Misiaszek, 2021; Kopnina, 2021).

In addition, the integration of local wisdom into science learning provides culturally familiar contexts that support students' understanding of abstract scientific concepts. Local cultural values and traditional environmental practices serve as concrete learning resources that help students connect science concepts with real-life experiences. This finding is consistent with research showing that local wisdom-based learning enhances students' engagement and conceptual understanding in science education (Mariani et al., 2021; Aikenhead & Elliott, 2022).

Regarding environmental awareness, the experimental group demonstrated a substantially greater improvement compared to the control group. This result indicates that the local wisdom-based ecopedagogy learning model does not only influence cognitive outcomes but also contributes to the development of students' environmental care character. By embedding values of environmental preservation rooted in local culture, students are encouraged to develop a sense of responsibility toward their environment from an early age (Tilbury, 2011).

The findings of this study support previous research highlighting the role of local wisdom in strengthening students' environmental awareness and environmental literacy. Studies have shown that integrating local cultural values into environmental education fosters positive

environmental attitudes and sustainable behaviors among students (Wagiran, 2019; Suastra, 2017). More recent studies have also confirmed that incorporating indigenous and local knowledge into science learning enhances students' environmental identity and sustainability awareness (McKinley et al., 2021; Ogunniyi & Hewson, 2023).

From a pedagogical perspective, this study emphasizes the importance of moving beyond memorization-oriented science instruction at the elementary school level. Conventional learning approaches often limit students' opportunities to relate scientific concepts to their everyday experiences. In contrast, the ecopedagogy learning model integrated with local wisdom provides meaningful learning experiences that support conceptual change, critical thinking, and environmental responsibility simultaneously (Hidayat & Nasir, 2021; Nurhayati, 2020).

This study contributes both practically and theoretically to elementary science education. Practically, the findings suggest that teachers can adopt local wisdom-based ecopedagogy as an alternative learning model to promote contextual, character-based, and sustainable science learning. Theoretically, this study provides empirical quantitative evidence supporting the effectiveness of ecopedagogy and local wisdom-based learning, an area that has previously been dominated by qualitative and descriptive studies (Rahmawati et al., 2020; Sari & Mulyani, 2022).Despite these contributions, this study has limitations related to sample size and research scope. The study was conducted in a single elementary school with a relatively small number of participants. Future research is recommended to involve larger samples and multiple school contexts to strengthen the generalizability of the findings and to examine the long-term impact of ecopedagogy learning models on students' environmental behavior.

In conclusion, the local wisdom-based ecopedagogy learning model is effective in improving students' science conceptual understanding and environmental awareness in elementary schools. Integrating local cultural values into science learning can serve as a strategic approach to fostering sustainable education and developing environmentally responsible future generations.

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Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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