

Ethnopedagogical Learning as a Multidimensional Approach to Improving Scientific Literacy, Critical Thinking, and Character Development in Primary Education

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DOI: 10.23917/ijolae.v8i2.16025

Received: March 21st, 2026. Revised: May 10th, 2026. Accepted: May 20th, 2026

Available Online: May 29th, 2026. Published Regularly: May, 2026

Abstract

Scientific literacy, critical thinking, and character development remain major challenges in Indonesian primary education due to the dominance of decontextualised learning approaches. Although ethnopedagogy has been widely associated with literacy development and culturally responsive learning, limited empirical studies have simultaneously examined its impact on scientific literacy, critical thinking skills, and character development within elementary school settings. Therefore, this study aimed to investigate the effectiveness of an ethnopedagogical learning module grounded in local wisdom for improving these competencies among elementary school students in Kupang, Indonesia. This study employed a quasi-experimental design with pre-test and post-test control groups involving 78 students, consisting of 38 students in the experimental group and 40 students in the control group. Data were collected using scientific literacy tests, critical thinking tests, and character observation instruments, then analysed using descriptive statistics, Mann-Whitney U tests, and MANOVA. The findings revealed that the experimental group achieved significantly higher improvements than the control group across all variables. Scientific literacy scores increased from 62.36 to 77.89, critical thinking scores improved from 62.98 to 81.05, and character development scores rose from 64.23 to 85.22. MANOVA analysis confirmed significant multivariate effects, with character development showing the largest effect size (partial $\eta^2 = 0.281$), followed by scientific literacy (partial $\eta^2 = 0.101$) and critical thinking (partial $\eta^2 = 0.093$). The study demonstrates the novelty of ethnopedagogical learning as a multidimensional, culturally responsive, and contextually grounded instructional approach that simultaneously strengthens cognitive and affective competencies. Therefore, ethnopedagogical learning can serve as an innovative pedagogical framework for supporting holistic education and the implementation of the Merdeka Curriculum in Indonesia.

Keywords: ethnopedagogical learning, scientific literacy, critical thinking, character education, innovative learning design, culturally responsive learning.

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1. Introduction

Scientific literacy, critical thinking, and character development are essential competencies required in twenty-first century

education. Scientific literacy enables individuals to understand scientific concepts, evaluate information critically, and make informed decisions related to health,

environmental sustainability, and social issues (Sharon & Baram-Tsabari, 2020). Through scientific literacy, learners are able to distinguish valid scientific information from misinformation and apply scientific reasoning to real-life contexts (Kraijitmate et al., 2019). In addition, scientific literacy supports citizens' participation in addressing contemporary societal challenges and strengthens their understanding of the nature of science (Rahman & Buck, 2023). Complementing this competency, critical thinking equips students with the ability to analyse information systematically, evaluate arguments, and formulate evidence-based conclusions (Tumbel, 2024). These abilities are increasingly important in democratic societies where individuals are expected to participate actively in public discourse and decision-making processes (Biringan et al., 2025). Therefore, strengthening scientific literacy and critical thinking has become a major concern in modern educational systems.

Alongside cognitive competencies, character development also plays a crucial role in shaping responsible and ethical citizens. In the digital era, where students are exposed to massive amounts of information, character functions as a moral compass that guides learners in evaluating information and making ethical decisions (Syahidi et al., 2023). The integration of character education with scientific literacy and critical thinking encourages students not only to understand scientific concepts but also to apply them responsibly within social and environmental contexts (Angela et al., 2025). Students with strong moral values tend to demonstrate greater responsibility toward environmental preservation, social participation, and ethical behaviour in everyday life (Syahidi et al., 2023). Consequently, the combination of

scientific literacy, critical thinking, and character education is essential for developing learners who are intellectually competent and socially responsible.

Despite the importance of these competencies, many educational systems, particularly in developing countries, continue to face challenges in improving students' scientific literacy, critical thinking, and character development. Previous studies revealed that educational curricula often fail to connect learning materials with students' cultural backgrounds and local experiences, resulting in low motivation and limited contextual understanding (Liu & Huang, 2016). This issue is particularly evident in Indonesia. Data from the Programme for International Student Assessment (PISA) 2018 showed that Indonesian students ranked 70th out of 78 participating countries, with an average scientific literacy score significantly below the OECD standard (Zulyusri et al., 2022). Similarly, the Progress in International Reading Literacy Study (PIRLS) placed Indonesia among the lowest-performing countries in reading proficiency, indicating weaknesses in reasoning and comprehension abilities (Maneba et al., 2021).

The condition is further reflected in students' critical thinking performance. Indonesian students continue to demonstrate limited abilities in analytical reasoning, problem-solving, and evaluation skills (Fatimah et al., 2023). Mahzumi et al. (2024) reported that students' abilities in explaining concepts and solving problems remained relatively low, indicating insufficient development of higher-order thinking skills. Mbato (2019) also found that many Indonesian learners struggled to apply critical thinking strategies effectively during reading activities. In addition to cognitive challenges, character-related issues remain

prevalent among students. Previous studies reported low levels of discipline, dishonesty in academic activities, and disruptive behaviours among Indonesian students (Aspiani et al., 2022). These findings suggest that improving cognitive achievement alone is insufficient without simultaneously strengthening students' character formation.

One major factor contributing to these problems is the lack of contextual and culturally relevant learning approaches. Conventional learning materials and teaching practices often fail to connect scientific concepts with students' social and cultural realities (Suhirman & Khotimah, 2020). Moreover, inadequate teaching materials and unsupportive learning environments limit students' opportunities to engage actively in scientific inquiry and reflective thinking (Astra et al., 2023). Therefore, innovative instructional materials that integrate local culture and contextual learning experiences are urgently needed to improve educational outcomes.

One promising approach is ethnopedagogy-based learning. Beyond integrating local wisdom, cultural values, and community practices, ethnopedagogical learning represents an innovative learning design that transforms traditional teacher-centred instruction into culturally responsive, student-centred, inquiry-based learning environments. This instructional innovation enables learners to construct scientific understanding through authentic cultural experiences while simultaneously developing higher-order thinking and character competencies (Ardiyani et al., 2025).

Through ethnopedagogical learning, scientific concepts are contextualised within students' cultural environments. This approach reflects the principles of progressive education, where learning is constructed through meaningful experiences,

active participation, reflection, and problem-solving within real-life contexts. Students become active agents in knowledge construction rather than passive recipients of information. Previous studies have shown that culturally relevant learning materials can improve students' understanding of scientific concepts and strengthen their scientific literacy (Syafitri & Syafriani, 2023). When students learn through familiar cultural contexts, they become more motivated to participate in learning activities and develop deeper conceptual understanding.

Furthermore, ethnopedagogical learning also contributes to the development of critical thinking skills. Contextual and culturally familiar problems encourage students to engage in analysis, reflection, and problem-solving processes that stimulate higher-order thinking (Ramadhan & Mardin, 2023). Ethnopedagogical practices also promote discussion and collaborative inquiry, which are essential components of critical thinking development (Vieira & Tenreiro-Vieira, 2014). Through the exploration of authentic local issues, students are encouraged to evaluate multiple perspectives and construct evidence-based reasoning.

In addition to cognitive benefits, ethnopedagogy has strong potential to support character development. Learning activities that incorporate local wisdom and cultural values promote empathy, tolerance, social responsibility, and respect for diversity (Zeidler et al., 2005). Ethnopedagogical learning enables students not only to become knowledgeable learners but also responsible citizens who contribute positively to their communities (Fatmawati & Rusmini, 2023). By engaging with ethical and cultural issues embedded in local contexts, students develop greater awareness of the social consequences of their actions and strengthen their moral reasoning.

Although previous studies have examined the relationship between ethnopedagogy and scientific literacy, cultural awareness, and personality development (Rahmawati et al., 2021), limited research has simultaneously investigated its effects on scientific literacy, critical thinking, and character development within a single integrated framework. Moreover, empirical studies focusing on the effectiveness of ethnopedagogical learning modules in primary education settings remain scarce. This gap indicates the need for further investigation regarding the implementation of ethnopedagogy-based instructional modules and their contribution to multiple dimensions of student development.

Therefore, the present study aims to examine the effectiveness of an ethnopedagogical learning module grounded in local knowledge for improving primary school students' scientific literacy, critical thinking skills, and character development in Kupang, Indonesia.

2. Method

a. Research Design

This study employed a quasi-experimental research design to examine the effectiveness of an ethnopedagogical learning module in improving elementary school students' scientific literacy, critical

thinking skills, and character development in Kupang, Indonesia. The research utilised a pre-test–post-test control group design involving experimental and control groups. This design was considered appropriate because it enabled the researchers to evaluate the effectiveness of the instructional intervention within a real educational setting while maintaining comparison between groups.

According to Taş and Coşkun (2014), quasi-experimental designs provide empirical evidence regarding the effectiveness of educational interventions implemented in authentic classroom contexts. Similarly, Johansen (2013) explained that the use of comparable groups combined with pre-test and post-test procedures allows researchers to identify changes in targeted learning outcomes more accurately. Previous studies have also demonstrated the effectiveness of quasi-experimental approaches in evaluating instructional modules in educational research contexts, including geometry learning (Yalley et al., 2021) and health literacy education (Yang et al., 2022). Therefore, the application of a quasi-experimental design was considered suitable for assessing the impact of the ethnopedagogical learning module on students' learning outcomes.

The overall research procedure is presented in Figure 1.

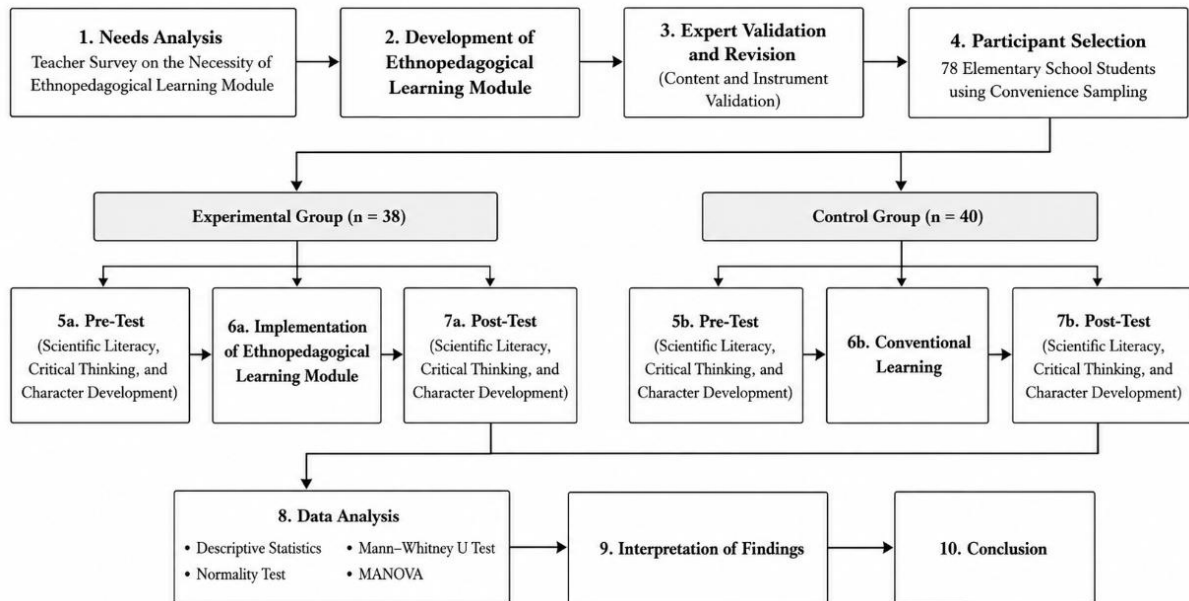


Figure 1. Research Procedure of the Quasi-Experimental Study

b. Participants

The study was conducted in Kupang, Indonesia. Kupang Regency has approximately 584 elementary schools consisting of 132 public schools and 452 private schools. The research was specifically carried out at SD Negeri Oeba 3 Kupang and SD Oeno Kupang. These schools were selected purposively because they had implemented the Merdeka Curriculum, which emphasises literacy-oriented and student-centred learning approaches. In addition, the selected schools possessed adequate human resources, learning facilities, and classroom conditions to support the implementation of the research intervention.

The participants were selected using a convenience sampling technique. In each school, Class A was assigned as the experimental group, while Class B served as the control group. Consequently, the total number of participants involved in this study was 78 elementary school students, consisting of 38 students in the experimental group and 40 students in the control group.

In terms of gender distribution, the experimental group consisted of 15 male students and 23 female students, while the control group consisted of 16 male students and 24 female students. Detailed participant information is presented in Table 1.

Table 1. Participant Information

School	Class	Group	Male	Female	Number
Elementary School of Oeba 3	Class A	Experimental group	8	11	19
	Class B	Control group	7	13	20
Elementary school of Oeno	Class A	Experimental group	7	12	19
	Class B	Control group	9	11	20

c. Instrument

This study focused on three primary variables, namely scientific literacy, critical thinking skills, and character development.

Different instruments were employed to measure each construct, and all instruments were validated by two educational experts prior to implementation. The use of separate

instruments for cognitive and affective outcomes was intended to reduce construct overlap and to provide a more comprehensive evaluation of the multidimensional learning effects of the ethnopedagogical module.

The scientific literacy instrument consisted of 32 test items divided into three dimensions: scientific functional literacy (9 items), scientific content and procedural literacy (14 items), and scientific cultural literacy (9 items). Expert validation indicated that all items were appropriate for measuring elementary school students' scientific literacy. To further assess construct validity, item-total correlation analysis was conducted. The results showed that all items achieved acceptable correlation coefficients ranging from 0.24 to 0.58, exceeding the minimum validity threshold.

Critical thinking skills were measured using a test consisting of 22 items covering five dimensions: analytical ability (4 items), synthesis ability (5 items), acknowledgement and problem-solving ability (3 items), concluding ability (6 items), and evaluation ability (4 items). Expert judgement confirmed that all items were conceptually appropriate for assessing students' critical thinking skills. However, item validity analysis revealed that two items obtained correlation coefficients below the required threshold. Consequently, these two items were removed, resulting in a final instrument consisting of 20 valid items.

Character development was assessed using an observation-based instrument consisting of 18 indicators, including religiosity, honesty, tolerance, discipline, hard work, creativity, independence, democracy, curiosity, national spirit, patriotism, appreciation of achievement, communicativeness, peacefulness, reading interest, environmental awareness, social

awareness, and responsibility. Each indicator was assessed using a five-point Likert scale ranging from 1 (Very Poor) to 5 (Very Good). Students' total scores were converted into percentage values based on the maximum possible score to determine their overall character development level.

d. Data Analysis

Several statistical procedures were employed to analyse the data, including descriptive statistics, inferential statistical analysis, and multivariate analysis of variance (MANOVA). Descriptive statistics were used to summarise students' pre-test and post-test scores in both the experimental and control groups. Because the study involved multiple dependent variables and a quasi-experimental design, the analysis emphasised both group differences and the consistency of improvement across scientific literacy, critical thinking skills, and character development.

Inferential statistical analysis was conducted to determine differences between groups following the intervention. Prior to hypothesis testing, normality and homogeneity assumptions were examined. Parametric statistical tests were applied when the assumptions were fulfilled, whereas non-parametric alternatives were employed when the assumptions were violated. The significance level for all analyses was set at $\alpha = 0.05$.

Furthermore, MANOVA was utilised to examine the simultaneous effect of the ethnopedagogical learning module on the three dependent variables: scientific literacy, critical thinking skills, and character development. MANOVA was considered appropriate because it minimises Type I error while capturing the multivariate relationships among the dependent variables. The magnitude of the treatment effect was

interpreted using partial eta squared (partial η^2) values.

3. Result and Discussion

The results of this study demonstrate that the ethnopedagogical learning module based on local knowledge contributed positively to students' scientific literacy, critical thinking skills, and character development. Statistical analyses revealed significant differences between the experimental and control groups across all measured variables, indicating the effectiveness of the instructional intervention. Furthermore, the findings suggest that integrating ethnopedagogical principles into elementary school learning not only enhances cognitive achievement but also strengthens students' moral and social development.

To provide a comprehensive interpretation of the findings, the discussion section is organised into four main points. First, the discussion focuses on the effectiveness of the ethnopedagogical learning module in improving students' scientific literacy. Second, it examines the contribution of ethnopedagogical learning to the development of students' critical thinking skills. Third, the discussion analyses the role of ethnopedagogical learning in strengthening students' character development. Finally, the discussion elaborates on the broader implications of ethnopedagogical learning as an innovative and contextual educational approach within Indonesian primary education.

a. The Effectiveness of the Ethnopedagogical Learning Module in Improving Students' Scientific Literacy

One of the primary findings of this study is that the ethnopedagogical learning module significantly improved elementary school students' scientific literacy. The statistical results demonstrate that students who participated in the ethnopedagogical learning intervention achieved substantially higher post-test scores compared to those who received conventional instruction. These findings indicate that integrating local knowledge and cultural contexts into science learning creates a more meaningful and contextualised learning experience that supports students' understanding of scientific concepts.

Scientific literacy is not limited to the acquisition of scientific knowledge but also includes the ability to interpret information, analyse scientific phenomena, and apply scientific reasoning in everyday life (Sharon & Baram-Tsabari, 2020). In this study, the ethnopedagogical module enabled students to connect scientific concepts with familiar cultural experiences and local practices found in their surrounding environment. This contextual approach appears to strengthen students' comprehension because learning materials become more relevant and relatable to their daily realities. As Syafitri and Syafriani (2023) explained, contextual learning environments improve students' engagement and facilitate deeper understanding of scientific inquiry processes.

The descriptive statistical analysis presented in Table 2 demonstrates a substantial increase in students' scientific literacy scores after the implementation of the ethnopedagogical learning module.

Table 2. Descriptive Statistics of Students' Scientific Literacy Scores

Group	Test	Mean Score
Control Group	Pre-test	62.25
Control Group	Post-test	70.00
Experimental Group	Pre-test	62.36
Experimental Group	Post-test	77.89

The data presented in Table 2 reveal that both groups experienced improvements in scientific literacy scores following the learning process. However, the experimental group demonstrated a considerably greater increase compared to the control group. The experimental group improved from a mean pre-test score of 62.36 to a post-test score of 77.89, while the control group increased from 62.25 to only 70.00. This finding suggests that the ethnopedagogical learning module produced stronger learning gains than conventional teaching methods.

The significant improvement in the experimental group may be attributed to the contextual and culturally responsive characteristics of ethnopedagogical learning. Through the integration of local wisdom, folklore, traditional practices, and familiar environmental issues, students were able to understand scientific concepts through concrete experiences rather than abstract explanations alone. This finding aligns with Pujawan et al., (2022), who argued that

culturally relevant science learning enhances students' conceptual understanding and scientific reasoning (Aningsih et al., 2022). In addition, contextualised learning activities encourage active student participation, curiosity, and inquiry-based exploration, all of which are essential components of scientific literacy development.

Another important aspect highlighted by Table 2 is that the relatively similar pre-test scores between groups indicate that both groups started with comparable levels of scientific literacy prior to the intervention. Therefore, the substantial difference observed in the post-test scores strongly suggests that the ethnopedagogical learning module was the main factor contributing to the improvement of students' scientific literacy outcomes.

To further confirm the effectiveness of the intervention, inferential statistical analysis using the Mann–Whitney U test was conducted, as presented in Table 3.

Table 3. Mann–Whitney U Test Result for Scientific Literacy

Variable	Group	N	Mean Rank	Mann–Whitney U	Z	p-value
Scientific Literacy	Control Group	40	32.88	495.00	-2.720	0.007
	Experimental Group	38	46.47			

The inferential statistical results shown in Table 3 confirm that the difference between the experimental and control groups was statistically significant. The experimental group obtained a higher mean rank (46.47) than the control group (32.88), indicating superior scientific literacy performance after the intervention.

Furthermore, the obtained p-value of 0.007 was lower than the significance threshold of 0.05, demonstrating that the ethnopedagogical learning module had a significant positive effect on students' scientific literacy.

These findings reinforce the argument that science learning becomes more effective

when students are encouraged to connect scientific knowledge with their sociocultural environment. Ethnopedagogical learning facilitates meaningful learning experiences because students are not merely memorising scientific facts but are actively interpreting scientific concepts within their local cultural contexts (Arifin et al., 2024). According to Wati et al. (2021), learning materials integrated with ethnoscience and local wisdom improve students' engagement and strengthen scientific literacy through direct and contextual experiences.

In addition, the ethnopedagogical module may also contribute to increased student motivation and classroom participation. Students tend to feel more connected to learning materials that reflect

their own cultural identities and community experiences. Liu and Huang (2016) noted that culturally disconnected curricula often reduce student motivation and engagement, whereas culturally responsive learning environments strengthen students' sense of relevance and belonging. In this study, students appeared more enthusiastic and participative during classroom discussions because the learning materials reflected familiar local realities (Hashim et al., 2026).

The multivariate analysis further supports the effectiveness of the ethnopedagogical learning module. The MANOVA results presented in Table 4 demonstrate that the instructional treatment significantly influenced students' scientific literacy outcomes.

Table 4. MANOVA Result for Scientific Literacy

Dependent Variable	F	p-value	Partial η^2	Effect Size
Scientific Literacy	8.522	0.005	0.101	Moderate

The MANOVA analysis presented in Table 4 indicates that the instructional treatment significantly affected students' scientific literacy, with an F value of 8.522 and a significance level of 0.005. Since the p-value was below 0.05, the result confirms that the ethnopedagogical learning module produced statistically significant improvements in students' scientific literacy performance. Furthermore, the partial eta squared value of 0.101 indicates a moderate effect size, suggesting that the intervention had a meaningful educational impact.

The moderate effect size observed in this study is particularly important because it demonstrates that the integration of ethnopedagogical principles can substantially improve learning outcomes even within elementary education contexts. This finding implies that contextual and culture-based instructional materials may serve as effective

alternatives to conventional textbook-centred approaches commonly used in Indonesian schools (M & Effendi, 2020). The incorporation of local wisdom into science learning not only enriches students' conceptual understanding but also strengthens the relevance of scientific knowledge within their social environment.

The findings of this study also support previous research demonstrating that ethnopedagogical and ethnoscience-based learning approaches positively influence scientific literacy development (Rahmawati et al., 2021; Verawati & Wahyudi, 2024). However, the present study extends previous literature by providing empirical evidence regarding the effectiveness of a structured ethnopedagogical learning module implemented through a quasi-experimental design. Unlike prior studies that mainly focused on conceptual discussions or limited

classroom applications, this research quantitatively demonstrates the measurable impact of ethnopedagogical learning on elementary school students' scientific literacy.

Overall, the results indicate that ethnopedagogical learning modules provide substantial benefits for improving students' scientific literacy through contextual, meaningful, and culturally responsive learning experiences. By integrating local knowledge into science education, students are encouraged to actively engage in scientific inquiry, connect scientific concepts with real-life experiences, and develop deeper conceptual understanding. Therefore, ethnopedagogical learning may serve as a promising instructional innovation for strengthening science education quality in Indonesian primary schools.

b. The Contribution of Ethnopedagogical Learning to Students' Critical Thinking Skills

Another important finding of this study is that the ethnopedagogical learning module significantly contributed to the development of students' critical thinking skills. The statistical results indicate that students in the experimental group achieved higher critical thinking scores compared to those in the control group after the implementation of the instructional intervention. These findings suggest that ethnopedagogical learning provides meaningful opportunities for students to engage in analytical reasoning, contextual problem-solving, reflective inquiry, and evaluative thinking processes.

Critical thinking is considered one of the essential competencies required in twenty-first century education because it enables students to analyse information critically, evaluate evidence, and formulate logical conclusions (Tumbel, 2024). In science education, critical thinking supports students in understanding scientific phenomena, identifying relationships between concepts, and solving contextual problems systematically. However, previous studies have reported that Indonesian students continue to demonstrate relatively low critical thinking performance in various educational assessments (Fatimah et al., 2023; Mahzumi et al., 2024). Therefore, the findings of this study provide important empirical evidence regarding the potential of ethnopedagogical learning to address this educational challenge.

The descriptive statistical analysis demonstrates that both the experimental and control groups experienced improvements in critical thinking scores after the learning intervention. However, the increase observed in the experimental group was substantially greater than that of the control group. Students who learned using the ethnopedagogical learning module achieved a post-test mean score of 81.05, while students in the control group only reached 74.49. These findings indicate that ethnopedagogical learning was more effective in improving students' critical thinking skills compared to conventional instructional approaches.

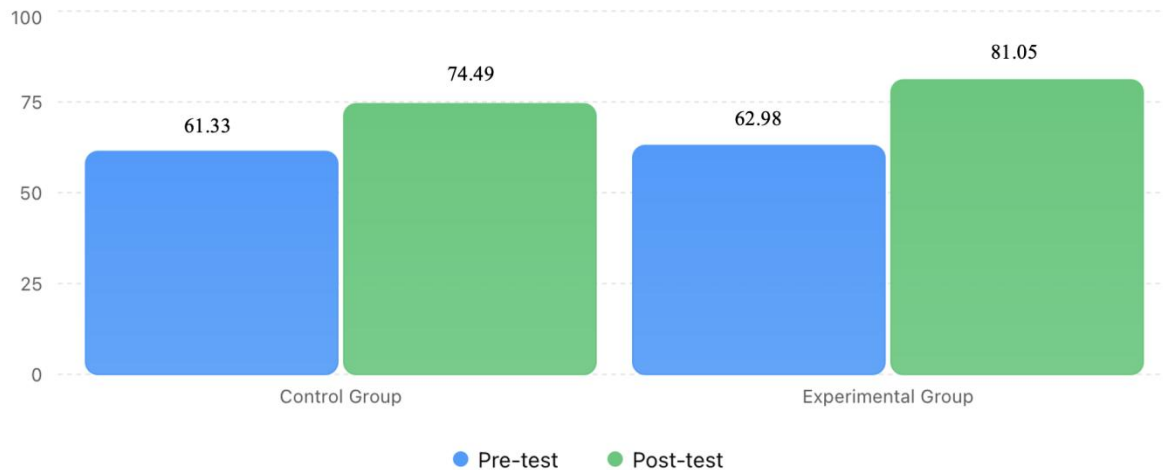


Figure 2. Comparison of Students' Critical Thinking Scores Between Groups

Figure 2 clearly illustrates the improvement in students' critical thinking performance before and after the instructional intervention. Both groups initially demonstrated relatively similar pre-test scores, indicating comparable baseline critical thinking abilities prior to treatment. However, after the implementation of the ethnopedagogical learning module, the experimental group showed a much steeper increase in post-test scores compared to the control group. This substantial improvement suggests that contextual and culturally relevant learning activities successfully stimulated students' higher-order thinking processes.

One possible explanation for this improvement is that ethnopedagogical learning creates authentic and contextual learning experiences that stimulate students' reasoning processes. In the learning activities, students were encouraged to analyse local issues, interpret cultural practices, discuss community-based problems, and connect scientific concepts with real-world situations. Such activities naturally require students to engage in higher-order thinking processes, including analysis, synthesis, evaluation, and problem-solving. According to [Ramadhan](#)

[and Mardin \(2023\)](#), contextual and culturally relevant learning materials can stimulate deeper cognitive engagement because students are required to connect academic concepts with meaningful life experiences.

Ethnopedagogical learning supports inquiry-based learning processes while also fostering critical education practices. Through the examination of local cultural issues, environmental challenges, and community traditions, students are encouraged to critically analyse social realities, evaluate multiple perspectives, and develop informed responses to contemporary societal issues. Such experiences promote critical consciousness and reflective citizenship among young learners. Inquiry-oriented activities encourage students to formulate questions, investigate problems, analyse findings, and evaluate possible solutions. [Maharani et al. \(2023\)](#) emphasised that inquiry-based learning significantly contributes to the development of critical thinking skills because students continuously engage in reasoning and reflective thinking processes throughout the learning experience.

The inferential statistical analysis using the Mann-Whitney U test further confirms the significant effect of the ethnopedagogical

learning module on students' critical thinking skills, as presented in Table 6.

Table 6. Mann–Whitney U Test Result for Critical Thinking Skills

Variable	Group	N	Mean Rank	Mann–Whitney U	Z	p-value
Critical Thinking	Control Group	40	32.90	496.00	-2.688	0.007
	Experimental Group	38	46.45			

The inferential statistical results shown in Table 6 confirm that the ethnopedagogical learning module had a statistically significant effect on students' critical thinking skills. The experimental group achieved a higher mean rank (46.45) compared to the control group (32.90), indicating superior critical thinking performance following the intervention. In addition, the obtained p-value of 0.007 was lower than the significance threshold of 0.05, confirming the statistical significance of the difference between groups.

These findings suggest that ethnopedagogical learning effectively facilitates students' cognitive development by creating opportunities for reflective and analytical thinking. Through culturally contextualised learning activities, students are encouraged to interpret information critically rather than merely memorising concepts. The use of local cultural contexts appears to make learning more understandable and meaningful, enabling students to evaluate problems from multiple perspectives. [Vieira and Tenreiro-Vieira](#)

(2014) argued that culturally responsive science learning promotes critical discussion and reflective inquiry, both of which are fundamental components of critical thinking development.

The results also indicate that ethnopedagogical learning may help students develop problem-solving skills more effectively than traditional instructional methods. In conventional classrooms, learning activities are often dominated by teacher explanations and textbook-centred instruction, limiting students' opportunities to actively analyse and evaluate information. In contrast, ethnopedagogical learning emphasises participation, contextual exploration, and collaborative inquiry. [Wenno et al. \(2021\)](#) explained that contextual and authentic learning situations increase cognitive complexity because students are required to apply reasoning skills in solving real-life problems.

The effectiveness of the ethnopedagogical learning module was further confirmed through MANOVA analysis, as presented in Table 7.

Table 7. MANOVA Result for Critical Thinking Skills

Dependent Variable	F	p-value	Partial η^2	Effect Size
Critical Thinking Skills	7.827	0.007	0.093	Moderate

The MANOVA analysis presented in Table 7 demonstrates that the instructional intervention significantly influenced students' critical thinking skills. The obtained F value of 7.827 with a p-value of 0.007 indicates a statistically significant

effect of the ethnopedagogical learning module on critical thinking performance. Furthermore, the partial eta squared value of 0.093 indicates a moderate effect size, suggesting that the intervention produced

meaningful improvements in students' higher-order thinking abilities.

The moderate effect size identified in this study highlights the educational importance of integrating local knowledge and cultural contexts into science learning. Although critical thinking development is influenced by multiple factors, the findings indicate that ethnopedagogical learning contributes substantially to strengthening students' reasoning and analytical abilities. This is particularly relevant in Indonesian educational contexts where critical thinking remains one of the most challenging competencies to develop effectively.

The findings of this study are consistent with previous research demonstrating the positive relationship between contextual learning and critical thinking development. Prayogi et al. (2024) found that inquiry-oriented and contextual learning significantly improved higher-order thinking skills among STEM learners. Similarly, Suhirman and Khotimah (2020) argued that contextual problem-based learning environments enhance students' scientific reasoning and critical thinking performance. However, the present study extends previous literature by specifically examining the effectiveness of ethnopedagogical learning modules implemented in elementary school settings through a quasi-experimental approach.

Another important implication of these findings is that ethnopedagogical learning may contribute to the development of culturally responsive education. By integrating local wisdom into classroom instruction, students are encouraged to critically examine social, environmental, and cultural issues within their own communities. This learning approach not only develops analytical skills but also strengthens students' awareness of their sociocultural environment (Ardiyani et al., 2025).

Consequently, critical thinking is developed not merely as an abstract cognitive skill but as a practical competency applicable to real-world situations.

Overall, the results demonstrate that the ethnopedagogical learning module significantly improved students' critical thinking skills through contextual, inquiry-based, and culturally meaningful learning experiences. The integration of local knowledge into science education created opportunities for students to engage in analytical reasoning, reflective discussion, and authentic problem-solving activities. Therefore, ethnopedagogical learning can be considered a promising pedagogical innovation for strengthening critical thinking development in Indonesian primary education.

c. The Role of Ethnopedagogical Learning in Strengthening Character Development

Another significant finding of this study is that the ethnopedagogical learning module substantially strengthened students' character development. Among the three dependent variables examined in this research, character development demonstrated the strongest improvement and the largest effect size. These findings indicate that ethnopedagogical learning does not merely strengthen cognitive competencies such as scientific literacy and critical thinking but also contributes significantly to students' moral, social, and behavioural development.

Character education has become an increasingly important component of contemporary education because schools are expected not only to develop students' academic competencies but also to foster ethical values, social responsibility, and positive behaviour (Krajitmate et al., 2019). In the Indonesian educational context, concerns regarding discipline, honesty,

responsibility, and social awareness among students continue to emerge (Aspiani et al., 2022; Arifin et al., 2024). Therefore, integrating character education into classroom learning activities is essential for promoting holistic student development.

The descriptive statistical analysis demonstrates that students who participated in the ethnopedagogical learning intervention

experienced greater improvement in character development compared to those in the control group. The experimental group improved from a pre-test score of 64.23 to a post-test score of 85.22, while the control group increased from 64.45 to 76.36. These findings indicate that the ethnopedagogical learning module was highly effective in promoting students' character formation.

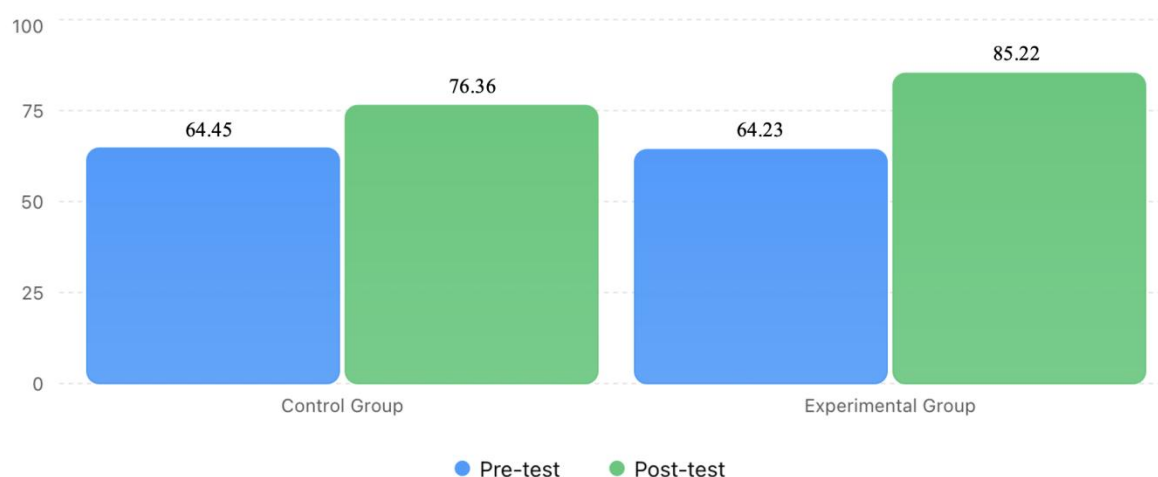


Figure 3. Comparison of Students' Character Development Scores Between Groups

Figure 3 clearly illustrates the substantial improvement in students' character development after the implementation of the ethnopedagogical learning module. Both groups initially demonstrated relatively similar character development scores during the pre-test stage, indicating comparable baseline conditions prior to the instructional intervention. However, after the treatment process, the experimental group demonstrated a much greater increase compared to the control group. The post-test score of the experimental group reached 85.22, considerably higher than the control group score of 76.36.

The figure also highlights the strong educational impact of integrating local wisdom into classroom instruction. Through collaborative activities, contextual

discussions, and culturally meaningful learning experiences, students appeared to develop greater responsibility, social awareness, cooperation, and ethical behaviour (Algifahmy, 2022). The substantial increase shown in the experimental group supports the argument that ethnopedagogical learning can serve as an effective pedagogical approach for strengthening character education within Indonesian primary school contexts.

One possible explanation for this improvement is that ethnopedagogical learning integrates local wisdom and cultural values directly into classroom activities. Through the inclusion of traditional practices, community values, and culturally contextualised discussions, students were encouraged to internalise values such as honesty, responsibility, discipline,

cooperation, empathy, and social awareness (Dilger, 2017). Unlike conventional instruction that often focuses primarily on academic achievement, ethnopedagogical learning provides opportunities for students to reflect on moral values embedded within their own cultural environment.

Furthermore, local cultural narratives and community practices introduced during learning activities appeared to create meaningful moral experiences for students. According to Fauzan et al. (2024), learning materials that integrate local wisdom can

strengthen students' moral awareness because ethical values are contextualised within familiar social realities. In this study, students not only learned scientific concepts but also discussed social responsibilities, environmental ethics, and community values related to the local culture of Kupang.

The development of students' character dimensions can be further observed through the distribution of observational scores across different character indicators, as presented in Table 9.

Table 9. Character Development Indicators in the Experimental Group

Character Indicator	Pre-test	Post-test
Discipline	63.21	84.50
Responsibility	64.10	86.21
Honesty	65.02	84.87
Cooperation	63.75	85.94
Environmental Awareness	64.33	87.15
Social Awareness	65.11	86.42

The findings presented in Table 9 reveal substantial improvements across all character indicators in the experimental group following the implementation of the ethnopedagogical learning module. Among the observed dimensions, environmental awareness and social awareness demonstrated the highest post-test scores. This finding is particularly important because ethnopedagogical learning often emphasises the relationship between humans, culture, and the natural environment. Through culturally contextualised discussions and activities, students developed greater awareness regarding environmental preservation and social responsibility.

The increase in cooperation and responsibility scores also indicates that collaborative learning activities embedded within the ethnopedagogical module positively influenced students' interpersonal

behaviour. During the learning process, students frequently engaged in group discussions, community-based observations, and collaborative problem-solving activities. Such experiences encouraged students to communicate effectively, respect different perspectives, and develop collective responsibility. According to Dilger (2017), community-oriented and culturally grounded learning environments promote empathy, collaboration, and civic engagement among students.

Another notable finding from Table 9 is the improvement in discipline and honesty. These values are particularly relevant in Indonesian educational settings where previous studies reported challenges related to academic dishonesty and behavioural discipline among students (Arifin et al., 2024; Aspiani et al., 2022). The integration of cultural and moral values into classroom instruction appears to strengthen students'

awareness of ethical behaviour because moral concepts are presented within meaningful social contexts rather than abstract moral instruction alone.

To further confirm the significance of the intervention, inferential statistical analysis using the Mann–Whitney U test was conducted, as presented in Table 10.

Table 10. Mann–Whitney U Test Result for Character Development

Variable	Group	N	Mean Rank	Mann–Whitney U	Z	p-value
Character Development	Control Group	40	27.91	296.50	-4.650	< .001
	Experimental Group	38	51.70			

The inferential statistical results shown in Table 10 demonstrate that the ethnopedagogical learning module had a statistically significant effect on students' character development. The experimental group achieved a substantially higher mean rank (51.70) compared to the control group (27.91). Furthermore, the obtained p-value of less than 0.001 confirms a highly significant difference between groups.

These findings indicate that ethnopedagogical learning was highly effective in strengthening students' moral and social behaviour. The substantial difference between the experimental and control groups suggests that character education becomes more meaningful when integrated into contextual and culturally relevant learning activities. Students appear to internalise moral values more effectively when ethical discussions are connected to their lived experiences and community practices.

The findings also support the argument that character development is strongly influenced by social learning experiences. Ethnopedagogical learning encourages students to participate actively in culturally meaningful discussions and collaborative activities that reflect community values. Such experiences create opportunities for students to practice moral behaviour rather than merely memorising ethical concepts. [Hendrawan \(2020\)](#) explained that ethnopedagogical approaches strengthen students' sense of belonging and social accountability because learning activities are closely related to community participation and local cultural identity.

The effectiveness of the ethnopedagogical learning module in improving character development was further supported by MANOVA analysis, as presented in Table 11.

Table 11. MANOVA Result for Character Development

Dependent Variable	F	p-value	Partial η^2	Effect Size
Character Development	29.676	< .001	0.281	Large

The MANOVA results presented in Table 11 indicate that the ethnopedagogical learning module produced a highly significant effect on students' character development. The obtained F value of 29.676 with a significance level below 0.001 confirms the robustness of the instructional

intervention. Furthermore, the partial eta squared value of 0.281 indicates a large effect size, suggesting that the intervention had a very strong educational impact on students' character formation.

Among the three dependent variables examined in this study, character

development demonstrated the largest effect size. This finding suggests that ethnopedagogical learning may be particularly effective in strengthening affective and behavioural dimensions of learning. One possible explanation is that local wisdom inherently contains moral, social, and cultural values that naturally support character formation. [Algifahmy \(2022\)](#) argued that ethnopedagogical learning transmits moral values through culturally meaningful experiences, enabling students to internalise ethical principles more effectively.

The large effect size also indicates that ethnopedagogical learning provides educational experiences beyond academic instruction. Students are not merely learning scientific concepts but also developing social empathy, civic awareness, and environmental responsibility ([Jannati et al., 2025](#)). Such holistic learning experiences are particularly important in contemporary education because schools are increasingly expected to develop students who are academically competent as well as socially responsible citizens.

The findings of this study are consistent with previous research indicating that culturally responsive learning contributes positively to students' moral and character development ([Fauzan et al., 2024](#); [M & Effendi, 2020](#)). However, this study extends previous literature by quantitatively demonstrating the strong effect of ethnopedagogical learning on multiple dimensions of character development within elementary education settings.

Overall, the results indicate that the ethnopedagogical learning module significantly strengthened students' character development through contextual, collaborative, and culturally meaningful learning experiences. The integration of local wisdom into classroom instruction enabled

students to internalise moral values, strengthen social awareness, and develop positive behavioural attitudes. Therefore, ethnopedagogical learning can be considered an effective pedagogical strategy for promoting holistic education in Indonesian primary schools.

d. Ethnopedagogical Learning as an Innovative and Contextual Educational Approach in Indonesian Primary Education

The findings of this study demonstrate that ethnopedagogical learning represents an innovative, culturally responsive, and contextually grounded educational approach capable of addressing multiple educational challenges within Indonesian primary education. The implementation of the ethnopedagogical learning module significantly improved students' scientific literacy, critical thinking skills, and character development simultaneously ([Maharani et al., 2023](#)). These findings indicate that integrating local wisdom into instructional practices not only enhances academic achievement but also contributes to holistic student development encompassing cognitive, affective, and social dimensions.

In recent years, Indonesian education has faced substantial challenges related to the quality of learning outcomes, particularly in scientific literacy and higher-order thinking skills. Conventional instructional approaches in elementary schools frequently remain teacher-centred and textbook-oriented, limiting students' opportunities to engage in contextual, inquiry-based, and culturally meaningful learning experiences ([Mbato, 2019](#)). Consequently, students often struggle to connect scientific concepts with real-life situations and local cultural realities. The findings of this study suggest that ethnopedagogical learning can serve as an

alternative instructional approach that addresses these limitations by contextualising learning within students' sociocultural environments.

One of the main strengths of ethnopedagogical learning lies in its ability to integrate local knowledge into formal educational settings. The ethnopedagogical learning module used in this study incorporated local cultural practices, community values, environmental issues, and traditional knowledge from Kupang into

classroom learning activities (Sharon & Baram-Tsabari, 2020). This integration enabled students to perceive scientific concepts not as abstract theories detached from daily life but as meaningful knowledge closely related to their social and cultural realities. This mechanism helps explain why the same intervention could simultaneously influence scientific literacy, critical thinking, and character development. The broader educational implications of ethnopedagogical learning are presented in Table 12.

Table 12. Educational Contributions of Ethnopedagogical Learning

Educational Aspect	Conventional Learning	Ethnopedagogical Learning	Educational Contribution
Learning Orientation	Teacher-centred	Student-centred	Enhances active participation
Learning Context	Textbook-based	Contextual and cultural	Improves learning relevance
Knowledge Source	Formal academic content	Integration of local wisdom	Strengthens meaningful learning
Student Engagement	Passive participation	Collaborative inquiry	Encourages critical reflection
Character Formation	Implicit moral instruction	Cultural value integration	Strengthens ethical awareness

The findings presented in Table 12 demonstrate that ethnopedagogical learning differs substantially from conventional instructional approaches in several educational dimensions. Conventional learning tends to emphasise teacher explanations and textbook dependency, whereas ethnopedagogical learning prioritises contextual exploration, collaborative inquiry, and active student participation (Verawati & Wahyudi, 2024). This shift from teacher-centred learning to student-centred learning is particularly important because it allows students to become active constructors of knowledge rather than passive recipients of information (Pujawan et al., 2022).

Another important contribution shown in Table 12 is the integration of local wisdom into the learning process. In ethnopedagogical learning, local cultural

values and community experiences become part of instructional materials and classroom discussions. This contextualisation enhances learning relevance because students can directly relate academic concepts to familiar situations within their environment. According to Ardiyani et al. (2025), culturally contextualised learning environments improve students' motivation and engagement because learning becomes more meaningful and connected to their identities.

The integration of cultural values into classroom learning also strengthens character formation. Ethical values such as cooperation, responsibility, respect, and environmental awareness are not merely taught theoretically but are experienced through culturally meaningful learning activities (Wenno et al., 2021). This holistic approach aligns with the goals of twenty-first century education,

which emphasise not only academic competence but also social responsibility and ethical citizenship.

The effectiveness of ethnopedagogical learning in supporting multidimensional

learning outcomes can also be observed through the comparative effect sizes obtained in this study, as presented in Table 13.

Table 13. Comparison of Effect Sizes Across Learning Outcomes

Dependent Variable	F Value	p-value	Partial η^2	Interpretation
Scientific Literacy	8.522	0.005	0.101	Moderate
Critical Thinking Skills	7.827	0.007	0.093	Moderate
Character Development	29.676	< .001	0.281	Large
Multivariate Effect	13.486	< .001	0.353	Large

Table 13 reveals that the ethnopedagogical learning module generated statistically significant effects across all dependent variables examined in this study. Scientific literacy and critical thinking skills demonstrated moderate effect sizes, while character development achieved a large effect size (Taş & Coşkun, 2014). Furthermore, the multivariate effect analysis produced a large overall effect size (partial $\eta^2 = 0.353$), indicating that the instructional intervention had a strong simultaneous influence on multiple dimensions of student development.

These findings highlight the multidimensional nature of ethnopedagogical learning. Unlike conventional instructional approaches that often focus primarily on cognitive achievement, ethnopedagogical learning supports holistic education by integrating intellectual, social, moral, and cultural dimensions simultaneously (Prayogi et al., 2024). This characteristic is particularly important in Indonesian education because national educational goals emphasise not only academic excellence but

also character development and cultural identity preservation (Rusiana et al., 2024).

The large effect size observed for character development suggests that ethnopedagogical learning may be especially effective in affective learning domains. Local wisdom inherently contains moral and social values that naturally support ethical learning processes (Syahidi et al., 2023). Through culturally contextualised discussions and community-based activities, students are encouraged to internalise social responsibility, empathy, and civic awareness. According to Algifahmy (2022), ethnopedagogical learning strengthens moral education because cultural values are embedded directly within authentic social experiences.

The implementation of ethnopedagogical learning also contributes to improving classroom engagement and participation. These engagement indicators should be explicitly linked to the classroom observation procedure so that readers can understand how the percentages were obtained, as presented in Table 14.

Table 14. Students' Learning Engagement During the Intervention

Learning Behaviour	Control Group (%)	Experimental Group (%)	Interpretation
Active Participation in Discussion	58.4	86.7	Higher engagement
Asking Questions	45.2	82.1	Increased curiosity

Learning Behaviour	Control Group (%)	Experimental Group (%)	Interpretation
Collaborative Problem Solving	61.3	88.5	Stronger cooperation
Reflection and Opinion Sharing	49.6	84.9	Improved critical reflection
Cultural Context Exploration	37.5	91.2	High contextual engagement

The findings presented in Table 14 demonstrate that students in the experimental group exhibited substantially higher engagement levels during classroom learning activities compared to students in the control group. Students who participated in ethnopedagogical learning were more active in discussions, more willing to ask questions, and more involved in collaborative problem-solving activities (Pujawan et al., 2022). These findings indicate that contextual and culturally meaningful learning environments significantly influence student participation and motivation.

One possible explanation for this increased engagement is that ethnopedagogical learning connects classroom content with students' lived experiences and cultural identities. Students appear more motivated when learning materials reflect familiar realities within their social environment. According to Syafitri

and Syafriani (2023), contextual learning improves students' willingness to participate because learners perceive educational activities as personally meaningful and socially relevant.

Another notable finding from Table 14 is the high percentage of students involved in cultural context exploration within the experimental group. This indicates that ethnopedagogical learning successfully encouraged students to explore and appreciate their local culture while simultaneously engaging with scientific concepts (Jannati et al., 2025). Such integration may strengthen students' cultural awareness and identity while promoting deeper conceptual understanding.

The broader pedagogical implications of ethnopedagogical learning for Indonesian primary education are further presented in Table 15.

Table 15. Pedagogical Implications of Ethnopedagogical Learning

Educational Dimension	Pedagogical Implication	Expected Impact	Educational Relevance
Curriculum Development	Integration of local wisdom	More contextual curriculum	Supports Merdeka Curriculum
Teaching Strategy	Inquiry and collaborative learning	Active learning environment	Enhances 21st-century skills
Learning Material	Culture-based instructional module	Meaningful learning experiences	Improves student engagement
Character Education	Embedded moral values	Strengthened ethical behaviour	Supports holistic education
Educational Equity	Recognition of local culture	Inclusive learning environment	Preserves cultural diversity

Table 15 demonstrates that ethnopedagogical learning possesses broad implications for educational innovation in Indonesia. One major implication relates to

curriculum development. The integration of local wisdom into instructional materials aligns strongly with the principles of the Merdeka Curriculum, which emphasises

contextual, student-centred, and culturally responsive learning approaches (Maharani et al., 2023). Ethnopedagogical learning therefore supports ongoing educational reforms aimed at improving the relevance and inclusiveness of Indonesian education.

Another important implication concerns teaching strategies. Ethnopedagogical learning encourages inquiry-based and collaborative instructional practices that promote active student engagement and higher-order thinking skills (Ajid et al., 2025). These pedagogical characteristics are highly relevant to twenty-first century education, which requires students to develop critical thinking, creativity, communication, and collaboration competencies (Kusumaningtyas et al., 2024).

The findings also indicate that ethnopedagogical learning contributes to educational equity by recognising and valuing students' cultural backgrounds. In many educational systems, local cultures are often marginalised within formal curricula dominated by standardised academic content. Ethnopedagogical learning addresses this issue by positioning local culture as a legitimate and valuable source of knowledge within classroom instruction. According to Liu and Huang (2016), culturally responsive curricula improve students' sense of belonging and educational participation because learning environments acknowledge their cultural identities.

The practical implementation challenges of ethnopedagogical learning are summarised in Table 16.

Table 16. Challenges and Recommendations for Ethnopedagogical Learning Implementation

Challenge	Description	Educational Impact	Recommendation
Limited Teacher Knowledge	Teachers may lack understanding of ethnopedagogy	Reduces instructional effectiveness	Teacher professional development
Limited Learning Resources	Lack of culture-based teaching materials	Restricts implementation	Development of local learning modules
Curriculum Constraints	Standardised curriculum demands	Limits contextual flexibility	Curriculum adaptation strategies
Time Allocation	Contextual learning requires longer discussion	Reduced instructional efficiency	Flexible classroom management
Cultural Diversity	Diverse local cultures across regions	Variation in implementation	Localised instructional adaptation

Table 16 indicates that although ethnopedagogical learning offers substantial educational benefits, several implementation challenges remain. One major challenge concerns teachers' limited understanding of ethnopedagogical principles and contextual learning strategies (Hendrawan, 2020). Many teachers may still rely heavily on conventional textbook-oriented instruction due to insufficient training regarding culture-based learning approaches (Ardiyani et al., 2025). Therefore, teacher professional development programmes are essential for strengthening educators' capacity to

implement ethnopedagogical learning effectively.

Another important challenge relates to the limited availability of ethnopedagogical instructional materials. Developing contextual and culture-based learning resources requires substantial time, effort, and collaboration with local communities (Kusumaningtyas et al., 2024). However, the findings of this study suggest that such investment is worthwhile because ethnopedagogical learning generates meaningful improvements across multiple learning dimensions.

Overall, the findings of this study demonstrate that ethnopedagogical learning represents a highly promising educational innovation for Indonesian primary education. By integrating local wisdom into classroom instruction, ethnopedagogical learning promotes meaningful learning, strengthens higher-order thinking skills, enhances character development, and supports culturally responsive education. Therefore, ethnopedagogical learning can serve as an important pedagogical framework for improving the quality, relevance, and inclusiveness of education in Indonesia.

4. Conclusion

This study concludes that the ethnopedagogical learning module based on local knowledge has a significant positive effect on elementary school students' scientific literacy, critical thinking skills, and character development in Kupang, Indonesia. The findings demonstrate that students who participated in the ethnopedagogical learning intervention achieved higher learning outcomes compared to those who experienced conventional instructional approaches. The statistical analyses, including descriptive analysis, Mann-Whitney U test, and MANOVA, consistently confirmed the effectiveness of the instructional intervention across all dependent variables. However, because this study used convenience sampling and non-random class assignment, the findings should be interpreted with caution and further validated through broader samples and stronger experimental controls.

The implementation of ethnopedagogical learning successfully improved students' scientific literacy by contextualising scientific concepts within students' cultural and environmental realities. Through the integration of local wisdom and

culturally relevant learning experiences, students were able to understand scientific concepts more meaningfully and apply scientific reasoning to real-life situations. Furthermore, the contextual and inquiry-based nature of ethnopedagogical learning significantly contributed to the development of students' critical thinking skills by encouraging analysis, reflection, problem-solving, and collaborative inquiry processes.

Among the examined variables, character development demonstrated the strongest improvement and the largest effect size. This finding indicates that ethnopedagogical learning is particularly effective in strengthening students' moral awareness, responsibility, cooperation, discipline, environmental awareness, and social sensitivity. The integration of cultural values into classroom learning activities enabled students to internalise ethical principles through meaningful and authentic social experiences.

The findings also highlight the broader educational significance of ethnopedagogical learning as an innovative and culturally responsive pedagogical approach in Indonesian primary education. Ethnopedagogical learning not only supports the development of twenty-first century competencies but also aligns with the principles of the Merdeka Curriculum, which emphasises contextual, student-centred, and meaningful learning. In addition, this approach contributes to preserving local cultural identity while simultaneously enhancing educational relevance and inclusiveness.

Therefore, ethnopedagogical learning can be considered a transformative educational innovation that supports curriculum reform, culturally responsive pedagogy, and holistic learner development. The findings provide empirical evidence for

integrating local wisdom into innovative educational practices that address both cognitive and character-related learning outcomes. Future studies are recommended to involve larger participant populations, different educational levels, and broader regional contexts to strengthen the generalisability of the findings. Further research may also explore the long-term impact of ethnopedagogical learning on students' academic achievement, cultural awareness, and socio-emotional development.

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