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Enhancing Students' Biodiversity Literacy Through the Sundanese Ethnoscience-Based Discovery Learning Model

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Abstract: Biodiversity literacy encompasses students' understanding of biodiversity concepts, its utilization, and conservation efforts. This study aims to determine the effect of the ethnoscience-based discovery learning model on biodiversity literacy and students' scientific explanation skills in the classification of living organisms in Grade X at SMA Negeri 3 Tasikmalaya for the 2024/2025 academic year. The research method used was a quasi-experimental design. This study was conducted at SMA Negeri 3 Tasikmalaya during the 2024/2025 academic year, with the population consisting of 432 students from twelve classes in grade X. The sample was selected using purposive sampling, resulting in class X.E-1 as the experimental group and class X.E-2 as the control group. Data collection techniques included a biodiversity literacy test consisting of 33 multiple-choice questions. The result showed that the average score for biodiversity literacy in the experimental class was 75.85 (SD = 12.89), while in the control class, it was 65.15 (SD = 15.74). The ANCOVA analysis yielded a significance value of 0.006 ($p < 0.05$), indicating a statistically significant effect. Therefore, the result concludes that the Sundanese ethnoscience-based discovery learning model significantly influences biodiversity literacy in the classification of living organisms among Grade X students at SMA Negeri 3 Tasikmalaya.

Keywords: biodiversity literacy, discovery learning, ethnoscience, biology.

▪ INTRODUCTION

Biodiversity is one of the important components in the balance of the ecosystem, which is currently experiencing challenges due to many human activities (Carranza et al., 2020). Therefore, immediate conservation efforts are necessary to ensure its sustainability. One way that can be done is through an education process that can instill an understanding of biodiversity both locally and globally. This education can also develop positive characters in maintaining the balance of the ecosystem (Katili et al., 2021; Ramdiah et al., 2020). In the context of biological studies, this type of knowledge is called biodiversity literacy.

Biodiversity literacy is the ability to understand and implement the main concepts of biodiversity that can change behavior and develop positive attitudes toward the environment (Janžekovič, 2022). This literacy involves not only concepts but also awareness of the need to take real action in environmental conservation efforts (Schneiderhan-Opel & Bogner, 2020). Previous research emphasized that in environmental education it is necessary to integrate local knowledge to provide contextual learning, but this type of literacy is still neglected (Sandoval-Rivera, 2020). The integration of local biodiversity contributes to increasing students' awareness of environmental issues around them (Druker-Ibáñez & Cáceres-Jensen, 2022). As a result, students will be able to find solutions to create a balanced ecosystem that is threatened by ecological challenges such as climate change or human activities.

Recent research shows a significant gap in students' biodiversity literacy. A study by Hooykaas et al. (2019) in the Netherlands reported that students were only able to

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accurately identify 35% of native species. Meanwhile, Aslan Efe & Efe (2022) found that biodiversity literacy among secondary school students in Turkey is still low, even though they already have a positive view of biodiversity. Research conducted by Argiyanti et al. (2024) shows that the biodiversity literacy of high school students in Indonesia is still low at the multidimensional level, which can lead to limitations in understanding biodiversity holistically. The results of a preliminary study at SMA 3 Tasikmalaya also indicated that the level of biodiversity literacy of students was still low, with a score of 53 out of 100. The results of interviews with biology teachers showed that one of the causes was the lack of integration of local biodiversity, which limited student involvement in understanding local biodiversity phenomena. These findings raise concerns that the younger generation lacks an attitude that prioritizes biodiversity, which has the potential to accelerate biodiversity loss (Usman et al., 2022).

To effectively improve biodiversity literacy, a science-based learning model is needed, such as discovery learning (Balážová et al., 2024; Linawati et al., 2023). Discovery learning is a learning model that actively involves students in scientific inquiry and problem solving, allowing them to develop knowledge through exploration and investigation (Ariati & Yurnetti, 2022). Students not only understand the relationship between species and the environment but also realize the impact of human activities on it through inquiry-based investigations. This process will make learning more meaningful and relevant to students' lives so that it can increase awareness of positive attitudes towards environmental sustainability (Macagno et al., 2024).

Discovery learning, as an example of a scientific approach learning model, has the potential to increase students' awareness of environmental issues, including biodiversity issues (Linawati et al., 2023; Minan et al., 2021). In addition, students often have difficulty constructing knowledge in discovery learning when they lack a basic understanding of the subject matter. Studies have shown that the integration of local knowledge has become an alternative in improving students' biodiversity knowledge (Druker-Ibáñez & Cáceres-Jensen, 2022). Therefore, the integration of Sundanese ethnoscience into the model is one possible option to overcome these difficulties and increase the effectiveness of discovery learning in biodiversity education. Sundanese ethnoscience is ecological knowledge grounded on the traditional wisdom of the Sundanese people handed down from generation to generation. This integration enhances conceptual knowledge, environmental consciousness, and favorable attitudes towards sustainability (Permana et al., 2019). Furthermore, this integration motivates students to think critically by means of research on local biodiversity pertinent to local culture and knowledge.

Several studies have explored ethnoscience-based discovery learning. For example, a study of Pursitasari et al. (2019) demonstrated that literacy demonstrated that discovery learning has been shown to positively impact students' science literacy, while Fadhilah & Diliarosta (2021) investigated that integrating local cultural knowledge with scientific concepts promotes contextual understanding. A study by Zidny & Eilks (2020) also emphasized the importance of integrating local knowledge into science learning to improve students' perspectives that are oriented toward sustainability. However, previous studies have still focused on general science literacy, not specifically on biodiversity literacy. Moreover, studies that directly combine discovery learning with ethnoscience to increase biodiversity literacy in secondary schools remain limited.

This study aims to address this gap by examining how the Sundanese ethnoscience-based discovery learning model affects students' biodiversity literacy. Through this study, it is expected to improve the quality of science education and support conservation efforts through learning. The results obtained are expected to provide insight into effective learning strategies in improving students' understanding and concern for biodiversity conservation.

▪ METHOD

Participant

The population in the study involved 432 students from class X of SMA 3 Tasikmalaya, covering 12 classes. Sampling used purposive sampling based on categories relevant to the research objectives (Creswell, 2012). The researcher picked the sample by examining classes with almost identical average ratings. This selection seeks to reduce external factors and confirm that the observed differences are due to the intervention. A sample of 68 students was recruited, comprising 34 students from class X-E 1 designated as the experimental group using a discovery learning model based on Sundanese ethnoscience and 34 students from class X-E 2 designated as the control group using a discovery learning model without Sundanese ethnoscience as a comparison.

Research Design and Procedures

This study was conducted for one month, from November 12 to December 12, 2024. This study consisted of several stages. First, both groups were given an initial test (pretest) to measure the level of biodiversity literacy before learning began. Next, they studied the topic "Classification of Living Things" in two learning sessions. The experimental group received learning with a Sundanese ethnoscience approach, which integrates knowledge of local biodiversity. Meanwhile, the control group followed learning without ethnoscience elements. After the learning sessions were completed, both groups were given a final test (posttest) to evaluate the development of their biodiversity literacy. The results of the initial test and the final test were compared to assess the effectiveness of the Sundanese ethnoscience-based discovery learning model in improving students' biodiversity literacy.

Instrument

This research used a test instrument to determine the extent of improvements in biodiversity literacy. The test instrument used in this research is the biodiversity literacy instrument. Biodiversity literacy is measured using a multiple-choice test with a total of 42 questions. The questions used were formulated based on the biodiversity literacy indicators from Katili et al. (2022), which consist of 6 indicators with a total of 7 questions from each indicator, including (1) the ability to define biodiversity and its utilization, (2) the ability to define biodiversity at the genetic, species, and ecosystem levels, (3) the ability to explain the loss of biodiversity and its causes, (4) the ability to understand the principles of biodiversity conservation, (5) the ability to differentiate biodiversity conservation efforts, and (6) the ability to communicate and create solutions for various biodiversity-related issues. The instruments used in this study were questions developed independently, so before being used as a research instrument, the questions underwent the stages of instrument validation by expert judgment, validity test, and reliability test.

Validation through expert judgment is conducted to determine whether the instrument is appropriate for students in terms of construction, language, and question content. Based on the expert judgment validation, it was found that the biodiversity literacy instrument developed fell into the "very good" category in terms of construction, language, and question content, making it suitable for use in this research.

A field validity test was conducted on Grade XI students at SMAN 3 Tasikmalaya, who had previously studied the topic "Classification of Living Things". Validation test using the Pearson's Product-Moment Formula, with the assistance of SPSS Version 25 for Windows. Based on the validity test results, it was found that for the biodiversity literacy test items, from 42 items, 33 items met the validation criteria with validity coefficient values ranging from 0.35 to 0.70, and 9 items did not meet the validation criteria. The reliability test will use the Cronbach's Alpha test, and the testing of the biodiversity literacy instrument will be assisted by SPSS Version 25 for Windows software. The biodiversity literacy instrument yielded a reliability value of 0.939, indicating the instrument's high level of reliability. This means that it has a "very high" correlation level ($0.80 < r \leq 1.00$), which is what Guilford (1956) says it should have. Based on the validity and reliability test results, 33 questions will be used as an instrument to measure the biodiversity literacy of experimental and control classes.

Data Analysis

The pretest and posttest results were first analyzed using descriptive statistics to determine the average score increase in each class. Next, prerequisite tests were conducted, including the Kolmogorov-Smirnov test for normality and Levene's test for homogeneity, to ensure the data met the assumptions for hypothesis testing. The hypothesis was then tested using ANCOVA to assess the effect of the learning treatment on biodiversity literacy in both classes.

▪ RESULT AND DISSCUSSION

The results of the biodiversity literacy test in the experimental and control classes were then analyzed with the prerequisite test with normality and homogeneity tests. This test is to ensure that the data was normally distributed and homogeneous, so the data was eligible to proceed to the hypothesis test in the form of an ANCOVA test. The normality test used is the Kolmogorov-Smirnov test with the help of IBM SPSS software version 25.0 for Windows. After finishing the normality test, the result of the significance value is 0.161 for the experimental class pretest data, 0.056 for the experimental class posttest data, 0.200 for the control class pretest data, and 0.058 for the control class posttest data. All the data exhibit a normal distribution because their values exceed 0.005. The result of normality test are presented in Table 2 below.

Table 1. Results of normality test for experimental and control classes

Class	Statistic	df	Sig.
Experimental pretest	.129	34	.161
Experimental posttest	.148	34	.056
Control pretest	.116	34	.200*
Control posttest	.148	34	.058
a. Liliefors Significance Corection			

In this research, the Levene test was chosen for the homogeneity test, and with the help of IBM SPSS software version 25.0 for Windows, the result of the homogeneity test is that the significance value is 0.382 based on the mean, 0.494 based on the median, 0.494 based on the median with adjusted df, and 0.421 based on the trimmed mean. Thus, the data obtained is homogeneous because the significance value for the pretest and posttest result is more than 0.05. The result of homogenity test are presented in Table 3 below.

Table 2. Results of homogeneity test for experimental and control classes

Type	Levene Statistic	Df1	Df2	sig
Pretest	1.907	1	66	.172
Posttest	.775	1	66	.382

Based on the results of the prerequisite test, it can be seen that the data has been taken from a normally distributed and homogeneous population, so the data make the requirements for further testing using the ANCOVA test (Analysis of covariance). ANCOVA test is to determine the effect of ethnoscience-based discovery learning model on students' biodiversity literacy. Ancova test was carried out with the help of IBM SPSS software version 25.0 for windows, the result of Ancova test are presented in table 4 below.

Table 4 shows the results of the ANCOVA test analysis of students' biodiversity literacy. The “Classes” section shows the testing of the ethnoscience-based discovery learning model on the biodiversity literacy obtained by the students. According to the test results, the significance value for the learning model is 0.006. Therefore, at a 95% confidence level, the use of the Sundanese ethnoscience-based discovery learning model greatly affects students' biodiversity literacy on the topic of the classification process of living entities. The adjusted model section shows a significance value of 0.002, indicating that Ho is not true. This means that the biodiversity literacy pretest and the Sudanese ethnoscience-based discovery learning model have an effect on the biodiversity literacy posttest results. Partial eta squared in the class section obtained a value of 0.109, which is included in the "moderate" category from (2002). The value found is still in the moderate-to-large range, which indicates that the Sundanese ethnoscience-based discovery learning model has been helping students improve biodiversity literacy.

Table 3. ANCOVA test results of biodiversity literacy

Test of Between-Subjects Effects						
Dependent Variable: Posttest LB						
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	2829.911	2	1414.956	7.164	0.002	0.181
Intercept	31631.652	1	31631.652	160.151	0.000	0.711
XLB (Biodiversity literacy pretest)	859.970	1	859.970	4.354	0.041	0.063
Classes	1567.950	1	1567.950	7.939	0.006	0.109
Error	12838.206	65	197.511			
Total	355622.000	68				

Corrected Total	15668.118	67

To show more clearly the effect of the intervention, Figure 1 compares the mean scores of the pre-test and post-test of the experimental and control groups. This visualization provides a broader view of the increase in biodiversity literacy after the intervention using Sundanese ethnoscience-based discovery learning model.

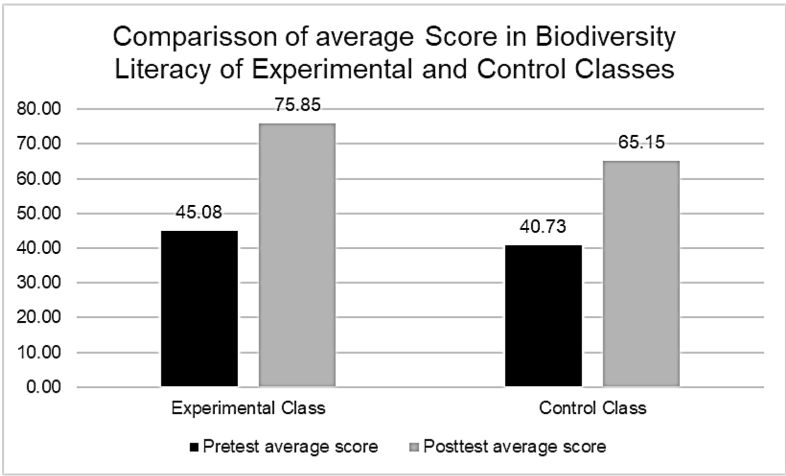

Figure 1. Bar diagram of average score in biodiversity literacy of experimental and control class

The integration of scientific knowledge that is contextual and relevant to students' local culture allows them to explore local biodiversity. These findings are further supported by qualitative data from student interviews conducted after the posttest. Several students from both the control and experimental classes were asked about their learning experiences, focusing on whether the learning approach helped them understand biodiversity concepts, including scientific classification, taxonomic ranks, and biodiversity conservation.

The results of this study show that the Sundanese ethnoscience-based discovery learning helps to enhance students' biodiversity literacy. These findings align with previous studies that have explored the effectiveness of discovery learning enhances students' conceptual understanding and problem-solving skills (Fikri & Adlini, 2023; Muhali et al., 2021). While Fuadi & Irdalisa (2024) demonstrated that integrating ethnoscience in biology education increases understanding of biological concepts by connecting scientific knowledge with local cultural practices.

Qualitative data from student interviews conducted post-intervention was thematically evaluated to support these results. The thematic study found three key themes: (1) challenges in remembering scientific names and classifications, (2) the role of local biodiversity, and (3) the impact of cultural relevance on motivation to learn biodiversity

Challenges in remembering scientific classification

Students in the control class said they struggled to remember the scientific names and traits of plants and animals they studied. One student said, "Because they are rarely encountered and used in our surroundings, I have forgotten some scientific names and traits of the plants and animals." The study indicated that students will know little about biodiversity if learning does not connect local contexts that are relevant to them.

The role of local biodiversity

Students in the experimental class demonstrated better understanding of biodiversity concepts. They attributed this to the use of familiar plant and animal species in lessons. One student commented, "I know the scientific names and characteristics of the plants and animals because we studied species commonly found in our environment, and their uses in local culture were explained, making learning easier to remember and apply." This suggests that including local biodiversity into scientific education helps to retain knowledge by strengthening daily interactions with these species.

The impact of cultural relevance on learning motivation to learn biodiversity

Students in the experimental class showed greater motivation to learn about biodiversity because they realized its cultural importance. One student said that “it is very intriguing to learn about local biodiversity through tradition. I now see how our culture values conservation, and I want to protect these plants and animals."

The ethnoscience-based discovery learning model applied in this study follows the six core phases of discovery learning: stimulation, problem statement, data collection, data processing, verification, and generalization. Including ethnoscience into these phases helps students to link biodiversity ideas with local culture knowledge, hence enriching the learning experience.

During the stimulation stage, practical examples of Sundanese culture, such as the use of local plants and animals that are often used in traditional medicine and food practices, are displayed in the form of photos and videos to introduce biodiversity. For example. Sundanese people use traditional medicine that utilizes various plants known as jamu, including sambiloto (Andrographis paniculata), which is used as a medicine for malaria or fever. Sundanese people also utilize edible plants known as lalapan as a nutritious food source. So, with this integration, students can understand how important the biodiversity around their local environment is. This is in line with the research of Damopolii et al. (2023) that learning using a local wisdom-based learning has an effect on increasing students' understanding of biodiversity in the local environment.

Meanwhile, in the problem statement phase, students are asked to create questions that are relevant to the results of their observations. Students create questions about how local plants are scientifically classified and how they contribute to biodiversity. The teacher facilitates students in formulating relevant questions by connecting the concept of biodiversity with ethnoscience. According to Eviota & Liangco (2020) the incorporation of ethnoscience into this education enables students to link personal experiences with fresh information, hence contextualizing and enriching learning.

At the data collection stage, students carry out various active participations, such as conducting direct observations in the surrounding environment to find various types of plants and discussing with community leaders about the functions of these plants. Control class students, on the other hand, mostly used textbooks without engaging with actual biodiversity instances. This stage's practical approach fits Ramdiah et al. (2020), who underlined that integrating local knowledge into science lessons improves students’ scientific literacy and understanding of biodiversity. Furthermore, Atmojo et al. (2021) revealed that local wisdom-based learning promotes students' comprehension of biodiversity protection, as they perceive its immediate application in their communities.

During the data processing phase, students examined their results by comparing scientific classifications with traditional naming systems in Sundanese culture. They addressed how plants are categorized based on their morphological characteristics in scientific taxonomy against their functional roles in local knowledge. At this stage, the teacher guides students to ensure that students draw connections between the two concepts so that students do not see conventional and scientific classifications as contradictory but rather as complementary. This is in line with Katili et al (2022) who emphasized the importance of the role of teacher scaffolding in ethnoscience learning that enables students to connect local and scientific knowledge.

Students share their results and participate in peer discussions to confirm the conclusions during the verification stage. The teacher encourages students' critical thinking by asking questions such as "How can knowledge about local biodiversity contribute to conservation efforts?" and "Why is it important to integrate cultural values in biodiversity learning?" Students in the experimental class showed a greater level of engagement in critical thinking to connect biodiversity with their cultural identity and everyday experiences. This finding is supported by Fajri et al. (2023), who stated that students' ability to apply scientific concepts to practical issues can be improved by learning that links local knowledge.

Finally, in the generalization stage, students reflect by drawing broader connections about the impact of ethnoscience integration in biodiversity learning. Based on the results of the reflection, many students realized the importance of the integration and even suggested conservation measures such as the need to plant more traditional medicinal plants in the school garden or the environment around the house. One student said, "Now I realize that biodiversity conservation is not only a scientific concept but also something related to our culture." In Sundanese culture, there are several traditional beliefs related to conservation efforts, such as the prohibition of cutting down trees carelessly, which is expressed in the proverb "ulah neukteuk tangkal sambarangan, bisi kaalang ku jurig," which means "don't cut down trees carelessly, or you will be disturbed by ghosts." These cultural values are informal environmental education that complements initiatives for biodiversity preservation. This is consistent with Montgomery et al. (2020), who discovered that when students view conservation as part of their cultural legacy rather than only an abstract scientific concept, they develop stronger environmental ethics.

To provide a comprehensive grasp of the comparative average scores for each biodiversity literacy indicator, researchers computed the average score of each student's performance across all indicators. Figures 2 and 3 display the bar diagrams representing these average scores.

The results of the study indicated that students who were taught with Sudanese ethnoscience-based discovery learning had more profound knowledge of biodiversity compared to students in the control class. Regarding the ability to distinguish biodiversity conservation efforts (indicator 5), the experimental class was better able to identify and distinguish conservation actions, especially those based on local knowledge. This finding is in line with Ogar et al. (2020), who emphasized that the integration of local knowledge in science learning will increase students' awareness of biodiversity conservation.

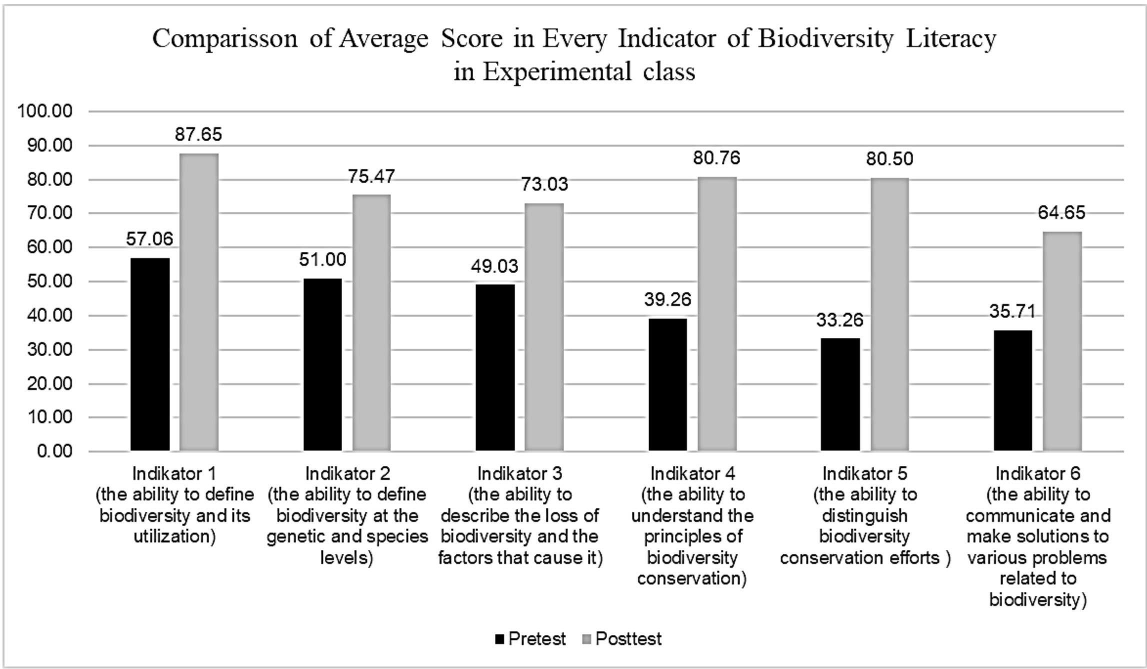

Figure 2. Bar diagram of average score in every indicator of biodiversity literacy in experimental class

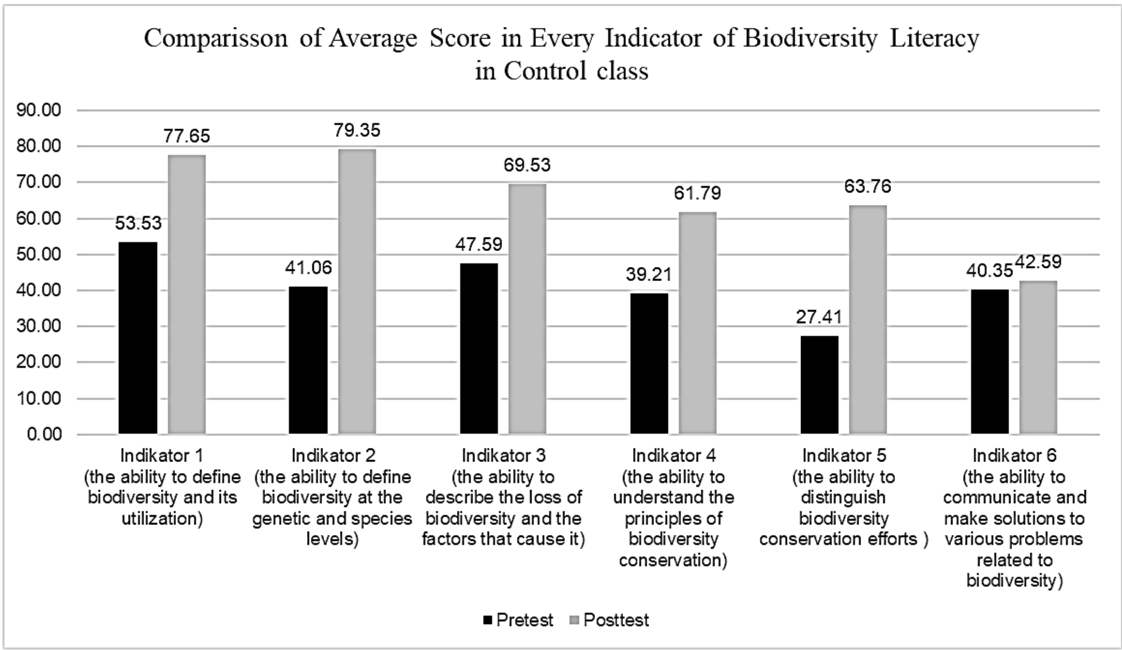

Figure 3. Bar Diagram of average score in every indicator of biodiversity literacy in control class

Students in the experimental class were able to connect scientific and practical concepts in life (indicator 4), which focuses on understanding the principles of biodiversity conservation. Students gain more contextual and broader knowledge about biodiversity by incorporating examples of sustainable environmental management in Sundanese culture, such as the use of coconut leaves for roofing and the mina padi system. Research Indrawan et al. (2012) supports this finding by stating that integrating traditional ecological knowledge helps students better understand sustainability.

Experimental class students showed a wider viewpoint on the ability to define biodiversity and its utilization (indicator 1) by connecting biological categories with local biodiversity and its applications in daily life. The discovery learning method motivated students to investigate the functions and advantages of different plant and animal species in their community, hence promoting a more relevant knowledge. This is in line with Suryawati & Osman (2017), who emphasized the importance of learning that is relevant to students' lives to be more effective in internalizing and understanding scientific concepts. Students in the experimental class showed a more critical understanding of the causes of biodiversity loss (indicator 3) because they could see the phenomenon directly with the changes that occurred in their environment. Learning by including ethnoscience examples can help students analyze directly and indirectly the causes of biodiversity loss. This confirms the results of research by Ilhami et al. (2019), which states that students' capacity to assess environmental problems more critically can be improved by integrating local knowledge.

Students in the experimental class showed significant improvement in defining biodiversity at the genetic and species levels (indicator 2), although some students still found it difficult. This result proves that Sundanese ethnoscience-based learning has provided a contextual dimension, but abstract concepts such as genetic diversity still require further explanation with visual models or practical exercises. For indicator 6 on problem-solving and communication skills related to biodiversity, students in the experimental class showed more active contributions in suggesting various solutions to conservation problems. This is because students feel more motivated to investigate biodiversity issues related to their culture, thereby improving critical thinking and scientific explanation skills. Incorporating local knowledge into science education helps students' cognition and attitudes. This helps shape future generations with strong moral values who value and uphold the wisdom of their cultural heritage (Habibiati et al. 2024).

The findings of this study generally indicate that the Sundanese ethnoscience-based discovery learning model is effective in improving students' biodiversity literacy. The findings of this study support previous studies that emphasize the effectiveness of ethnoscience-based education in improving students' understanding of biodiversity. For example, Suryawati & Osman (2017) in Malaysia discovered that a contextual approach in scientific teaching enable students to relate biodiversity ideas to their daily lives. Ogar et al. (2020) in Nigeria also found that including local knowledge into science education raises students' awareness of conservation initiatives, therefore supporting the result that experimental class students were more able to recognise and distinguish conservation strategies depending on local knowledge.

However, when compared to studies at higher educational levels, ethnoscience-based approaches may need to be complemented with more scientific methodologies. University students in the UK were more likely to embrace global policy-based strategies than those based in local knowledge (Neale et al., 2018). A study done in Finland also revealed that university students were more used to data-driven and scientific modeling approaches when grasping conservation concerns (Yli-Panula et al., 2022). While ethnoscience is good in improving biodiversity awareness among secondary school pupils, at the university level a mix of modern scientific frameworks and traditional knowledge systems is required to guarantee a deeper and more relevant understanding of biodiversity ideas. Furthermore, in countries with technology-driven education systems such as Australia, students often rely more on technology-based solutions than local knowledge-based approaches to conservation efforts (Almeida et al., 2018). This difference suggests that the success of ethnoscience-based education can differ depending on the national education system and degree of education.

▪ CONCLUSION

The results of this study indicate that the Sundanese ethnoscience-based discovery learning model has a significant effect on students' biodiversity literacy. This conclusion is evidenced by the difference in biodiversity literacy scores between the experimental and control groups. Furthermore, the results of the ANCOVA hypothesis test showed a significance value of 0.006 < 0.05, indicating that students' biodiversity literacy was greatly influenced by Sundanese ethnoscience-based discovery learning. The results of the study provide recommendations for teachers to integrate ethnoscience into classroom learning. Teachers can invite local cultural figures to share knowledge about traditional medicinal plants and their applications to encourage students to investigate biodiversity more. Students can be involved in research projects on local biodiversity, allowing them to connect scientific concepts with real-world applications. The results also highlight the need for a more culturally responsive curriculum that integrates local wisdom and biodiversity conservation efforts.

Despite these findings, this study has several limitations. The quasi-experimental design used does not allow for strong causal conclusions, as other variables may have influenced the results. Additionally, the study only included one school in Tasikmalaya, potentially limiting the generalizability of the findings. Expanding the study to multiple schools in different schools in Tasikmalaya can provide a broader perspective on the effectiveness of the ethnoscience-based discovery learning model.

The measurement of biodiversity literacy relied only on multiple-choice tests, which may not fully capture students' understanding and reasoning. To address this, future research should incorporate a combination of assessment methods, such as essay questions and structured interviews, to gain a more comprehensive understanding of students' biodiversity literacy. The ethnoscience-based discovery learning model is expected to be applied not only to the material of classification of living things but also to other biology materials and in other lessons so that in the future it can be known what variations of the implications of this research are in various other science concentrations.

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