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Integration of Bioconservation Education as A Conservation Strategy Biodiversity in Realising The Sdgs In Aceh

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Abstract. *Aceh has a very high level of biodiversity, particularly through the existence of the Leuser Ecosystem Area (KEL), which is a strategic habitat for various rare species such as the Sumatran elephant (Elephas maximus sumatranus), Sumatran tiger (Panthera tigris sumatrae), and Sumatran orangutan (Pongo abelii). This area also plays an important role in maintaining ecological balance by providing ecosystem services such as climate regulation, clean water supply, and protection from hydrometeorological disasters. The integration of bioconservation learning into formal education is a means of strengthening students' understanding of local ecological issues. In addition to providing a theoretical foundation, this article reviews the effectiveness of bioconservation learning based on the latest research findings, including a study of students at Bandar Pondok Baru State Senior High School 1. The study showed a significant increase in students' knowledge levels after participating in a series of contextually designed bioconservation lessons. This study aims to analyse the increase in knowledge of students at SMA Negeri 1 Bandar Pondok Baru after participating in bioconservation learning. The research design used a One- Group Pretest–Posttest on 30 Grade XI students. The results showed a significant increase in the average score from 54.80 (pretest) to 83.10 (post-test), which illustrates a positive change in their understanding. These findings reinforce the effectiveness of the bioconservation learning model in improving students' understanding of KEL conservation and its relevance to the SDGs. This approach is recommended as local content for schools in the Leuser buffer zone to strengthen the role of education in long- term environmental conservation efforts.*
Keywords: *Bioconservation, Biodiversity, Leuser Ecosystem, SDGs, Sustainable Education.*

1. Introduction

The Leuser Ecosystem Area (KEL) is one of the most significant conservation areas in the world because it harbours extremely high biodiversity and provides various important ecosystem services, such as climate regulation, clean water supply, flood prevention, and carbon sequestration. The KEL also serves as a critical habitat for umbrella species such as orangutans, tigers, elephants, and Sumatran rhinos, whose existence is increasingly threatened by habitat degradation (DPR Aceh, 2021). Ecological pressures such as deforestation, poaching, and land conversion make the protection of the KEL an urgent strategic issue. In this context, environmental education plays an important role in fostering ecological awareness from an early age and encouraging the younger generation to understand the interconnection between humans and the environment.

Bioconservation learning is an educational approach that integrates the concepts of biology, ecology, and conservation into learning experiences relevant to the local context. Johnson (2002) explains that contextual learning encourages students to build understanding through direct experience, making it more meaningful and permanent. In line with this, Ardoin et al. (2020) emphasise that experience-based environmental education has a significant impact on students' knowledge, attitudes, and conservation behaviour. Previous research on schools around the Leuser area by Akmal et al. (2023)

also shows that the bioconservation learning model can significantly improve students' knowledge, especially when linked to the ecological realities they face.

Furthermore, the global framework of the Sustainable Development Goals emphasises the importance of integrating environmental education into the curriculum. SDG 4.7 promotes education for sustainable development, while SDG 15 emphasises the protection and restoration of terrestrial ecosystems. Thus, the application of bioconservation learning in schools around the KEL area has strategic potential in strengthening students' ecological literacy, while preparing the younger generation to play an active role in sustainable environmental conservation.

2. Method

This study used a quantitative approach with a One-Group Pretest–Posttest design, which aimed to measure the effectiveness of bioconservation learning on improving students' knowledge. This design was chosen because it was able to provide a clear picture of changes in learning outcomes after the intervention, even without a control group (Creswell, 2014).

Research Subjects

The research subjects in this study were 30 students in the 11th grade at SMA Negeri 1 Bandar Pondok Baru in the current academic year. The sampling technique used purposive sampling, considering that the school is located within the buffer zone of the Leuser Ecosystem Area (KEL). This geographical condition provides a strong contextual relevance for students, as they live in an environment directly affected by the ecological dynamics of KEL.

Research Instruments

The main instrument in this study was an objective multiple-choice test consisting of 40 questions, compiled based on bio-conservation learning competency indicators relevant to the KEL context. The instrument was developed following content validity validation by two experts, namely a lecturer in ecological biology and an expert in environmental education. The validation results showed that all questions were consistent with the construct of bio-conservation knowledge.

To ensure the reliability of the instrument, a reliability test was conducted using Cronbach's Alpha, which obtained a value of 0.82, indicating a high level of internal consistency ($\geq$0.80). The instrument grid covers five main domains: (1) KEL biodiversity; (2) ecological threats; (3) ecosystem services; (4) principles and practices of bioconservation; and (5) relevant SDG concepts, particularly SDG 4.7 and SDG 15.

Learning Procedures

The bioconservation learning procedure was carried out over six weeks with a series of activities designed based on an experiential learning approach. This model was chosen because it combines cognitive, affective, and psychomotor elements, thereby enhancing students' understanding and conservative attitudes (Ardoin et al., 2020). The learning stages included:

1. Interactive Classroom Sessions, where teachers deliver material related to KEL ecology, basic concepts of bioconservation, and the urgency of conserving key species. These sessions are designed to build students' conceptual knowledge.

2. Local Case Study Analysis, which involves understanding real ecological issues such as deforestation, human-animal conflict, habitat degradation, and plantation expansion. The analysis is conducted in groups to encourage critical thinking.
3. Documentary Film Screening, which presents portraits of animals and threats to the Leuser ecosystem. Visualisation is used to increase students' emotional engagement and strengthen the affective dimension of learning.
4. Digital Campaign Mini-Project, which involves creating posters and content for environmental conservation campaigns. This activity is part of active learning that allows students to apply their knowledge in creative works.
5. Joint Discussion with Environmental Practitioners, featuring local conservation activists to provide field insights related to Leuser conservation efforts. This stage aims to enrich students' understanding through social interaction and empirical perspectives.

3. Results and Discussions

Data analysis was conducted using descriptive statistics to calculate the mean, standard deviation (SD), minimum and maximum values for both the pretest and post-test. This analysis was important to examine the distribution of data and changes in student learning outcomes after the treatment was administered.

To measure the effectiveness of learning, the gain score (the difference between the post- test and pre-test scores) and normalised gain (N-Gain) were calculated based on Hake's formula (1998). N-Gain was used to determine the effectiveness of the learning intervention, with categories of high (>0.7), moderate (0.3–0.7), and low (<0.3).

In addition to quantitative data, the results of participatory observations during the learning process were used as supporting qualitative data to enrich the interpretation, such as observations of student interest, discussion quality, and participation in mini-projects. The combination of quantitative and qualitative data resulted in a more comprehensive analysis, as recommended by Creswell (2014) in educational research.

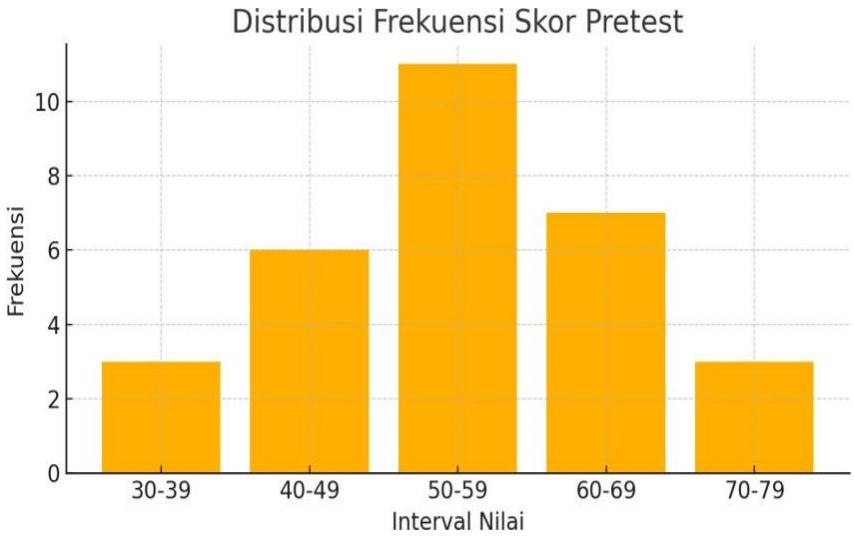
Table 1. Descriptive Statistics of Pre-test and Post-test Scores (N = 30)

Statistics	Pre-test	Post-test
Mean	54.80	83.10
Median	55.00	84.00
Mode	55.00	82.00
Standard Deviation (SD)	9.10	6.2
Variance	82.81	38.44
Minimum Value	38.00	70.00
Maximum Score	72.00	96.00
Range	34	26
Ideal Maximum Score	100	100

Descriptive analysis shows a significant increase in students' knowledge levels after participating in bioconservation learning. The average pre-test score increased from 54.80 to 83.10, with a gain score increase of 28.30 points. In addition, the minimum post- test score increased dramatically from 38 to 70, indicating an even distribution of understanding across the class.

The reduction in score variation from SD = 9.10 to SD = 6.20 indicates that the learning not only increased the average score but also reduced the knowledge gap

between students. This is in line with Johnson's (2002) view, which emphasises that contextual learning can equalise students' learning experiences through collaborative activities.



In general, the distribution of scores on the post-test shows that more than 80% of students achieved a high category. This achievement reinforces the findings of previous research (Akmal et al., 2023), which shows that the integration of local-based conservation learning can significantly improve the knowledge of high school students in the Leuser area.

Table 2. Calculation of Gain Score and N-Gain

Component	**Value**
Mean Pretest	54.8
Post-test Mean	83.10
Gain Score (Post – Pre)	28.30
Maximum Improvement	100 – 54.80 = 45.20
N-Gain	28.30 / 45.20 = 0.63
N-Gain Category	**Moderate–High**

A value of 0.63 indicates that the effectiveness of bioconservation learning is in the medium–high category, meaning that the learning programme is highly effective in improving students' knowledge.

The results of the study show that bioconservation learning has a significant impact on increasing the knowledge of students at Bandar Pondok Baru State Senior High School 1. The average increase of 28.30 points reinforces empirical evidence that integrating local contexts into biology learning can improve students' understanding of environmental and conservation issues. This improvement is not only reflected in the final scores, but also in a more consistent level of understanding, as seen in the decrease in standard deviation.

Theoretically, the success of this learning can be explained through the constructivist learning framework. According to Johnson (2002), students construct new knowledge when they are able to connect the concepts they learn with real-life experiences. In this study, the concepts of ecology and conservation were presented in

the context of KEL, which is close to the students' lives. This facilitated the concept elaboration process and enabled students to retain information more permanently.

In addition, the use of documentary media and empirical case studies strengthened the cognitive and affective aspects of the students. According to Chawla (2020), emotional experiences associated with nature can increase students' internal motivation to understand and practise conservation behaviours. Mini-project activities such as creating conservation campaign posters are also in line with Kolb's experiential learning model,

which emphasises the cycle of learning through experience, reflection, conceptualisation, and application.

These findings are also consistent with the research by Ardoin et al. (2020), which states that direct and participatory environmental education has a strong influence on shaping environmental literacy. Student involvement in discussions with local environmental practitioners connects theory and conservation practice, so that the material is not only understood passively but also through social interaction.

On the other hand, these findings are relevant to the Sustainable Development Goals (SDGs) framework. SDG 4.7 encourages the integration of environmental and sustainability education into formal education systems. The bioconservation learning applied in this study can be categorised as a direct implementation of SDG 4.7 because it equips students with knowledge and skills related to sustainability. In addition, SDG 15, which emphasises the preservation of terrestrial ecosystems, is also highly relevant given the research focus on the preservation of KEL as a strategic conservation area.

This discussion is also reinforced by Fajri's (2025) research, which states that students' biodiversity literacy can increase significantly when learning materials are linked to local biodiversity issues. This is evident in this study, where the relevance of the material to students' daily lives makes learning activities more meaningful. The presence of real issues such as human-animal conflict, deforestation, and habitat degradation meant that students not only understood the theory but also realised the urgency of conservation actions.

Thus, bioconservation learning not only improves cognitive aspects but also forms the foundation for environmental attitudes and awareness. This shows that this learning model is worthy of adoption as local content in schools around KEL as part of a long-term environmental conservation strategy.

4. Conclusions

Based on the results of research on the Integration of Bioconservation Education as a Strategy for Biodiversity Conservation in realising the SDGs in Aceh at SMA Negeri 1 Bandar Pondok Baru as Support for the SDGs, it can be concluded that this learning model has a significant impact on increasing students' knowledge about the Leuser Ecosystem Area (KEL) and its relevance to the Sustainable Development Goals (SDGs). The implementation of bioconservation learning for six weeks successfully increased the average score of student knowledge from 54.80 on the pretest to 83.10 on the post-test, with a gain score of 28.30 and an N-Gain value of 0.63, which is in the medium-high category.

This improvement shows that the integration of biology, ecology, and conservation concepts linked to the local context of KEL can strengthen students' cognitive understanding more effectively than conventional learning. The results of this study also indicate that experiential learning and contextual learning approaches can foster students'

ecological literacy and environmental awareness more deeply. These findings are in line with previous studies that confirm that participatory and locally relevant environmental education has a significant impact on changing the knowledge and conservative behaviour of the younger generation.

Thus, bioconservation learning is highly recommended to be included as local content in schools around the Leuser Ecosystem Area. The integration of conservation education into the school curriculum is a strategic step in supporting the achievement of SDG 4.7 on sustainable education and SDG 15 on the preservation of terrestrial ecosystems. In addition to improving academic achievement, this learning model has the potential to shape a generation with ecological competence, environmental empathy, and commitment to long-term conservation efforts.

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