Ethno-Pedagogy as a Pedagogical Bridge: Traditional Ecological Knowledge as Cultural Resources for Culturally Responsive Teacher Education

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Abstract. Ethno-pedagogy and Traditional Ecological Knowledge (TEK) represent culturally embedded forms of knowledge that can function as critical cultural resources for culturally responsive education. This study proposes an ethno-pedagogical framework for integrating TEK into teacher education through the development of culturally responsive learning materials for pre-service teachers in East Java, Indonesia. Using a qualitative case study approach, data were collected through semi-structured interviews, reflective journals, teaching materials, and field observations of local cultural practices and rituals, including bersih desa and nyadran. Thematic analysis reveals that pre-service teachers perceive ethno-pedagogy as a pedagogical bridge between scientific knowledge and locally embedded ecological practices, enabling the integration of cognitive (knowledge synthesis), affective (cultural transmission), and behavioral (transformative competence) dimensions of learning. Engagement with TEK as a cultural resource enhances teachers' cultural sensitivity, ecological literacy, and capacity to design contextually meaningful educational materials. The findings highlight the role of ethno-pedagogy in strengthening culturally responsive education by embedding local knowledge systems within formal learning contexts. The study suggests that teacher education programs should position ethno-pedagogy as a core pedagogical competency for mediating between formal curricula and indigenous knowledge, thereby reinforcing the social, cultural, and ethical foundations of education.

Keywords: ethno-pedagogy; traditional ecological knowledge; culturally responsive education; Javanese cultural practices; teacher educationFirst Section

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1. Introduction

Learning ecological wisdom or traditional ecological knowledge (TEK) has increasingly become a critical component of environmental education across many countries (Choi, Choi, & Lee, 2007; Kim & Lee, 2016; Nam, Lee, & Lee, 2014; Selasih & Sudarsana, 2018). TEK encompasses the cumulative body of knowledge, practices, and beliefs developed by indigenous and local communities through their interactions with the natural environment. As global education systems search for more holistic and sustainable paradigms, integrating TEK into formal curricula is seen as an essential step toward enhancing ecological literacy and promoting cultural continuity (McCarter & Gavin, 2011; Yashmita-Ulman & Singh, 2024). This pedagogical shift not only deepens students' understanding of ecological systems but also repositions cultural identity and traditional wisdom as vital resources for sustainable living.

In Indonesia—a nation rich in biodiversity and cultural plurality—local wisdom (kearifan lokal) plays a strategic role in environmental management and community well-being. Many indigenous and rural communities continue to practice ecological traditions that sustain both livelihoods and environmental balance. These practices are rooted in collective rituals, symbolic exchanges, and seasonal knowledge systems that reflect deeply relational worldviews. Preserving such local wisdom as a living source of innovation and social prosperity is therefore crucial. Within this context, education serves as a powerful tool for transmitting cultural values while simultaneously reinforcing ecological responsibility among the younger generation.

The integration of TEK in school education has shown significant potential for strengthening environmental literacy, cultural preservation, and transformative learning (Li & Shein, 2023; Feinstein, 2004). TEK-based learning encourages students to contextualize abstract ecological concepts through their lived experiences, often connecting scientific understanding with local practices. This form of learning also fosters a "sense of place," identity formation, and emotional attachment to nature—key dimensions of sustainable education. However, integrating TEK into formal education also faces notable challenges, such as epistemological differences between indigenous and scientific systems, limited teacher training, and the risk of cultural misappropriation when traditional knowledge is superficially adopted (Kim, Asghar, & Jordan, 2017; Lange et al., 2025; Bredal-Tomren, 2025).

Recent studies across diverse regions demonstrate both opportunities and constraints of such integration. For instance, an undergraduate course on Hawaiian environmental knowledge produced transformative learning outcomes by immersing students in indigenous ecological practices (Feinstein, 2004). In Norway, the inclusion of Sámi traditional knowledge into national science curricula revealed the importance of collaboration with local communities to ensure authenticity and respect for indigenous epistemologies (Lange et al., 2025; Bredal-Tomren, 2025). Similarly, on Malekula Island in Vanuatu, educators recognized the potential of TEK for enhancing school curricula but

highlighted institutional and epistemological barriers that must be addressed for successful implementation (McCarter & Gavin, 2011). These cases collectively affirm that effective integration requires interdisciplinary strategies, teacher training, and culturally sensitive pedagogy grounded in collaboration with local communities (Ortiz et al., 2025; Dei et al., 2025).

In Indonesia, one promising framework for bridging local knowledge and formal education is ethno-pedagogy. This approach refers to a pedagogical orientation that values the integration of local cultural practices, indigenous wisdom, and ecological understanding within the learning process (Mag, 2011; Klara, 2015; Rexhepi & Bajrami, 2025). Ethno-pedagogy is closely related to biocultural diversity, ethnobotany, ethnography, and folklore studies—fields that emphasize the inseparability of cultural and ecological systems. In regions such as Ponorogo, East Java, traditional rituals involving the use of natural resources can serve as culturally embedded learning contexts. Through ethno-pedagogy, teachers and students can jointly explore how such traditions embody ecological principles, social ethics, and intergenerational sustainability.
From an educational perspective, ethno-pedagogy also plays a transformative role in teacher preparation. Pre-service teachers trained under this approach are encouraged to explore students' socio-cultural backgrounds, bridging the often-wide gap between academic instruction and community life. By engaging with local ecological knowledge, teachers develop ethno-pedagogical competence—a core element of professional culture that aligns educational practices with current socio-cultural realities. Such competence enables teachers to not only transmit knowledge but also cultivate ecological awareness and cultural empathy in their students.

Given these considerations, this study aims to examine how pre-service teachers perceive and apply ethno-pedagogical principles in constructing locally grounded educational resources grounded in Traditional Ecological Knowledge. By situating this inquiry within Indonesia's diverse educational and cultural landscape, the study contributes to the global discourse on the integration of TEK and ethno-pedagogy as transformative pathways toward biocultural sustainability. Specifically, it seeks to understand the urgency of implementing ethno-pedagogy in developing teaching materials that focus on biodiversity conservation.

2. Methodology

This study employed a qualitative case study design to explore how pre-service teachers perceive and apply ethno-pedagogical principles in developing culturally responsive learning materials grounded in Traditional Ecological Knowledge (TEK). Twenty-five pre-service teachers enrolled in a teacher education program in East Java, Indonesia, were selected through purposive sampling, informed by pretest results assessing baseline knowledge as well as their exposure to local ecological practices and cultural rituals, including bersih desa and nyadran. The study followed systematic procedures

across participant selection, data collection, and analysis to ensure methodological transparency.

Data were collected over three months using multiple qualitative sources, including semi-structured interviews, reflective journals, analysis of teaching materials, and field observations of local cultural practices. Semi-structured interviews were conducted using a guided protocol to elicit participants' understanding and application of ethnopedagogical concepts, while reflective journals and teaching artifacts captured their ongoing learning processes and instructional design practices. Field observations were used to contextualize participants' engagement with local cultural knowledge systems.

Data were analyzed using thematic analysis following Braun and Clarke (2006). The coding process involved three iterative stages: initial open coding to identify meaningful units of data, categorization to group similar codes, and thematic development to construct overarching themes. These themes were continuously refined through comparison across data sources and iterative review. Both deductive (framework-driven) and inductive (data-driven) approaches were employed to ensure that analysis captured both theoretical constructs and emergent patterns.

To enhance credibility, methodological triangulation was applied across interviews, journals, artifacts, and observations. In addition, member checking was conducted by inviting participants to review and confirm preliminary interpretations. Ethical approval was obtained from the affiliated university, informed consent was secured from all participants, and the study adhered to strict ethical considerations, particularly in relation to cultural sensitivity and the respectful engagement of indigenous knowledge.

3. Literature Review and Conceptual Framework

3.1 Traditional Ecological Knowledge (TEK) as a Pedagogical Resource

The growing body of research on Traditional Ecological Knowledge (TEK) underscores its pedagogical value in advancing environmental literacy and sustainable learning (McCarter & Gavin, 2011; Kim, Asghar, & Jordan, 2017). TEK represents a complex system of understanding that integrates ecological observation, moral cosmology, and adaptive practices passed through generations. Unlike scientific environmental education, which often abstracts human–nature relations into quantifiable models, TEK is inherently relational and performative—it is learned through ritual, storytelling, and lived experience within ecological contexts (Li & Shein, 2023; Ortiz et al., 2025).

Integrating TEK into school education transforms the learning process into a culturally embedded practice. Students not only acquire knowledge about biodiversity and ecological cycles but also learn the ethics of care, reciprocity, and spiritual responsibility toward the environment. Such integration encourages "ecological identity formation"

(Feinstein, 2004), where students understand themselves as part of an interdependent ecological system. This aligns with recent frameworks of biocultural diversity education, which view education as a mediating process between cultural continuity and ecological resilience (Dei et al., 2025).

However, scholars also caution that TEK cannot simply be incorporated into curricula as "content." Instead, it must be approached through epistemological pluralism that respects indigenous worldviews and avoids tokenistic appropriation (Bredal-Tomren, 2025; Lange et al., 2025). As noted by Kim et al. (2017), the epistemic foundation of TEK—its narrative form, symbolism, and oral transmission—differs from the empirical structure of Western scientific education. Therefore, successful integration demands transformative pedagogical frameworks that foster dialogue between knowledge systems rather than assimilation into one dominant paradigm.

3.2. Ethno-Pedagogy and Biocultural Learning

Ethno-pedagogy emerges as a relevant pedagogical approach to bridge the epistemological gap between TEK and formal education (Mag, 2011; Klara, 2015). Rooted in anthropological and educational theories, ethno-pedagogy promotes teaching methods that draw from local cultural systems, values, and ecological practices. It aligns with the broader educational turn toward place-based and community-based learning models that situate education within the socio-ecological realities of learners (Rexhepi & Bajrami, 2025).

Within the Southeast Asian context, ethno-pedagogy is particularly significant because traditional education systems historically evolved through oral traditions, apprenticeship, and communal rituals. These pedagogies were not only cognitive but experiential—teaching through doing, observing, and participating in social–ecological interactions. The application of ethno-pedagogy in modern education seeks to recover these immersive learning forms by integrating local rituals, ecological practices, and social cooperation into structured curricula.

Empirical research shows that ethno-pedagogical strategies can enhance teachers' cultural awareness and students' engagement with sustainability issues (Selasih & Sudarsana, 2018). For instance, pre-service teachers trained under ethno-pedagogical frameworks demonstrate higher competencies in developing culturally grounded teaching materials and in connecting scientific content with local ecological contexts. Such approaches also align with transformative learning theory, which posits that learners reconstruct their worldview through critical reflection on lived experiences and cultural narratives.

3.3. The Indonesian Context: Local Wisdom and Biodiversity Conservation

Indonesia's ecological and cultural landscapes provide fertile ground for the development of ethno-pedagogy. The country's 17,000 islands host over 300 ethnic groups, each possessing distinct ecological knowledge systems embedded in rituals, cosmologies, and livelihood practices. From the subak irrigation system in Bali to the sasi marine conservation rituals in Maluku, these traditions represent sophisticated ecological governance mechanisms. However, modernization and standardized education systems have marginalized such knowledge, treating it as folklore rather than living ecological science.

Recent policy initiatives, including the Merdeka Belajar (Freedom to Learn) framework, open opportunities to re-contextualize local knowledge within education. Incorporating TEK and ethno-pedagogy can strengthen environmental education while promoting cultural identity formation among students. For example, in Ponorogo (East Java), local rituals such as bersih desa and nyadran utilize natural resources as symbols of gratitude and ecological balance. These practices—often involving collective action, sharing of food, and the cleaning of public spaces—reflect sustainable community ethics that can be used as case studies in classroom learning.

Through ethno-pedagogy, teachers can transform these traditions into pedagogical materials, linking ritual practices to concepts such as biodiversity, circular economy, and environmental ethics. By doing so, education becomes a site of biocultural revitalization, connecting local cosmology with modern sustainability discourse.

3.4. Barriers and Opportunities in TEK Integration

Despite its promise, the integration of TEK and ethno-pedagogy faces structural and epistemic challenges. Studies in different regions indicate that teachers often lack adequate training and conceptual frameworks to meaningfully incorporate indigenous knowledge into lessons (McCarter & Gavin, 2011; Lange et al., 2025). Moreover, educational institutions frequently privilege written, scientific knowledge over oral and symbolic forms, leading to epistemological exclusion. This structural bias not only marginalizes local wisdom but also limits students' exposure to plural ways of knowing.

Another barrier lies in cultural sensitivity. As Ortiz et al. (2025) warn, educators must "listen deeply" to indigenous voices to prevent the misappropriation of cultural practices. Effective integration therefore requires collaboration with community elders, cultural leaders, and local ecological experts. The success of the Sámi integration model in Norway demonstrates that co-designing curricula with indigenous communities ensures authenticity and reciprocal learning. Similarly, participatory learning approaches (Barraza & Bodenhorn, 2012) foster critical thinking and mutual respect across epistemic boundaries.

However, the growing body of literature also highlights opportunities. Ethno-pedagogical approaches can act as bridging epistemologies—frameworks that enable dialogue between scientific and traditional worldviews without subordination. When supported by teacher training and institutional policy, they can transform schools into "ecocultural learning spaces" where students engage both cognitive and affective dimensions of sustainability (Dei et al., 2025).

Table 1. Barriers and Opportunities in Integrating Traditional Ecological Knowledge (TEK) and Ethno-Pedagogy in Education

Aspect	Description	Examples / Evidence	References
Barriers: Structural & Epistemic	Teachers lack training and frameworks to integrate TEK; institutions favor written/scientific knowledge, marginalizing oral/symbolic forms	Limited teacher preparedness; exclusion of local wisdom from curriculum	McCarter & Gavin, 2011; Lange et al., 2025
Barriers: Cultural Sensitivity	Risk of misappropriation of indigenous knowledge; lack of engagement with local communities	Need to "listen deeply" to indigenous voices; co-design curricula with Sámi communities in Norway	Ortiz et al., 2025; Barraza & Bodenhorn, 2012
Opportunities: Bridging Epistemologies	Ethno-pedagogical approaches mediate between scientific and traditional knowledge	Creation of ecocultural learning spaces; integration of cognitive and affective dimensions of sustainability	Dei et al., 2025
Opportunities: Transformative Learning	Teacher training + policy support enable effective TEK integration	Teachers and students develop competencies in ecological stewardship and community engagement	Dei et al., 2025

4. Results and Discussion

4.1. Pre-service Teachers' Understanding of Ethno-Pedagogy

The analysis revealed that most pre-service teachers demonstrated a growing awareness of the pedagogical significance of local culture in environmental education. Participants acknowledged that traditional ecological practices within their communities—such as bersih desa, nyadran, and communal planting rituals—offer rich material for classroom instruction. These findings align with Klara (2015) and Mag (2011), who emphasized that ethno-pedagogy serves as a contextualized mode of learning grounded in biocultural diversity. The teachers recognized that integrating local wisdom does not merely add cultural content to lessons but reshapes their pedagogical orientation toward more community-based and relational learning.

One participant noted that local rituals provide a meaningful entry point for learning environmental values: “When we talk about bersih desa or nyadran, students immediately understand why nature matters, because these rituals are already part of their lives, not just school content” (PT7).

Pre-service teachers also perceived ethno-pedagogy as a bridge connecting academic theory with the lived realities of rural learners. Similar to Selasih and Sudarsana (2018), their reflections suggested that local traditions provide opportunities for experiential and participatory learning that fosters environmental empathy. This awareness signals a pedagogical shift from rote instruction to critical engagement with local ecological contexts. Moreover, it encourages teachers to reinterpret indigenous knowledge as part of environmental ethics rather than as peripheral folklore.

4.2. Application of Ethno-Pedagogical Principles in Teaching Materials

When tasked with designing teaching materials, participants used natural and cultural resources from their surroundings as learning media. Examples included using local plants for biodiversity identification, traditional farming techniques to explain ecosystem balance, and ritual symbols to illustrate ecological interdependence. This practical engagement reflects the cognitive dimension of the conceptual framework, where teachers synthesize scientific and traditional ecological knowledge.

Reflective journals revealed that integrating local practices reshaped how participants designed learning activities: “Using traditional farming practices made ecological concepts easier to explain, because students could connect science lessons with what their families do every day” (PT12).

Following Mag (2011), such integration of knowledge transforms abstract ecological theory into concrete, place-based learning. Teachers’ lesson designs displayed varying levels of ethno-pedagogical competence, with some incorporating local narratives and others employing community-based projects. The most effective designs were those that positioned students as co-researchers—documenting and analyzing traditional ecological practices in their villages. This participatory approach aligns with the affective and behavioral dimensions of the framework, where learning fosters emotional connection and actionable responsibility toward biodiversity.

4.3. Ethno-Pedagogical Competence as Professional Development

Ethno-pedagogical competence emerged as a transformative component of teacher professionalism. Teachers who engaged deeply with local wisdom developed stronger cultural sensitivity and ecological understanding. Engagement with community elders also prompted participants to reconsider their professional identity:
“I realized that being a teacher is not only about delivering the curriculum, but about helping students respect and continue the knowledge of their community” (PT19). As

suggested by Kim, Asghar, and Jordan (2017), this competence is essential in overcoming epistemological boundaries between scientific and indigenous systems of knowledge. The teachers' reflective journals indicated that working with elders, community leaders, and local farmers allowed them to reinterpret their role—not merely as transmitters of knowledge but as facilitators of cultural continuity.

This process is consistent with Dei et al. (2025), who argue that education rooted in cultural epistemologies can serve as a foundation for sustainable learning. By situating pedagogy within biocultural contexts, teachers not only enrich their instructional strategies but also contribute to the preservation of ecological wisdom. The findings thus reinforce the argument that teacher education programs should integrate ethno-pedagogy as a foundational competency, preparing educators to mediate between formal science and local ecological traditions.

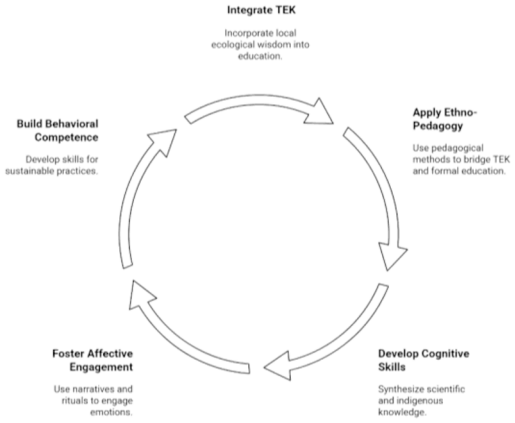

Figure 1 Cyclical Relationship between Traditional Ecological Knowledge (TEK) and Ethno-Pedagogy in Culturally Responsive Teacher Education

This process illustrates a cycle of sustainability education in which Traditional Ecological Knowledge (TEK) serves as the foundational resource, derived from local rituals, myths, and ecological practices. Ethno-Pedagogy (EP) functions as the pedagogical bridge, translating TEK into structured learning experiences within formal education. Through this bridge, teachers are able to operationalize TEK across three interrelated dimensions:

1. Cognitive Dimension (Knowledge Integration) – Pre-service teachers synthesize scientific knowledge with local ecological insights, co-creating teaching materials that are contextually meaningful and academically rigorous.
2. Affective Dimension (Cultural Transmission) – Learning activities embed cultural narratives, rituals, and place-based experiences, nurturing students' emotional attachment to their environment and reinforcing the value of local wisdom.

3. Behavioral Dimension (Transformative Competence) – Teachers and students cultivate competencies for sustainable action, including conservation practices, community engagement, and stewardship of natural resources.

Through this multidimensional approach, EP enables students not only to acquire knowledge but also to internalize ecological ethics and a sense of belonging to their biocultural environment. By situating pedagogy within these contexts, teachers enrich their instructional strategies while actively contributing to the preservation of ecological wisdom. This cycle emphasizes that teacher education programs must integrate ethno-pedagogy as a core competency, equipping educators to mediate effectively between formal science curricula and the lived ecological knowledge of local communities.

In essence, the framework represents a continuous and reinforcing loop: TEK informs EP, which shapes teacher competence, leading to effective Biodiversity Conservation Education (BC), which in turn sustains and reinforces the relevance and practice of TEK in the community. This cyclical process ensures that education becomes both a medium for cultural preservation and a driver for ecological sustainability, fully aligned with the arguments presented by Dei et al. (2025).

4.4. Implications for Biodiversity Conservation Education

The implementation of ethno-pedagogy in teacher training has far-reaching implications for biodiversity conservation. As seen in Ponorogo and other regions of Indonesia, traditional rituals already embed principles of sustainability, reciprocity, and communal care. Transforming these traditions into structured educational content can promote conservation awareness among students while revitalizing community participation. McCarter and Gavin (2011) and Feinstein (2004) have demonstrated similar outcomes in other cultural contexts, where integrating indigenous ecological knowledge strengthened learners' environmental literacy. In the Indonesian case, this approach also reinforces cultural resilience—protecting both natural ecosystems and cultural heritage. The study thus positions ethno-pedagogy not only as a pedagogical innovation but as a socio-ecological strategy for sustaining biodiversity through education.

5. Conclusion

This study highlights the urgency of implementing ethno-pedagogy in teacher education programs as a pathway to develop teaching materials focused on biodiversity conservation. By engaging pre-service teachers in contextualized learning processes grounded in local ecological knowledge, the study suggests that ethno-pedagogy has potential to connect traditional wisdom with modern environmental education, at least within the East Javanese teacher education context examined here.

Three key insights emerge. First, ethno-pedagogy functions as a mediating framework that integrates cognitive, affective, and behavioral dimensions of learning—linking scientific and indigenous knowledge systems. Second, teacher competence in ethno-pedagogy enhances professional and ecological literacy, enabling educators to design lessons that are culturally relevant and ecologically meaningful. Third, ethno-pedagogy contributes to biodiversity conservation by transforming cultural practices into active learning resources that promote sustainability ethics among students.

Within the context of this study, sustainable education appears deeply intertwined with local cultural roots, suggesting that culturally embedded pedagogies merit greater attention in teacher education programs. For the East Javanese context studied, and potentially for other culturally diverse regions in Indonesia, ethno-pedagogy offers a promising decolonial and locally grounded approach to ecological learning—one that values the wisdom of communities as integral to environmental stewardship. However, broader applicability of these findings would require further empirical validation across different cultural and institutional settings. Future research should expand this framework through longitudinal studies assessing how ethno-pedagogical integration influences students' ecological attitudes and community engagement over time.

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Disclosure of Interests.

The author full declare that there is no conflict of interest in doing this research

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