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THE EFFECT OF THE *PROBLEM-BASED LEARNING* MODEL INTEGRATED WITH ETHNOSCIENCE ON THE CRITICAL THINKING SKILLS OF 10TH GRADE STUDENTS AT SMAN 1 SENTAJO RAYA

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ABSTRACT

This study was motivated by the low critical thinking skills of students in biology learning. The low critical thinking skills of students are caused by the use of learning models that lack variety and the lack of student concern for the environment. This study aims to determine the effect of the Problem-Based Learning (PBL) model integrated with Ethnoscience on students' critical thinking skills in the subject of environmental change and preservation in class X at SMAN 1 Sentajo Raya. The research used a Quasi-Experimental method with a Pre-test-Post-test Non-Equivalent Control Group Design. The research sample consisted of two classes selected by Random Sampling, namely the experimental class that was given the integrated PBL treatment with Ethnoscience and the control class that used the Discovery Learning model assisted by PowerPoint. The research instruments were critical thinking skills tests and observation sheets. The results showed that the critical thinking skills of students in the experimental class were higher than those in the control class. This was evident from the pretest average score of 42.8 in the experimental class and 39.86 in the control class, and the posttest average score of 80.13 in the experimental class and 67.2 in the control class. Data analysis using an independent sample t-test showed a significance value (2-tailed) of 0.00 < 0.05 with a t-value > t-table, namely 5.545 > 1.994. It can be concluded that the application of the integrated ethnoscience Problem Based Learning model has an effect on students' critical thinking skills in the subject of environmental change and preservation in class X at SMAN 1 Sentajo Raya.

Keywords: Ethnoscience; Critical thinking skills; Problem-Based Learning.

INTRODUCTION

The era of globalization has brought significant changes to various aspects of life, including education. Education plays an important role in improving the quality of human resources who are able to adapt to developments in science and technology. Teachers, as educators, have a major role in ensuring the achievement of quality learning that is relevant to the needs of the 21st century. According to Supentri, et al. (2022), teachers who understand their duties and responsibilities are the key to the success of the educational process. In line with the Future of Jobs report (World Economic Forum, 2020), there are four main competencies that need to be developed in the 21st century, namely self-management, working with people, technology adaptation, and problem solving. 21st-century skills also require 4C skills (critical thinking, creativity, collaboration, communication) to be important competencies that need to be instilled through the learning process.

Critical thinking skills are one of the aspects that students must have in order to be able to face the complexity of global challenges. This ability plays a role in improving the quality of learning and encouraging students to think analytically and reflectively (Wayudi, M., et al., 2020). However, interviews and observations at SMAN 1 Sentajo Raya show that students' critical thinking skills, especially in 10th grade biology, are still relatively low. After conducting an initial critical thinking test, the average score was 34%, which is categorized as very uncritical (Fitri, et al., 2023). This condition shows that students still have difficulty analyzing, concluding, and evaluating information. One of the causes is the use of the Discovery Learning model, which has not been optimal in fostering critical thinking and contextual problem-solving skills, as seen from the majority of students who scored below the Learning Objective Achievement Criteria (KKTP).

This weakness calls for innovation in learning strategies that can stimulate active student engagement while developing higher-order thinking skills. One such strategy is the implementation of the Problem-Based Learning (PBL) model, which emphasizes contextual problem-based learning to train critical thinking, collaboration, and problem-solving skills. This learning model is more meaningful when it is relevant to real-life problems (Arsih et al., 2021). Students are not only required to understand the problem, but also to be able to work together to solve it, thereby stimulating their critical thinking skills. This is in line with the Indonesian Ministry of Education, Culture, Research, and Technology Regulation No. 48 of 2022, which emphasizes the importance of reasoning and problem-solving skills in national education assessments.

In addition to low critical thinking skills, interviews with biology teachers also showed that students' concern for the environment is still low. Students tend to lack understanding of the relationship between biological concepts and environmental phenomena occurring in their surroundings. This low level of environmental awareness indicates that the learning process is not yet fully contextual and has not instilled local wisdom values that reflect concern for the environment. Therefore, efforts are needed to link biology learning with local cultural values oriented towards environmental preservation.

The integration of the Problem-Based Learning model with the ethnoscience approach is highly relevant to biology learning, especially in the subject matter of environmental change and preservation. This subject matter discusses various complex environmental phenomena and requires students to think critically in identifying the causes, impacts, and solutions to environmental problems (Miterianifa, & Mawarni, 2024). The application of the PBL model integrated with ethnoscience can help students hone their critical thinking skills, as they are required to interact directly with the environment and find solutions to existing problems (Amini, 2021). For example, in Kuantan Singingi Regency, there is a tradition called Mamucuak, which is the activity of catching fish in a forbidden pool that is only done once a year. This reflects the values of environmental preservation that can be used as a source of learning in biology (Firmanda, et al., 2023). Each PBL syntax can be enriched by local wisdom, so that students learn not only from biology textbooks, but also through surrounding phenomena. The integration of the PBL model with the Ethnoscience approach is able to create contextual, meaningful learning and shape students' character to care for the environment.

Several previous studies support the effectiveness of the PBL model and the ethnoscience approach. Nuralita, et al. (2020) concluded that the application of the Ethnoscience-based PBL model was able to improve student learning outcomes compared to conventional models. Furthermore, research by Oktapia, V., et al. (2024) shows that the application of PBL integrated with Ethnoscience has a significant effect on improving students' critical thinking skills. Thus, this study aims to determine the effect of the Problem-Based Learning model integrated with Ethnoscience on the critical

thinking skills of 10th grade students at SMAN 1 Sentajo Raya. This study is expected to contribute to the development of innovative learning models based on local culture and serve as a reference for educators in improving the quality of contextual, character- building, and sustainable biology learning.

RESEARCH METHODS

This study used a quantitative approach with a *Quasi Experiment* method with *a Pretest- Posttest Non-Equivalent Control Group Design*. The research was conducted at SMAN 1 Sentajo Raya in the even semester of the 2024/2025 academic year (April–June 2025). The planning and preparation of learning tools were carried out at the Biology Education Study Program, University of Riau. The population in this study was all 10th grade students at SMAN 1 Sentajo Raya, consisting of three classes, namely X.1, X.2, and X.3. From this population, two classes *were randomly sampled* as research samples, namely classes X.1 and X.3, each consisting of 30 students. Class X.1, as the experimental class, applied the integrated Ethnoscience *Problem-Based Learning* model, while class X.3, as the control class, used the *PowerPoint-assisted Discovery Learning* model.

This study began with administering *a pretest* to both classes to determine the students' initial critical thinking skills before being given treatment. After that, the experimental and control classes received treatment according to their respective learning models. In the experimental class, the learning process was carried out by applying the steps of *Problem-Based Learning* integrated with the context of ethnoscience, while the control class carried out learning using *Discovery Learning* assisted by *PowerPoint.* After the treatment was completed, both classes were given *a posttest* to determine the improvement in students' critical thinking skills after participating in the learning process.

The parameters observed in this study were critical thinking skills, which included the ability to analyze, synthesize, recognize and solve problems, draw conclusions, and assess and evaluate. Data were collected through tests and observations based on critical thinking indicators. Tests were used in the form *of pre-tests* and *post-tests.* Meanwhile, observations were conducted during the learning process using observation sheets. Observations were conducted by two observers to assess students' critical thinking skills in each meeting.

The research instruments used consisted of learning tools and data collection instruments. The learning tools included the Learning Objective Flow (ATP), teaching modules, student assignment sheets (LTPD), as well as teaching materials and learning media designed to integrate the context of ethnoscience. The data collection instruments were critical thinking test questions and observation sheets. The test questions were compiled based on the grid for each critical thinking indicator, while the observation sheets were used to assess the implementation and student activities during the learning process. Before use, the instruments were tested to determine their validity, reliability, level of difficulty, and discriminating power using SPSS version 25.

The research data were analyzed using descriptive and inferential statistical methods. Descriptive analysis was used to determine the improvement in students' critical thinking skills, while inferential analysis was used to test the research hypothesis. Inferential analysis used the *Independent Samples T-Test* at a significance level of 0.05 after meeting the prerequisites of normality and homogeneity to determine the effect of the integrated ethnoscience *Problem-Based Learning* model on students' critical thinking skills.

The research procedure consisted of three stages, namely preparation, implementation, and reporting. In the preparation stage, the researcher conducted preliminary observations of the learning process, developed learning tools and research instruments, and conducted instrument trials. The implementation stage included administering *a pretest,* conducting the learning process, observing the learning process, and administering *a posttest.* The reporting stage involved analyzing the research data, drawing conclusions, and compiling a final report.

RESULTS AND DISCUSSION

Results

Instrument Feasibility Test Results

The research instrument used consisted of a critical thinking skills test comprising 25 questions. Before use, the instrument was tested for validity, reliability, difficulty level, and discriminating power. The results of the instrument feasibility test are presented in Table 1.

Table 1. Results of the Critical Thinking Skills Test Instrument Feasibility Test

Type of Test	Results
Validity	Valid
Reliability	Reliable (r = 0,851)
Level of Difficulty	Moderate and difficult
Discriminative Power	Moderate and high

All items were found to be valid and reliable with a reliability coefficient of 0.851, indicating high consistency. From the difficulty level test results, 15 items were classified as moderate and 10 items as difficult. Meanwhile, the discrimination power test results showed that 14 items were classified as moderate and 11 items as high. Thus, all items are suitable for use in research because they meet the criteria of validity, reliability, difficulty level, and adequate discrimination power.

Critical Thinking Skills Based on *Pretests* and *Posttests*

The *pretest* and *posttest* data were taken from the experimental and control classes, which were then analyzed and calculated for each class. The *pretest* and *posttest* data on the critical thinking skills of students in the control and experimental classes are presented in Table 2.

Table 2. Average *Pretest* and *Posttest* Scores for Students' Critical Thinking Skills

Class	*Pretest* Average	Category	*Posttest* Average	Category
Control	39,86	Not Critical	67,20	Moderately Critical
Experimental	42,80	Not Critical	80,13	Critical

Based on Table 2, it can be seen that the average *pretest* scores of students in both classes were still in the very non-critical category. After the treatment, there was an increase in both classes, but the increase in the experimental class was higher (from 42.80 to 80.13) than in the control class (from 39.86 to 67.20). This shows that the *Problem-Based Learning* (PBL) model integrated with Ethnoscience has a positive effect on improving students' critical thinking skills.

The *pretest* and *posttest* data results from the two classes measured the level of students' critical thinking skills based on each critical thinking skill indicator. The presentation of *pretest* and *posttest* data based on critical thinking indicators can be illustrated in the following diagram:

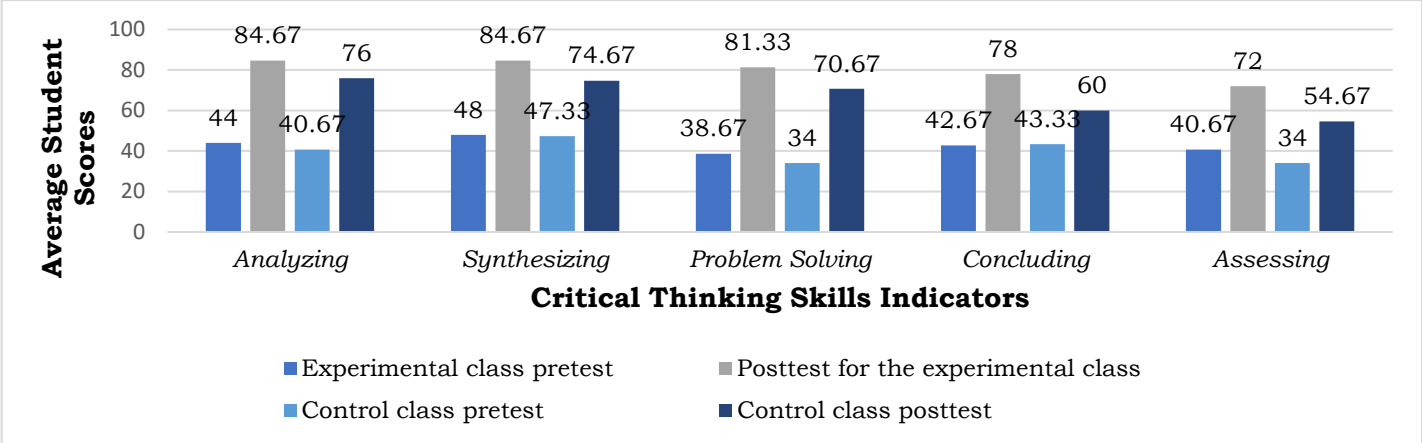

Figure 1. Diagram of Average Critical Thinking Skill Indicator Scores

Figure 1 shows an increase in each critical thinking skill indicator from *the pretest* to *the posttest* in both the control and experimental classes. After the scores were converted into critical thinking skill scores for each indicator, it was found that the experimental class had a higher average score than the control class. Of the five highest critical thinking skill indicators in the control class, the indicator of analysis obtained a score of 76, which was categorized as fairly critical, while the highest critical thinking skill indicator in the experimental class, namely the indicators of analysis and synthesis, obtained a score of 84.67, which was categorized as critical.

Critical Thinking Skills Based on Observation Results

Critical thinking skills were also observed during the learning process using observation sheets. The average results of the observation of students' critical thinking skills in the control class and the experimental class can be seen in Table 3.

Table 3. Results of Student Critical Thinking Skills Observation

Class	Average (%)	Category
Control	51,6	Moderately Critical
Experimental	62,9	Critical

The observation results show that the critical thinking activities of students in the experimental class were in the critical category with an average of 62.9%, while the control class was in the fairly critical category with an average of 51.6%. Of the five highest critical thinking skill indicators in the control class, the indicator of synthesizing obtained 55.4% and was categorized as fairly critical, while the highest critical thinking skill indicator in the experimental class, the indicator of analyzing, obtained 67.2% and was categorized as critical.

Hypothesis Testing

Based on the results of the prerequisite test that had been carried out, it was found that the data was normally distributed and had homogeneous variance. This means that the hypothesis test can be continued using *the Independent Samples T-Test* with a significance level of <0.05, so the hypothesis is accepted. The following are the results of the hypothesis test in Table 4:

Table 4. Critical Thinking Skills Hypothesis Test

Independent Samples Test

		t-test for Equality of Means			
		T	**Df**	**Sig. (2-tailed)**	**Mean Difference**
Posttest	Equal variances assumed	5.545	58	.000	12.933
	Equal variances not assumed	5.545	57.251	.000	12.933

Based on the results of the critical thinking skills hypothesis test in Table 4, the significance value (Sig. 2-tailed) is 0.00 < 0.05 with a t-count value > t-table, namely 5.545 > 1.994. This indicates that there is a significant difference between the critical thinking skills of students taught using the integrated PBL model with Ethnoscience and students taught using the *Discovery Learning* model assisted by *PowerPoint.* Thus, $H_{(0)}$is rejected and H_1 is accepted, which means that the integrated *Problem-Based Learning* model with Ethnoscience has a significant effect on the critical thinking skills of 10th grade students at SMAN 1 Sentajo Raya.

Discussion

Instrument Feasibility Test

The results of the research instrument feasibility test show that 25 items have met the criteria of validity, reliability, level of difficulty, and good discriminatory power. The validity of the instrument shows that each item has been able to measure critical thinking skill indicators in accordance with the research focus, namely the application of the integrated Ethnoscience *Problem- Based Learning* (PBL) model. This shows the integration between the content of the questions and the critical thinking skill indicators, which include analyzing, synthesizing, recognizing and solving problems, concluding, and evaluating. These findings support the opinion of Hidayati *et al.* (2021), who assert that valid instruments are able to accurately describe students' critical thinking skills, so that the measurement results can be used as a reliable assessment. This view is in line with Lukman *et al.* (2023), who stated that a valid critical thinking test instrument will reflect students' ability to understand concepts and relate them to the local cultural context.

The reliability test results showed a coefficient of 0.851, which is in the high category. Based on the criteria proposed by Arikunto (2020), this value indicates that the instrument has an excellent level of consistency. High reliability on each item provides stable results when administered to groups with similar characteristics. This means that the data produced is consistent and can be used as a

basis for drawing valid conclusions. These results also support the research by Yulianti and Arrahim (2024), who obtained a Cronbach's Alpha reliability value of 0.854 in measuring critical thinking skills, indicating good instrument consistency.

The difficulty level analysis shows that 15 items are classified as moderate and 10 items are classified as difficult. This finding indicates that the difficulty level of the items is balanced. According to Nurpitasari (2023), instruments with a balanced distribution of difficulty levels are able to stimulate critical thinking skills optimally because the questions are neither too easy nor too difficult. This finding is also supported by Agusta (2022), who explains that the proportion of moderate and difficult questions can accurately measure variations in student abilities, especially in solving complex problems such as in problem-based learning.

The discrimination power test results show that 14 items have moderate discrimination power and 11 items have high discrimination power. Items with good discrimination power are able to clearly distinguish between high and low ability students, thus providing accurate information for researchers. This reinforces the findings of Nurhalimah *et al.* (2022) that items with high discriminating power play an important role in objectively identifying differences in student abilities. Items with good discriminating power also demonstrate the effectiveness of items in measuring the level of mastery of material and critical thinking skills (Nafs *et al.*, 2023).

Critical Thinking Skills Indicators

The results showed that students' critical thinking skills improved across all indicators after the implementation of the integrated Ethnoscience *Problem-Based Learning* (PBL) model. In general, the most significant improvement occurred in the experimental class compared to the control class.

The analytical skills of students in the experimental class improved compared to the control class. Through the application of integrated PBL and Ethnoscience, students were encouraged to analyze local environmental phenomena such as the use of banana leaves as food wrappers in the context of ethnobotany and the structure of Gadang houses in the context of ethnotechnology. Group discussions and exploration of local culture stimulated students to compare, identify, and relate scientific concepts to traditional community practices. These activities reinforced the PBL syntax, particularly in the stage of orienting students to problems and guiding investigations, which proved effective in fostering students' analytical skills. These results support the findings of Triyanti (2022) and Milatti and Fitrihidajati (2024) that the application of PBL can improve critical thinking skills through the process of contextual problem solving. Thus, the integration of Ethnoscience context into the PBL model contributes to improving students' analytical skills regarding culture-based phenomena.

Students' synthesis skills also improved after participating in learning with the integrated PBL model of Ethnoscience. In the context of ethnoecology, students were able to explain the impact of chemical pesticide use on soil pollution, while in the context of ethnotechnology, students were able to identify the function of the Gadang house structure as a form of disaster mitigation. Learning that emphasizes local cultural values helps students relate scientific concepts to local community wisdom, thereby developing the ability to formulate relevant arguments and solutions. Through group investigation activities, students become accustomed to integrating data into a single, comprehensive conclusion. These findings are in line with the results of research by Ilhamdi (2025) and Nuralita *et al.* (2020), which show that the Ethnoscience-based PBL model is capable of developing synthesis skills because it trains students to think integratively and contextually.

Problem recognition and solving skills also experienced a significant increase in the experimental class. Through Ethnoscience contexts such as *Manubo* traditions and the *Subak* irrigation system, students learned to understand the relationship between cultural practices and their ecological impact. The integrated Ethnoscience learning process made students realize that local wisdom can be a solution to environmental problems. These activities foster reflective, contextual, and problem-solving skills. This is in line with the results of research by Sape and Tudjuka (2025) and Rahman *et al.* (2022), which states that the combination of PBL and ethnoscience is effective in developing students' problem-solving skills. Therefore, the application of PBL integrated with Ethnoscience not only strengthens cognitive abilities but also fosters ecological awareness and responsibility for environmental conservation.

In the conclusion indicator, students in the experimental class demonstrated better reasoning skills in drawing conclusions based on data and cultural context. Students were able to conclude the importance of forest conservation based on the customs of the Baduy tribe and explain the ecological

impact of the burning tradition in the *Ngaben* ceremony. Through the fourth stage of PBL syntax, namely developing and presenting work results, students were trained to express ideas and draw conclusions based on empirical evidence. The integration of Ethnoscience values helped students see the relationship between culture and scientific concepts, so that the conclusions produced were more applicable and meaningful. These results support the findings of Bilqiis *et al.* (2023) and Tuah *et al.* (2025), which confirm that the PBL model encourages students to draw conclusions based on evidence and improves their reflective abilities. Thus, the application of PBL integrated with ethnoscience plays an important role in developing students' reasoning, argumentative, and reflective abilities.

The last indicator, namely assessment and evaluation skills, also showed a significant improvement in the experimental class. Students were able to assess the advantages and disadvantages of a cultural phenomenon based on scientific knowledge, for example, comparing the efficiency of traditional tools such as mortars and pestles with modern machines in the context of ethnotechnology, as well as assessing the effectiveness of the *Subak* system in maintaining water and environmental balance. Through the fifth stage of PBL syntax, namely analyzing and evaluating the problem-solving process, students are trained to assess the validity of arguments, consider various points of view, and reflect on learning outcomes. These findings are in line with Sembiring *et al.* (2025) and Andriani (2025), who state that assessment and evaluation skills require continuous practice so that students become accustomed to assessing and providing critical feedback.

The Effect of the Integrated Ethnoscience *Problem-Based Learning* Model on Critical Thinking Skills

Critical thinking skills in this study were reviewed based on five indicators, namely analyzing, synthesizing, recognizing and solving problems, concluding, and assessing and evaluating. The results of the hypothesis test using *the Independent Samples T-Test* showed a significance value (Sig. 2-tailed) of 0.00 < 0.05, so H_0 was rejected and H_1 was accepted. This means that the *Problem- Based Learning* (PBL) model integrated with Ethnoscience has a significant effect on the critical thinking skills of 10th grade students at SMAN 1 Sentajo Raya.

Before the treatment, the *pretest* results showed that the critical thinking skills of students in the control and experimental classes were in the very non-critical category. These similar initial conditions indicate the homogeneity of the students' initial abilities, so that the comparison after the application of the learning model can describe the objective influence. After five learning sessions, the *posttest* results showed that the critical thinking skills of students in the experimental class increased significantly with an average of 80.13% (critical category), while the control class only reached an average of 67.2% (sufficiently critical category).

The improvement in students' critical thinking skills was also evident from the results of observations during the learning process. In the problem orientation syntax, students were directed to explore contextual phenomena through an Ethnoscience approach. For example, in the context of ethnobotany, students compared the use of banana leaves as environmentally friendly ketupat wrappers with the use of plastic, which pollutes the ecosystem. In the context of ethnoecology, students analyzed the *Manubo* tradition (catching fish using poison) and compared it with the *Mamucuak* tradition in Lubuk Larangan as a form of water conservation. Meanwhile, in the context of ethnoteknologi ( ), students examined the *Mandulang Ome* practice (gold mining), which is more environmentally friendly than the use of *Dompeng* machines that cause water pollution. These activities train students to think analytically about the relationship between culture, the environment, and biological concepts. This is in line with the findings of Ismail *et al.* (2022), who state that the use of local cultural phenomena in learning can increase student participation and critical thinking skills.

Integrated PBL learning with Ethnoscience not only helps students understand biological concepts scientifically, but also encourages them to relate local knowledge as a source of learning in problem solving. Hidayati and Julianto (2025) explain that the integration of Ethnoscience can foster reflective attitudes and information assessment skills because students compare scientific and local cultural perspectives. These results also reinforce the research of Festiyed *et al.* (2022) that local community knowledge is relevant to modern technology and science, so it can be used as a basis for formulating innovative solutions to contextual problems. During the learning process, students actively discussed, provided critical responses to the cases presented, and developed data- based problem-solving strategies. This is in line with the research by Muhartini *et al.* (2023), which found

that PBL encourages students' curiosity and motivation to learn to find scientific solutions to contextual problems.

CONCLUSIONS

Based on the hypothesis test results, a significance value of 0.00 < 0.05 was obtained, so H_0 was rejected and H_1 was accepted. Thus, it can be concluded that the integrated ethnoscience *Problem-Based Learning* model has a significant effect on the critical thinking skills of 10th grade students at SMAN 1 Sentajo Raya. For future research, the control class should also be given treatment involving the ethnoscience approach so that the quality of learning is more even and the comparison of research results is more objective. Future researchers are expected to expand their references and relate ethnoscience elements to more diverse learning materials that are closer to students' daily lives, so that the application of local cultural values becomes more meaningful. For teachers or education practitioners, the application of the Ethnoscience-integrated *Problem-Based Learning* model requires effective time management. Therefore, teachers need to make careful plans so that all stages of learning can be carried out optimally without reducing the essence of the learning activities.

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