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Effectiveness of Local Wisdom-Based Project-Based Ethnopedagogical Learning in Enhancing Students' Critical Literacy: A Quasi-Experimental Study

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ABSTRACT

This study aims to analyze the effectiveness of Project-Based Ethnopedagogical Learning (PBEL) based on local wisdom in enhancing students' critical literacy. Local wisdom, which has long been part of the community's cultural identity, is viewed as having the potential to serve as a contextual learning resource capable of stimulating higher-order thinking skills. The study used a quasi-experimental non-equivalent control group design involving 69 Grade X students from two intact classes selected through purposive sampling at SMA Negeri 4 Mataram, Indonesia. Class X-6 (35 students) received PBEL based on Lombok local wisdom, while Class X-7 (34 students) followed conventional learning. The PBEL intervention integrated project activities with the exploration and revitalization of local wisdom values through culturally contextual learning tasks. The critical literacy instrument was developed based on the indicators of interpretation skills, analysis skills, inference skills, evaluation skills, and self-regulation skills. Data were analyzed using Analysis of Covariance (ANCOVA) and Least Significant Difference (LSD) tests to examine the effectiveness of the treatment. The results showed a significant class effect on posttest critical literacy after controlling for pretest scores, $F = 93.010$, Sig. = 0.000, partial $\eta^2 = 0.585$, with a higher adjusted mean in the PBEL class (86.78) than in the conventional class (65.36). These findings indicate that PBEL offers practical novelty by transforming local wisdom into project-based inquiry and reflection activities that strengthen both cultural identity and critical literacy. This study implies that local wisdom-based PBEL can be adopted as a contextual instructional strategy for critical literacy development in Indonesian secondary education.

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INTRODUCTION

Entering the era of Society 5.0, the educational paradigm has undergone a significant shift. The government stipulates that graduates are not only required to master their scientific disciplines but are also expected to creatively and effectively apply their knowledge in resolving various real-world problems within society (Hamimi et al., 2024). This era of change is inevitable and demands the preparedness of human resources who are not only academically competent but also adaptive, competitive, and possess strong social and cultural awareness. These changes also encourage a transformation in literacy approaches. Traditional literacy, which focuses on basic skills in reading, writing, and arithmetic, is considered insufficient to address the challenges of the 21st century (Mytra et al., 2021; Wakifah et al., 2023). Therefore, there is a need to strengthen new forms of literacy, particularly critical literacy.

Critical literacy is the ability to understand, analyze, evaluate, and reflect on information before making decisions or formulating ideas (Rahman & Atjalau, 2019). Critical literacy serves as a foundation for shaping individuals who think independently, act responsibly, and possess strong character in navigating the complexities of the information age (Ninawati, 2019). Individuals with critical literacy skills are better equipped to confront various problems and to generate innovative solutions and ideas that contribute to career success and community life (Giselsson, 2020). Accordingly, the development of critical literacy is believed to be a key factor in preparing adaptive, solution-oriented, and highly competitive generations capable of responding to the dynamics of the Society 5.0 era.

However, empirical conditions in the field indicate that Indonesian students' literacy levels remain relatively low. Findings from the PISA assessment show that Indonesian students' science and mathematics literacy are still far below the OECD average (Nurhasanah et al., 2020). The National Assessment also reports that the literacy level of Indonesian learners reaches only 6.06%, reflecting the generally weak literacy skills among students. A study by (Almarashdi & Jarrah, 2023) emphasizes that students tend to be better at interpreting problems than at applying or formulating scientific solutions. One of the main factors contributing to low critical literacy is the lack of learning strategies that foster reflective thinking activities and habituation in solving contextual problems (Prananda et al., 2021).

To address these challenges, a learning strategy is required that is not only adaptive to the changing times but also contextual to local culture. One relevant approach is ethnopedagogical

learning, which positions local culture as a source of values, knowledge, and learning practices (Alditia & Nurmawanti, 2023). Local culture holds significant educational potential in shaping students' character and ways of thinking, as well as in strengthening the connection between learning materials and their social realities (Fadli & Irwanto, 2020). In the context of Lombok culture, elements such as the *gogo rancah* farming system, the *Bau Nyale* tradition, the *besiru* customary ceremony, and the *awiq-awiq* customary regulations represent concrete forms of social practices rich in values and can be utilized as contextual learning resources (Dewi et al., 2021; Utami et al., 2020). Through an ethnopedagogical learning strategy, students not only learn content related to their cultural background but are also encouraged to internalize these values in their daily lives (Douglas, 2020).

The integration of local wisdom values can be strengthened through an ethnopedagogically based Project-Based Learning strategy. In this study, local wisdom was operationalized into concrete project tasks, learning materials, and assessment activities by using several Lombok cultural elements. The *Bau Nyale* tradition was transformed into learning materials on marine ecosystems, biodiversity, and community-based conservation; the *gogo rancah* farming system was used as a project context for analyzing local agricultural adaptation and environmental sustainability; *awiq-awiq* customary regulations were used as materials for evaluating local ecological ethics and conservation practices; while *besiru* and *sangkep* were integrated into collaborative project activities and group deliberation processes. Students were asked to document cultural practices, conduct simple observations or interviews, analyze the relationship between local wisdom and biological concepts, and present project-based solutions to contextual environmental or social issues.

This strategy enables students to engage actively in meaningful projects that revitalize local culture, such as documenting Sasak folklore, simulating traditional deliberation practices (*sangkep*), and implementing customary-based environmental conservation activities. Through this engagement, students not only build critical literacy but also develop cultural competence the ability to understand, appreciate, and consciously and responsibly actualize cultural values in their daily lives. Levine & Tamburrino (2024) state that this strategy provides students with the opportunity not only to learn about their culture but also to internalize these values in their actions, making them an integral part of their identity and everyday behavior. In addition, Dewi et al., (2021) note that learning grounded in local culture has the potential to enhance students' understanding and active engagement. Through a Project-Based Ethnopedagogical Learning

strategy, students are encouraged to think critically, analyze social challenges, and develop solutions rooted in local wisdom, thereby strengthening their critical literacy. This learning approach contributes to shaping a generation that is not only academically competent but also aware of and responsible for their cultural heritage.

Although previous studies have examined project-based learning, ethnopedagogy, local wisdom, and critical literacy, most of them have treated these components separately or have emphasized conceptual and cultural enrichment without testing an integrated intervention through a quasi-experimental design. Empirical evidence remains limited regarding how Lombok local wisdom can be operationalized within PBEL to strengthen students' interpretation, analysis, inference, evaluation, and self-regulation. This study therefore advances the literature by examining a local wisdom-based PBEL model as a culturally contextual and empirically tested strategy for enhancing critical literacy.

Based on the aforementioned discussion, research is needed on Project-Based Ethnopedagogical Learning through the revitalization of Lombok's local wisdom. The primary objective of this study is to analyze the effectiveness of Lombok local wisdom–based Project-Based Ethnopedagogical Learning in enhancing students' critical literacy. The findings of this research are expected to provide meaningful contributions to the design of learning approaches that are locally relevant yet globally competitive.

RESEARCH METHODS

Research Design and Procedure

This study employed a quasi-experimental design using a non-equivalent control group model, namely a semi-experimental design involving two groups of students an experimental class and a control class with relatively comparable academic characteristics. The research procedure began with administering a pretest to both groups to determine their initial critical literacy abilities. Subsequently, the experimental class received treatment through the implementation of Project-Based Ethnopedagogical Learning, which integrates project activities with the exploration and revitalization of local wisdom, while the control class followed conventional instruction in accordance with standard school practices. The learning activities were conducted over several sessions based on the planned intervention design. After the treatment was completed, both groups were given a posttest using the same instrument to measure improvements in critical

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literacy. The quasi-experimental research design with a non-equivalent control group model is presented in Table 1 (Cohen et al., 2018).

Table 1. Non-Equivalent Control Group Design

Groups	Pretest	Treatment	Posttest	Treatment Description
Experiment	O_1	X_1	O_2	Receiving Project-Based Ethnopedagogical Learning based on local wisdom.
Control	O_3	X_2	O_4	Participating in conventional learning without the implementation of PBEL.

Notes:
O_1, O_3= Students' critical literacy pretest.
X_1 = Implement the treatment for students, which involves Project-Based Ethnopedagogical Learning Integrating Local Wisdom.
X_2 = Implement the treatment for students, which involves Conventional Learning.
O_2, O_4= Students' critical literacy posttest.

Research Population and Sample

This study was conducted at SMA Negeri 4 Mataram, located in the City of Mataram, West Nusa Tenggara. The research population consisted of all Grade X students of SMA Negeri 4 Mataram in the Odd Semester of the 2025/2026 academic year, comprising seven classes. The sample in this study was determined using purposive sampling. This technique was chosen because the researcher could not randomly assign students to classes; therefore, the groups were selected from existing classes by considering equivalence in ability, learning schedules, and class size. To strengthen baseline equivalence, a one-way ANOVA was conducted on the students' initial abilities in the two selected classes. The result showed no significant difference between the classes ($F = 0.514 > 0.05$), indicating that both classes had comparable initial abilities. Class X-6, consisting of 35 students, was assigned as the experimental class, while Class X-7, consisting of 34 students, served as the control class. The total number of students involved in this study was 69. This number meets the standard requirements for a quasi-experimental study (Cohen et al., 2018; Mursali et al., 2024).

Instruments for Data Collection

The instrument used in this study was a critical literacy test sheet. The critical literacy test was developed based on the indicators of Facione's taxonomy of critical thinking skills, namely: (1) interpretation skills, (2) analysis skills, (3) inference skills, (4) evaluation skills, and (5) self-regulation skills (Sultan et al., 2017). The instrument was developed through a test blueprint, item construction, expert validation, limited try-out, and reliability analysis. The test consisted of five

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open-ended items, with two items representing each critical literacy indicator. Content validity was assessed by three experts using Aiken's V, with coefficients ranging from 0.83 to 0.92, indicating high content validity. Construct alignment was ensured by mapping each item to the intended indicator. The limited try-out showed that all items were valid, with corrected item-total correlations ranging from 0.42 to 0.79, and the instrument demonstrated good reliability, as indicated by a Cronbach's alpha coefficient of 0.86. Test scoring was carried out using a rubric with a scale ranging from 0 to 4.

Data Analysis

The data analysis technique in this study was carried out through several stages to ensure accurate interpretation of the effectiveness of Project-Based Ethnopedagogical Learning. First, student score data were obtained through critical literacy tests administered before the treatment (pretest) and after the treatment (posttest) in both the experimental and control classes. These scores were then used to examine changes in each group's abilities. Before conducting the main analysis, prerequisite tests were performed, including normality and homogeneity tests, to ensure that the data met the assumptions of parametric statistics. In addition, the specific assumptions for ANCOVA were examined, including linearity between pretest and posttest scores and homogeneity of regression slopes. The homogeneity of regression slopes was tested through the interaction between class and pretest scores, and the non-significant interaction indicated that the assumption was met. The main analysis employed ANCOVA, with the posttest scores as the dependent variable and the pretest scores as the covariate to control for initial differences in ability between groups, thereby providing a more accurate comparison of outcomes. Effect size was reported using partial eta squared (partial η^2) and interpreted to determine the practical magnitude of the treatment effect, not merely its statistical significance. If the ANCOVA results indicated significant differences, the analysis was followed by an LSD post-hoc test to identify which groups showed significant score differences. The ANCOVA and LSD tests were conducted using the SPSS program at a 5% significance level.

RESEARCH RESULT

Based on the series of data analyses conducted on the pretest and posttest scores of students in both treatment groups, a comprehensive overview was obtained regarding the effectiveness of Project-Based Ethnopedagogical Learning based on local wisdom in improving critical literacy. The analyses which included prerequisite testing, comparison of students' initial and final scores,

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as well as the application of ANCOVA and the follow-up LSD test provided an empirical basis for evaluating the effectiveness of the implemented learning model. The following explanation presents the data processing results systematically to illustrate the changes that occurred in each group and the significant differences observed as a result of the treatment. The pretest and posttest critical literacy scores are presented in Figure 1.

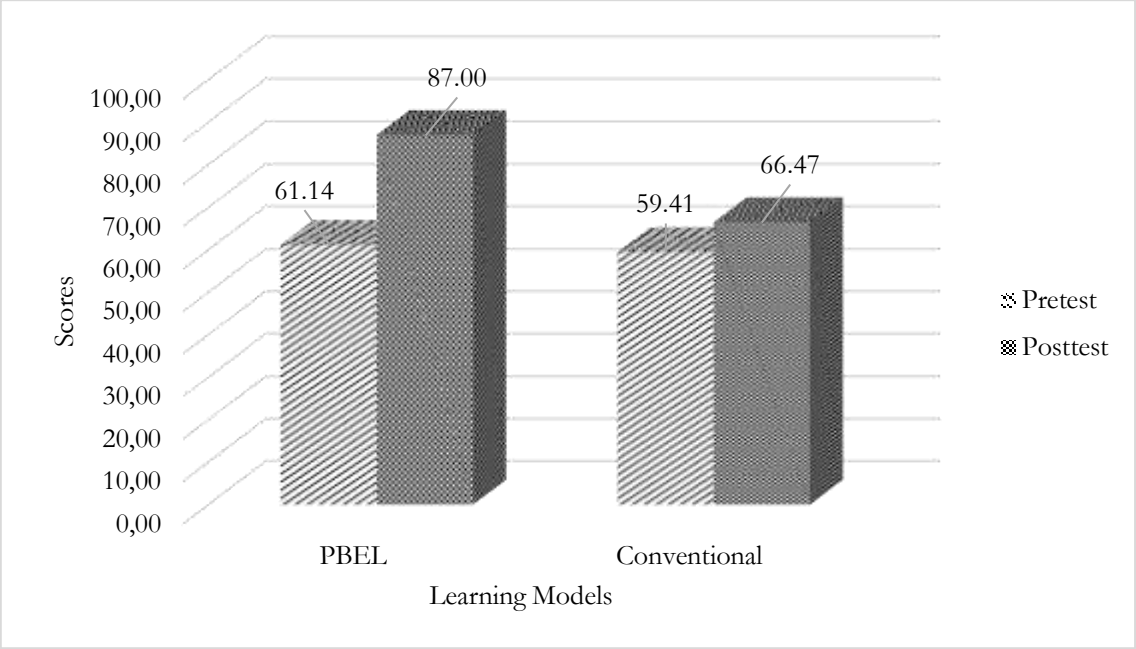

Figure 1. Pretest and posttest results of students' literacy critical

Figure 1 presents a comparison of the pretest and posttest critical literacy scores of students in the experimental and control classes. In the pretest phase, the experimental class obtained an average score of 61.14, while the control class averaged 59.41, indicating that both groups possessed relatively equivalent initial abilities. After the treatment, the posttest score of the experimental class increased sharply to 87.00, which was higher than the control class, which reached 66.47. Based on the reported mean scores, the normalized gain of the experimental class was approximately 0.67, indicating a medium-to-high improvement, whereas the control class obtained an approximate normalized gain of 0.17, indicating low improvement. This contrast shows that PBEL produced not only a higher final mean score but also a stronger proportional learning improvement than conventional instruction. Therefore, the substantial improvement in the experimental class reflects the practical effectiveness of implementing Project-Based Ethnopedagogical Learning based on local wisdom in enhancing students' critical literacy, while

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the smaller gain in the control class indicates that conventional learning did not produce critical literacy development as strong as the PBEL model.

The effectiveness of the Project-Based Ethnopedagogical Learning model on students' critical literacy was examined through parametric statistical analysis. The initial stage involved conducting normality and homogeneity tests to ensure that the data met the assumptions required for such analysis. Once these prerequisites were fulfilled, the analysis proceeded with ANCOVA to identify differences in learning outcomes between the experimental and control classes while accounting for the influence of initial ability. The results of the normality test are presented in Table 2.

Table 2. Results of normality test

Data	Uji Shapiro-Wilk			α
	Statistic	df	Sig.	
Residual Postest Critical Literacy	0.967	69	0.063	0.05

The results of the normality test using the Shapiro–Wilk method showed that the residual posttest data of students' critical literacy were normally distributed, as indicated by a significance value of 0.063, which is higher than the $\alpha = 0.05$ threshold. This value indicates that there was no significant deviation from a normal distribution, and thus the data fulfilled the fundamental assumption required for parametric analysis. With the normality assumption satisfied, the next step was to conduct a homogeneity test to ensure equality of variances between groups before proceeding with further analyses. The results of the homogeneity test are presented in Table 3.

Table 3. Results of homogeneity test

Data	Levene's Test of Equality of Variances				α
	F	Df1	Df2	Sig.	
Postest Critical Literacy	0.318	1	67	0.575	0.05

The results of the homogeneity test in Table 3 indicate that the residual posttest variance of students' critical literacy was homogeneous, as shown by the Levene's Test significance value of 0.575, which is greater than $\alpha = 0.05$. This condition suggests that both groups exhibited comparable data dispersion, meaning there was no variability difference that could affect the analytical process. With the homogeneity assumption fulfilled, the data were deemed suitable for analysis using parametric statistical techniques, specifically the ANCOVA test. The ANCOVA results are presented in Table 4.

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Table 4. Results of the ANCOVA test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	8976.205[a]	2	4488.103	52.951	0.000	0.616
Intercept	11935.347	1	11935.347	140.815	0.000	0.681
Pretest	740.180	1	740.180	8.733	0.004	0.117
Class	7883.461	1	7883.461	93.010	0.000	0.585
Error	5594.085	66	84.759			
Total	415550.000	69				
Corrected Total	14570.290	68				

The ANCOVA results presented in Table 4 indicate a significant effect of class on posttest critical literacy after controlling for pretest scores, $F = 93.010$, $p < 0.001$, partial $\eta^2 = 0.585$. This partial eta squared value indicates a large effect, suggesting that the PBEL intervention explained a substantial proportion of variance in posttest critical literacy beyond students' initial ability. The covariate was also significant, $F(1, 66) = 8.733$, $p = 0.004$, partial $\eta^2 = 0.117$, indicating that pretest scores contributed to posttest performance and therefore needed to be controlled. These findings demonstrate that the local wisdom-based PBEL model contributed more effectively to enhancing critical literacy than conventional instruction. This result provides the basis for conducting further analysis through the Least Significant Difference (LSD) test. The LSD test results are presented in Table 5.

Table 5. Significance of the Difference in Mean Critical Literacy Scores Based on the LSD Test

Variable	Class	Corrected average	LSD notation
Critical Literacy	PBEL	86.78	**a**
	Conventional	65.36	**b**

The LSD test results in Table 5 show that the adjusted mean critical literacy score for the experimental class reached 86.78 and was assigned notation *a*, while the control class obtained an adjusted mean of only 65.36 with notation *b*. The adjusted mean difference of 21.42 points confirms that the two groups fall into significantly different categories and that the PBEL class achieved a substantially stronger outcome after pretest differences were controlled. This finding reinforces the ANCOVA result and indicates that the improvement in the experimental class was meaningful both statistically and practically.

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DISCUSSION

The findings of the study indicate that the implementation of local-wisdom-based Project-Based Ethnopedagogical Learning (PBEL) has a significant effect on improving students' critical literacy. This is evidenced by higher posttest scores in the experimental class compared to the control class, based on both descriptive and inferential analyses. PBEL was effective because it did not merely present local wisdom as learning content, but transformed it into project-based inquiry, cultural exploration, evidence gathering, and reflective activities. Through these processes, students were encouraged to connect biological concepts with real cultural practices, examine information from multiple perspectives, and justify their ideas based on evidence. Therefore, the dimensions of critical literacy most likely strengthened through this intervention were interpretation, analysis, inference, evaluation, and self-regulation, particularly because students were required to interpret local phenomena, analyze sociocultural and scientific relationships, draw conclusions from contextual information, evaluate the relevance of evidence, and reflect on their learning process (Ginting et al., 2026). However, the effectiveness of PBEL may depend on the availability of relevant local cultural resources, teachers' ability to facilitate ethnopedagogical projects, and students' familiarity with the cultural context, as culturally responsive implementation is closely related to teacher readiness, self-efficacy, and contextual support (Peterson & Jensen, 2025). Thus, its implementation in other regions may require contextual adaptation rather than direct replication. These findings are consistent with previous studies revealing that project-based learning can enhance student engagement in exploration, problem-solving, and evidence-based conclusion-making, thereby directly contributing to the development of critical literacy (Agustira et al., 2025; Ratna et al., 2025; Sari et al., 2023).

The integration of local wisdom within PBEL further strengthens cultural relevance in the learning process by contextualizing learning materials within cultural experiences closely related to students' daily lives. This approach aligns with the ethnopedagogical framework described in various studies, wherein the utilization of local culture has been shown to foster cultural awareness, enhance critical thinking skills, and expand students' understanding of the relationship between cultural values and learning processes (Anggraeni et al., 2025; Hikmah et al., 2025). This local-culture-based learning also contributes to cultural literacy and social responsibility, ensuring that learning not only focuses on cognitive achievement but also on character development and social connectedness.

In addition, PBEL reflects the effectiveness of multiliteracy pedagogy, which emphasizes the importance of local relevance in enhancing student engagement and comprehension (Wibowo, 2022). The multiliteracy approach highlights the use of diverse representations, contexts, and cultural practices to broaden students' interpretation of learning materials. By connecting academic concepts with authentic cultural experiences, PBEL strengthens the previously developed ethnopedagogical framework, as described by (Fauzan et al., 2024; Haliq et al., 2023), who emphasize the importance of cultural awareness in promoting learning effectiveness. Therefore, the integration of local wisdom in PBEL not only reinforces cultural relevance but also demonstrates alignment with contemporary educational methodologies that position critical literacy as a key 21-century competency.

The ANCOVA and LSD test results indicate that ethnopedagogically oriented learning models, including Project-Based Ethnopedagogical Learning (PBEL), are proven to significantly enhance students' Higher-Order Thinking Skills (HOTS) compared to conventional learning methods. These findings are consistent with previous studies demonstrating that culture-based learning models foster deeper student engagement and activate critical thinking skills in the processes of analyzing, evaluating, and creating information (Suprojo et al., 2025; Wiwik et al., 2025). The ANCOVA analysis in this study reinforces evidence that culturally relevant learning contexts yield positive effects on cognitive development, as also emphasized in literature highlighting the importance of local perspectives as an integral component of instructional design (Suprojo et al., 2025; Suryani, 2023). Thus, the findings of this study support the scientific consensus that integrating local cultural values into learning not only enriches the learning experience but also enhances instructional effectiveness in developing higher-order thinking skills.

Moreover, PBEL has been shown to effectively accommodate critical literacy indicators, including the ability to interpret, evaluate, and reflect more successfully than traditional learning approaches. Conventional methods often emphasize memorization and basic comprehension, providing limited opportunities for students to develop critical reasoning or reflective thinking (Wati et al., 2023; Yosepha et al., 2023). In contrast, PBEL emphasizes the application of concepts in real-world contexts through direct engagement with the surrounding environment and community, encouraging students to understand issues more deeply and relate them to sociocultural values(Agustira et al., 2025). This approach broadens students' perspectives, enabling them to participate more actively in society, as highlighted by (Hajijah et al., 2025), who report that project- and culture-based learning fosters social awareness and prepares students to face real-life

societal challenges. Thus, PBEL not only enhances academic skills but also strengthens critical literacy aimed at cultivating reflective and responsible citizens.

Various studies have confirmed that participatory approaches and the integration of local wisdom in education contribute significantly to enhancing students' critical literacy. Learning mechanisms such as interdisciplinary workshops, collaborative research, and project-based activities enable students to study local issues in depth while connecting them to broader academic concepts. Autthawuttikul et al. (2022) and Ida Bagus et al. (2024) demonstrate that strategies aligning the learning process with local cultural values, contexts, and practices can strengthen conceptual understanding and improve students' abilities to interpret and critique social phenomena. The integration of local knowledge into learning, as described in the study Widana et al. (2023) and in Japar et al. (2022), reveals that local cultural knowledge, skills, and values serve as a foundation for critical pedagogy that enables students to critique cultural narratives and develop more profound evaluative abilities.

In addition to strengthening critical literacy, educational frameworks grounded in local wisdom have also been shown to develop critical thinking skills and creativity both of which are essential elements in shaping participatory citizens. Studies by Ulum et al. (2025) and (Yamin et al., 2024) indicate that approaches rooted in local culture support higher-order cognitive development through learning activities oriented toward problem-solving and creative exploration. Curricula enriched with local wisdom contribute significantly to enhancing students' analytical abilities and cultural awareness (Damariswara et al., 2025; Ramadhani et al., 2025).

These findings reinforce the discourse on culturally responsive pedagogy, which emphasizes the importance of adapting learning content to align with students' real-life experiences so that they become more engaged and acquire deeper cognitive competencies. Andriani et al. (2023) and Wahyuningtyas et al. (2025) further assert that such approaches not only improve learning outcomes but also cultivate a sense of ownership over the learning process, making it more relevant, meaningful, and effective in developing students' analytical and evaluative abilities.

The findings of this study provide an important contribution to the development of educational science, particularly in relation to culturally responsive pedagogy and critical literacy. The evidence that PBEL is capable of enhancing students' analytical, evaluative, and reflective abilities indicates that the integration of local wisdom is not only contextually relevant but also effective in strengthening higher-order thinking skills. These implications underscore the need for curriculum development and learning models that are more adaptive to local cultural contexts,

while also opening avenues for further research on the role of local wisdom in shaping learning processes that are more critical, meaningful, and participatory.

The findings of this study provide an important contribution to the development of educational science, particularly in relation to culturally responsive pedagogy and critical literacy. The evidence that PBEL is capable of enhancing students' analytical, evaluative, and reflective abilities indicates that the integration of local wisdom is not only contextually relevant but also effective in strengthening higher-order thinking skills. However, these implications should be interpreted cautiously because the study involved only two intact Grade X classes in one senior high school, used a quasi-experimental design without full random assignment, and may have been influenced by teacher-related and implementation factors. Since PBEL was developed around Lombok local wisdom, its application in other contexts requires adaptation to local cultural resources and students' cultural experiences (Ginting et al., 2026; Peterson & Jensen, 2025; Wang et al., 2026). These These implications underscore the need for curriculum development and learning models that are more adaptive to local cultural contexts, while also opening avenues for further research on the role of local wisdom in shaping learning processes that are more critical, meaningful, and participatory.

CONCLUSION

Based on the findings of this study, it can be concluded that Project-Based Ethnopedagogical Learning (PBEL) based on local wisdom was effective in improving the critical literacy of Grade X students at SMA Negeri 4 Mataram. The ANCOVA analysis indicated a significant difference between the experimental and control classes after controlling for students' initial ability, showing that PBEL contributed meaningfully to students' critical literacy development. This conclusion was further supported by the LSD test results, which showed that the average critical literacy score of students in the experimental class was significantly higher than that of students in the control class. Within the context of this study, PBEL can be considered a promising contextual learning strategy because it integrates project-based activities with local cultural resources, enabling students to interpret, analyze, evaluate, and reflect on information through meaningful learning experiences. Practically, teachers may implement PBEL by designing projects that connect curriculum content with local wisdom, supported by clear learning guidelines, assessment rubrics, and reflective activities. Future research is recommended to involve larger and more diverse samples, apply stronger experimental designs, and examine the effectiveness of PBEL across different cultural

and school contexts. Further studies may also investigate which components of PBEL contribute most strongly to each dimension of critical literacy.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

KREDIT AUTHORSHIP CONTRIBUTION STATEMENT

S. Mursali: conceptualization, methodology, project administration, writing – original draft, and writing – review & editing. **S. D. Utami:** investigation, data curation, funding acquisition, and writing – original draft. **S. N. Primawati:** resources, investigation, validation, and writing – original draft. **I. N. Dewi:** funding acquisition, methodology, and project administration. **A. Sukri:** formal analysis, supervision, and visualization.

DECLARATION OF THE USE OF AI

During the preparation of this work, the authors used ChatGPT to enhance the clarity of the writing. After using ChatGPT, the authors reviewed and edited the content as needed and took full responsibility for the publication's content.

DATA AVAILABILITY STATEMENT

Derived data supporting the findings of this study are available from the corresponding author [initials, SM] on request.

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