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Implementation of a Problem-Based Learning Model Incorporating the Ethnoscience of Embun Upas to Improve Students' Science Literacy Skills at MTS Ma'arif Garung

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ABSTRACT

One of the causes of low science literacy among students in Indonesia is the prevalence of traditional pedagogical approaches in science education, which fail to connect the material to real-world contexts. This study aims to improve students' science literacy skills through the application of a Problem-Based Learning model incorporating the ethoscience of "embun upas" in the topic of changes in the states of matter. This quantitative study employed a quasi-experimental design with a non-equivalent control group. Instruction was conducted over four sessions spanning two weeks, during which the experimental class received instruction using the Problem-Based Learning model grounded in the ethnoscience of "embun upas," while the control class received conventional instruction. Data collection involved two methods: observation to monitor the implementation of the learning process and a test to evaluate students' science literacy competencies. The research instruments were assessed based on validity, reliability, difficulty level, and discriminative power. Descriptive statistics were used to analyze the data. Preliminary tests included normality and homogeneity tests, while hypothesis testing utilized the independent samples t-test and the N-Gain test. The observation results showed that the implementation rate of the learning process reached 85%, indicating that the learning model was implemented effectively. The experimental class had an average posttest score of 76.36, exceeding the control class's average score of 62. The independent-samples t-test yielded a significance value of $0.000 < 0.05$, indicating a significant difference in science literacy skills between the two classes. The N-Gain analysis results showed that the experimental class achieved a score of 0.5918, falling into the moderate category, while the control class achieved a score of 0.2995, falling into the low category. The research findings indicate that the application of Problem-Based Learning that integrates the ethoscience of embun upas effectively enhances students' science literacy skills through more contextual, engaging, and relevant learning.

Keywords: Problem-Based Learning; Ethnoscience; Embun Upas; Science Literacy

INTRODUCTION

The World Economic Forum emphasizes that science literacy is one of the key 21st-century skills that fosters scientific reasoning and action in understanding and addressing various social challenges (Pratiwi et al., 2019). Science literacy plays a crucial role in developing students' critical

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and analytical thinking skills so that they can solve everyday problems, face global challenges such as climate change and technological advancements and make decisions based on valid information and scientific evidence (Cahyanto et al., 2024). Science literacy encompasses the ability to understand and evaluate scientific concepts and phenomena, identify scientific issues, and draw conclusions based on scientific evidence (Toharudin et al., 2023). In addition, science literacy also encompasses the ability to apply scientific knowledge to understand and address various science and technology issues in daily life and serves as one of the indicators of students' academic achievement (Ahsani et al., 2024). Science literacy also demonstrates the ability to use scientific knowledge to analyze and interpret information, solve problems, and make decisions regarding natural phenomena and the impact of human activities on the environment (Sanjiartha et al., 2024; Yuliastrin et al., 2025)

Data from the Programme for International Student Assessment (PISA) show that Indonesian students' science literacy scores have consistently remained below the average from 2000 to 2022. Indonesia remains one of the 10 countries with the lowest rankings across these eight assessments. In PISA 2022, Indonesia achieved a science literacy score of 383, lower than the international average of 485 and a decline from the 2018 PISA score of 396 (OECD, 2023). Although Indonesia's ranking improved slightly compared to the previous cycle, this improvement does not reflect a significant enhancement in science literacy achievement. The PISA 2022 report explains that the decline in learning outcomes observed in many countries following the COVID-19 pandemic also influenced changes in cross-national rankings. Therefore, score performance is a more appropriate indicator for describing students' science literacy abilities than changes in rankings alone.

PISA test results show that students have a limited understanding of fundamental scientific concepts, which correlates with low levels of science literacy in Indonesia. Additional factors contributing to the decline in science literacy include reliance on traditional teaching methods, students' inability to analyze data presented in tables and graphs, and their lack of interest in engaging with scientific literature. Due to teachers' weak understanding of science literacy, their role remains crucial, as education often emphasizes content mastery over the development of critical thinking skills. Therefore, improving science literacy requires collaboration among educators, students, and academic institutions. This can be achieved through the implementation of innovative and contextual learning that encourages students' active engagement in the scientific process (Yusmar & Fadilah, 2023)

Natural Sciences studies living organisms and the various events and processes that occur within them. Natural Sciences aims to explain various natural phenomena and mysteries, including the origin of the cosmos and its components, as well as the various processes, mechanisms, properties of objects, and events that occur within it (Lubis et al., 2023). Science instruction must be designed to actively engage students in constructing knowledge and connecting scientific concepts to phenomena they encounter in daily life. However, science teaching practices in schools remain teacher-centered and focused on delivering content through lectures and rote memorization. This situation results in students having limited opportunities to investigate, analyze, and connect science concepts to real-world problems, thereby preventing their science literacy skills from developing optimally (Firmansyah & Jiwandono, 2022; Wahyuni, 2022). Despite curriculum changes, science instruction in schools remains teacher-dominated and heavily reliant on lectures and memorization of topics. As a result, students have fewer opportunities to investigate, analyze, and connect the material they learn to everyday issues and phenomena.

The implementation of the problem-based learning (PBL) model is crucial for improving the quality of the educational process. PBL is an educational approach rooted in constructivist philosophy, which emphasizes students' active participation in the construction of knowledge through experiential learning. The PBL approach is characterized by contextual and collaborative learning, an emphasis on problem-solving, and the development of metacognitive skills. By implementing PBL, students deepen their understanding of specific subjects while refining their critical thinking skills through active engagement in problem-solving (Muhartini et al., 2023)

The ethoscience approach is an effort to reframe scientific knowledge that has developed within a community into a form that can be scientifically explained. Science is closely related to the local knowledge that exists and evolves within a community because it is the discipline that studies various natural phenomena. Ethnoscience-based learning is important because it draws on students' prior knowledge based on their experiences and culture within their environment. This local knowledge is then analyzed and linked to formal science concepts so that it can be used as a resource for learning in school. The ethnoscience approach is defined as an educational strategy that integrates cultural elements into the learning process (Khoiri & Sunarno, 2018)

The model can be integrated with an ethoscience approach to create learning that is more contextual, relevant, and aligned with students' daily lives. The ethoscience approach connects scientific concepts with culture, local knowledge, and phenomena occurring in the community, thereby helping students understand scientific concepts while applying them to solve problems in their surrounding environment. In addition to supporting curriculum implementation, this approach also fosters an appreciation for local culture, strengthens national identity, and enhances students' cognitive abilities and understanding of scientific concepts (Alfiana & Fathoni, 2022). The PBL model encourages students to think critically, solve problems, and apply scientific knowledge in real-world situations, thereby contributing to the improvement of science literacy as one of the key competencies of the 21st century (Cahyo & Diyana, 2025). Integrating local knowledge into science learning can improve students' science literacy because it makes the learning process more meaningful, contextual, and closely tied to their experiences, while also contributing to the preservation of local culture (Putra & Wahyuni, 2025)

The PBL model and the ethoscience approach can improve science literacy through more contextual and meaningful learning (Damayanti et al., 2024). However, there has been limited research integrating the PBL model with the local phenomenon of "embun upas" as an ethoscience context within the topic of changes in the states of matter. "Embun upas" is a natural phenomenon occurring in the Dieng Highlands where temperatures drop to freezing, causing ice crystals to form on plant surfaces; it is known locally for its potential to damage crops (Hidayah et al., 2022). This phenomenon has also given rise to various forms of local wisdom aimed at protecting plants from damage, such as watering plants before dawn, using plant covers, and adjusting planting patterns to weather conditions (Firdaus et al., 2023). Consequently, it holds potential as an authentic learning context to connect the concept of changes in the state of matter with real-world problems in students' environments. Therefore, this study offers a novel approach in the form of applying a PBL model based on the "Embun Upas" ethoscience to enhance students' science literacy skills.

The researchers conducted a study on the application of the PBL method, grounded in the "Embun Upas" ethoscience, to improve students' science literacy skills. This study aims to: (1) evaluate the effectiveness of the PBL paradigm that integrates "Embun Upas" ethoscience in improving students' science literacy skills, (2) evaluate the differences in science literacy skills between students participating in PBL with "Embun Upas" ethnoscience and those participating in conventional learning methods; and (3) determine the extent of improvement in students' science literacy skills following the implementation of the PBL model incorporating "Embun Upas" ethnoscience.

METHOD

This study employed a quantitative methodology. This approach generated quantitative data, which was then statistically analyzed to address research challenges and assess the research hypotheses (Muin, 2023). The design used was a quasi-experimental framework utilizing non-equivalent control groups, including an experimental class and a control class drawn from a population with generally homogeneous characteristics. The study population consisted of all seventh-grade students at MTs Ma'arif Garung, with the sample comprising Class VII B as the experimental group and Class VII A as the control group, selected using a random sampling method. Data collection was conducted using observational and test-based approaches. Observations assessed the implementation of the learning process, while multiple-choice tests measured students' science literacy skills based on criteria such as the ability to explain phenomena scientifically, evaluate and design scientific investigations, interpret scientific data and evidence, and use scientific information for decision-making and action.

The implementation of the learning process was observed using an observation sheet based on the PBL model syntax. The aspects observed included: (1) student orientation toward the problem, (2) organizing students for learning, (3) guiding individual and group investigations, (4) developing and presenting work products, and (5) analyzing and evaluating the problem-solving process. Each aspect was rated using a four-point Likert scale: 1 = poor, 2 = adequate, 3 = good, and 4 = very good. Observations were conducted by a science teacher acting as an observer, who had been provided with observation guidelines and an explanation of the assessment indicators before the learning process began. The percentage of instructional implementation was calculated using the formula:

$$\text{Learning implementation} = \frac{\text{skor diperoleh}}{\text{skor total}} \times 100\%$$

Before being used in the data collection process, the research instruments were evaluated to ensure their suitability for measuring students' science literacy consistently and accurately. This analysis included tests of validity, reliability, difficulty level, and item discrimination.

1. Validity tests
   A validity test was conducted to determine the extent to which each question in the test could assess the specified construct. The results of the validity test showed that, out of 12 questions and 21 respondents, valid data were obtained for questions 1 through 10, since $r_{calculated} > r_{table}(0.433)$ at a 5% significance level.
2. Reliability Test
   Reliability testing evaluates the reliability and consistency of a test instrument. An effective test instrument will produce consistent results under identical conditions. The reliability test result for the science literacy assessment was 0.826, which meets the reliability criterion that a score $\geq$ 0.70 indicates excellent reliability of the test items.
3. Item Difficulty Test
   The item difficulty analysis was conducted to classify each question as easy, moderate, or difficult. This study revealed that, of the 12 items assessed, 3 were classified as easy, 7 as moderate, and 2 as difficult.
4. Discriminant validity test
   A discrimination test was conducted to assess the ability of test items to distinguish between high- and low-ability students for each question. An effective assessment instrument can reveal a broad spectrum of student competencies. The analysis showed that items 1, 2, 4, 6, 7, 8, 9, 10, 11, and 12 had adequate discriminative power, while items 3 and 5 also demonstrated sufficient discriminative power. The results indicated that most items effectively distinguished among students' various levels of science literacy.

Descriptive statistical analysis was conducted to summarize the research data by calculating the mean, count, maximum, and minimum values of the pretest and posttest results. Next, the necessary assessments were conducted, including tests of normality and homogeneity. The normality test assessed whether the research data followed a normal distribution, with the data considered normally distributed if the significance value was > 0.05. The homogeneity test evaluated the comparison of variances between the experimental and control groups, considering the data homogeneous if the significance value was > 0.05. After all necessary assessments were completed, hypothesis testing was conducted using a t-test to determine whether there was a significant difference in posttest scores between the experimental and control groups. The test criteria indicated that a significance value < 0.05 indicates a significant difference between the two groups. The N-Gain test was administered to assess the improvement in students' science literacy skills following the implementation of the PBL approach using the Embun Upas ethoscience. N-Gain values are classified as high if > 0.7, moderate if between 0.3 and 0.7, and low if < 0.3.

RESULTS AND DISCUSSION

This study examined the implementation of PBL using the Embun Upas ethoscience method to improve students' science literacy skills. The PBL model integrating Embun Upas ethoscience combines problem-solving with local knowledge regarding the Embun Upas phenomenon.

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Students gained a theoretical understanding of science and its relevance to real-world situations. To apply the PBL model with "embun upas" ethoscience, students were presented with a contextual question regarding the impact of "embun upas" on farmers' crops in the Dieng highlands. Next, students were asked to study the theory of phase changes to identify the causes of "embun upas." During this process, students were instructed to engage in critical thinking to address issues related to the "embun upas" phenomenon.

The learning process begins with the presentation of the "embun upas" phenomenon which frequently occurs in the Dieng highlands as a contextual problem closely related to students' daily lives. During the problem-orientation stage, the teacher displays images and videos of the frost phenomenon and poses guiding questions regarding the formation process of frost and its impact on agricultural crops. Next, during the student-organization stage, students are divided into several groups to identify problems, formulate questions, and develop an investigation plan based on the observed phenomenon. During the investigation guidance stage, each group gathered information from various sources, engaged in discussions, and linked the community's local knowledge about "embun upas" to the scientific concept of the change of state of matter, specifically the process of deposition. The stage of developing and presenting the results was carried out through group presentations on the mechanisms behind the formation of "embun upas," the factors influencing it, and measures that can be taken to minimize its impact on crops. In the final stage, the teacher and students reflect on and evaluate the problem-solving process, emphasizing the alignment between local knowledge and the scientific concepts they have learned. The integration of "embun upas" ethoscience into each stage of PBL is expected to provide a contextual learning experience, increase student engagement in the learning process, and facilitate the development of science literacy skills.

Data collection generated descriptive results from the pretest and posttest administered to both research groups. Before instruction, students' science literacy skills were assessed through a pretest to establish their baseline competencies. The same assessment instrument and administration procedures were applied to the control and experimental groups to support a comparable initial measurement. Each group comprised 25 students, providing equal sample sizes for the subsequent comparison. These baseline data served as the reference for determining the magnitude of change after the learning intervention. Table 1 summarizes the pretest scores obtained by the control and experimental groups.

Table 1. Pretest Results

Class	Number of Students	Total Scores	Average	Lowest Score	Highest Score
Control	25	1,159	46.36	25	75
Experimental	25	1,167	46.68	25	75

Table 1 presents the students' science literacy scores before the learning intervention. The control group obtained a total score of 1,159, with a mean of 46.36, a minimum score of 25, and a maximum score of 75. The experimental group recorded a total score of 1,167 and a mean of 46.68, with the same minimum and maximum scores of 25 and 75, respectively. The difference between the twopretest means was only 0.32 points. The identical score range and the small difference in mean scores indicate that the two groups had highly similar initial science literacy performance. Consequently, subsequent differences in posttest performance can be interpreted against a relatively comparable baseline.

After the learning activities were completed, a posttest was administered to both groups to measure students' final science literacy competencies. The posttest used the same scoring framework as the pretest so that changes in performance could be examined consistently. Equivalent administration procedures were maintained for the control and experimental groups to reduce measurement-related differences. Comparing the posttest with the baseline results provides evidence of the learning gains achieved within each group. Comparing posttest performance across groups also indicates whether the PBL model integrated with Embun Upas ethnoscience produced better outcomes than conventional instruction. Table 2 presents the posttest results for both groups.

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Table 2. Posttest Results

Class	Number of Students	Total Scores	Average	Lowest Score	Highest Score
Control	25	1,550	62	41	83
Experimental	25	1,909	76.36	50	100

Table 2 summarizes the science literacy scores obtained after the intervention. The control group achieved a total score of 1,550 and a mean of 62.00, with scores ranging from 41 to 83. In comparison, the experimental group obtained a total score of 1,909 and a mean of 76.36, with scores ranging from 50 to 100. The experimental group's mean posttest score was therefore 14.36 points higher than that of the control group. Its higher minimum and maximum scores also indicate a general upward shift in the distribution of science literacy performance. Although these descriptive results favor the experimental group, inferential testing was required to determine whether the observed difference was statistically significant.

Before hypothesis testing, preliminary analyses were conducted to determine whether the data satisfied the assumptions required for parametric analysis. The normality test examined whether the pretest and posttest scores in each group followed an approximately normal distribution. The homogeneity test assessed whether the group variances met the criterion for equivalence. For both tests, a significance level of 0.05 was used as the decision threshold. A significance value greater than 0.05 was interpreted as meeting the relevant assumption. The normality and homogeneity test results are presented in Tables 3 and 4, respectively.

Table 3. Normality Test Results

Dataset	Significance (p)	Alpha	Interpretation
Control group pretest	0.332	0.05	Normally distributed
Control group posttest	0.219	0.05	Normally distributed
Experimental group pretest	0.259	0.05	Normally distributed
Experimental group posttest	0.217	0.05	Normally distributed

Table 4. Homogeneity Test Results

Group	Significance (p)	Alpha	Interpretation
Control	0.154	0.05	Homogeneous
Experimental	0.445	0.05	Homogeneous

The prerequisite-test results indicate that the data satisfied the reported criteria for normality and homogeneity. The normality significance values were 0.332 and 0.219 for the control-group pretest and posttest, respectively. For the experimental group, the corresponding significance values were 0.259 and 0.217. Because all four values exceeded 0.05, there was no statistical evidence that the score distributions departed from normality. The homogeneity analysis also produced significance values of 0.154 for the control group and 0.445 for the experimental group, both above the 0.05 threshold. Based on these results, the data were considered suitable for hypothesis testing with an independent samples t-test.

After the assumptions of normality and homogeneity were satisfied, hypothesis testing proceeded using an independent samples t-test. The test compared the science literacy performance of the experimental group with that of the control group after instruction. The null hypothesis stated that there was no statistically significant difference between the two group means, whereas the alternative hypothesis stated that a significant difference existed. The decision criterion was set at an alpha level of 0.05. A p-value below this threshold would provide sufficient evidence to reject the null hypothesis. Table 5 presents the independent samples t-test result.

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Table 5. Independent Samples t-Test Results

Outcome	Students per Group (n)	Significance (2-tailed)	Criterion	Interpretation
Science literacy skills	25	$p < 0.001$	$p < 0.05$	Significant difference

The independent samples t-test produced a significance value reported by the statistical output as 0.000, which is conventionally expressed as $p < 0.001$. Because this value was below the 0.05 threshold, the null hypothesis was rejected. The result indicates a statistically significant difference in science literacy performance between the experimental and control groups. The descriptive statistics show that the direction of this difference favored the experimental group, whose mean posttest score was 76.36 compared with 62.00 in the control group. Thus, the group receiving PBL integrated with Embun Upas ethnoscience achieved stronger final performance than the group receiving conventional instruction. To complement this between-group comparison, N-Gain analysis was used to examine the magnitude of improvement within each group, as shown in Table 6.

Table 6. N-Gain Results

Group	N-Gain Score	N-Gain (%)	Interpretation
Control	0.2995	29.95	Low (less effective)
Experimental	0.5918	59.18	Moderate (quite effective)

The N-Gain analysis shows that the control group achieved an average normalized gain of 0.2995, equivalent to 29.95%. This result falls within the low category ($g < 0.30$), indicating limited improvement in science literacy skills under conventional instruction. The experimental group achieved a higher average normalized gain of 0.5918, equivalent to 59.18%. Because this value lies within the interval $0.30 \leq g < 0.70$, the improvement in the experimental group is classified as moderate and the intervention as quite effective. The difference of 29.23 percentage points between the two N-Gain percentages provides additional evidence that the experimental group experienced greater improvement. In addition, observations of the learning process showed an implementation rate of 85%, indicating that learning activities proceeded well according to plan. The research findings show that the combination of the PBL model with the “embun upas” ethoscience can be implemented effectively. Students’ active engagement in discussions, investigations, and problem-solving regarding the “embun upas” phenomenon enhances the contextual relevance and significance of learning, thereby improving their science literacy skills.

The research findings indicate that the implementation of the PBL paradigm with “Embun Upas” ethoscience improves students’ reading and comprehension skills in science. The results show that the PBL paradigm integrating “Embun Upas” ethoscience significantly enhances students’ science literacy skills. The t-test results indicate a substantial difference in students’ science literacy skills between the control group, which used a conventional learning model, and the experimental group, which used the PBL learning model incorporating “embun upas” ethoscience; thus, the alternative hypothesis (Ha) is accepted, stating that “There is a difference in students’ science literacy skills between the control class, which used a conventional learning model, and the experimental class, which used the PBL learning model incorporating ‘embun upas’ ethoscience.” This is consistent with research conducted by Baren Mamora & Setyawarno (2026), which showed that a PBL model utilizing the local potential of coarse salt yielded a significant value of 0.025 (<0.05), indicating a substantial difference between the experimental and control groups (Mamora & Setyawarno, 2026).

The N-Gain test revealed a significant improvement in students’ science literacy skills; the experimental group achieved a score of 0.5918 in the moderate category, while the control group scored 0.2995 in the low category. Based on the category interpretations, science literacy proficiency in the experimental class was deemed fairly effective, with an estimated value of 59.18%, whereas the control class was considered less effective, with an estimated value of 29.95%. This finding is consistent with research conducted by Teguh Wibowo and Ariyatun, which showed that ethoscience-based learning yielded an N-Gain score of 0.47 in the experimental group classifying it as moderate while the control group achieved 29.95%. These findings suggest that ethoscience-based chemistry education can serve as an alternative teaching approach to enhance students' scientific competencies (Wibowo & Ariyatun, 2020). Additionally, a study conducted by Sinta Dwi Ningrum et al. revealed that the PBL model achieved an N-Gain value of 65% for students categorized as having medium to high ability levels. The application of PBL techniques significantly improved students' science literacy competencies (Ningrum et al., 2026).

Nevertheless, the improvement in science literacy skills in the experimental class only reached the moderate category with an N-Gain value of 0.5918. These results indicate that the implementation of PBL using the "embun upas" ethoscience approach has not yet been able to produce improvements in the high category. One factor suspected to be the cause is the relatively short duration of the learning implementation, which consisted of only four sessions over two weeks. The development of science literacy skills requires a continuous process because it demands not only mastery of concepts but also the ability to identify scientific problems, interpret evidence, and apply scientific concepts in various contexts. In addition, some students were still adapting to the PBL model, which requires independent learning, group discussions, and scientific inquiry; consequently, not all students were able to make optimal use of the learning process. Another contributing factor was the students' relatively low initial science literacy skills, as indicated by the average pretest scores for both groups, which were below 50.

On the other hand, the control class also experienced an increase in science literacy skills with an N-Gain score of 0.2995, although it fell into the low category. This increase is reasonable because during the study, students continued to receive instruction in accordance with the applicable curriculum, so the learning process continued. Additionally, administering a pretest before the intervention allowed students to gain an understanding of the types of questions they would face on the post s (testing effect), enabling some students to demonstrate an increase in their scores. The development of students' learning abilities during the learning process (maturation effect) may also have contributed to the improvement in learning outcomes in the control class. However, this improvement was still significantly lower than that of the experimental class, indicating that the integration of PBL with ethoscience provided an additional contribution to the improvement in science literacy.

Research findings indicate that the implementation of a PBL approach integrating ethoscience on dew enhances students' science literacy skills. The application of an ethoscience-based PBL model to seventh-grade students at SMP Negeri 1 Pantai Labu had a significant effect on students' science literacy abilities (Siregar & Nasution, 2024). The integration of problem-based learning with ethnoscience has proven successful in improving students' science literacy regarding the concept of acid-base titration. Research shows that an ethnoscience-oriented PBL framework enhances students' science literacy (Devi, 2023). Research findings indicate that integrating a PBL framework with ethnoscience on dew creates a more dynamic, contextual, and meaningful learning experience. Incorporating the phenomenon of dew into learning activities enhances students' understanding of scientific concepts both theoretically and in relation to their environmental experiences. Through authentic and relevant learning experiences, students find it easier to grasp the content and apply scientific knowledge in various contexts of daily life.

The findings of this study align with constructivist theory, which states that students actively construct knowledge through experience-based learning and environmental interactions, rather than passively absorbing it from teachers. Throughout the educational process, students are given the opportunity to develop their understanding through observation, dialogue, discovery, and problem-solving relevant to the academic material. In this scenario, educators primarily act as facilitators, guiding students to independently uncover and develop concepts (Rizki et al., 2025). Within a constructivist framework, students are not passive recipients of information; rather, they are actively engaged in constructing their own knowledge through observation, discussion, investigation, and problem-solving activities. The application of the PBL model using ethnoscience enables students to develop scientific understanding based on phenomena observed in everyday life.

The implementation of the PBL model using the "embun upas" ethoscience approach also faces several challenges during the learning process. In the early stages, some students were not yet accustomed to identifying problems independently or connecting local phenomena with scientific concepts. Teachers needed to provide more intensive guidance so that students could formulate problems, search for relevant information, and construct arguments based on scientific evidence. Additionally, discussion and presentation activities required effective time management so that the entire PBL sequence could be carried out optimally.

The integration of "embun upas" ethoscience in this study was not merely used as an example at the beginning of the learning process but was integrated into every phase of the PBL process. The "embun upas" phenomenon served as the primary context for problem orientation, the basis for formulating investigative questions, group discussions, and reflections on the solutions generated by the students. Students not only learn local knowledge about "embun upas" but also relate it to scientific concepts of the changes in the state of matter specifically the process of deposition, the factors influencing the formation of "embun upas," and efforts to mitigate its impact on plants. Thus, ethnoscience serves as a learning context that helps students construct scientific concepts based on real-world experiences in their surroundings, rather than merely as an illustration or additional example. The connection between learning materials and real-world situations enriches the learning experience and aids students' understanding of scientific concepts. Therefore, a PBL paradigm rooted in the ethnoscience of embun upas can serve as a viable educational alternative to enhance students' science literacy skills.

CONCLUSION

The application of the PBL model integrated with the "embun upas" ethnoscience has proven effective in improving students' science literacy skills compared to conventional learning through contextual and meaningful instruction. Observation results showed a learning implementation rate of 85%, indicating that the implementation of the learning model proceeded smoothly. An independent samples t-test revealed a significant difference between the experimental and control classes (sig. = 0.000 < 0.05). N-Gain analysis showed that the improvement in science literacy skills in the experimental class fell into the moderate category (0.59), while the control class fell into the low category (0.30). These findings reinforce the constructivist theory that integrating real-world problems and local wisdom into the PBL model can support the development of science literacy and serve as an alternative for teachers in designing more contextual science instruction. Nevertheless, the research results should be interpreted while considering limitations such as the relatively small sample size, implementation at a single school, and measurements that focused solely on cognitive aspects. Therefore, future research is recommended to involve a larger sample and multiple schools, implement a longer learning duration accompanied by a follow-up test, develop instruments that cover the affective aspects of science literacy, and test the effectiveness of the ethnoscience-based PBL model on different science materials and in different cultural contexts.

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