

Sustainable Numeracy Literacy Learning Based on Local Wisdom Through Digital Media: An Ethnomathematical Approach to Quality Education and Environmental Awareness

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Abstract. This paper introduces an integrated model of numeracy literacy learning that combines ethnomathematics, local wisdom, and digital media within a sustainability framework. The model responds to the urgent need for quality education that is not only technologically relevant but also culturally meaningful and environmentally responsible. Ethnomathematics provides a foundation for connecting mathematical concepts with everyday practices such as weaving patterns, indigenous measurement systems, and agricultural cycles, all of which demonstrate sustainable resource use and ecological reasoning. When supported by digital media such as mobile applications, interactive modules, or augmented reality these cultural practices can be transformed into engaging learning experiences that strengthen students' mathematical literacy, creativity, and problem-solving skills. Beyond pedagogy, this approach directly aligns with Sustainable Development Goal (SDG) 4: Quality Education, while also contributing to SDG 11: Sustainable Cities and Communities through cultural preservation, and SDG 13: Climate Action by promoting ecological awareness. Policy implications include the need to embed culturally responsive pedagogy into national curricula, invest in teacher professional development, and expand equitable access to digital infrastructure. Overall, this study positions education as a vehicle for sustainability by demonstrating that integrating local wisdom and digital innovation can build resilient, inclusive, and environmentally conscious learning systems.

Keywords: Sustainable Numeracy Literacy; Local Wisdom; Sustainable Development Goals; Quality Education; Environmental Awareness.

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1 Introduction

In the rapidly evolving educational landscape, the integration of local wisdom into literacy and numeracy learning has become an essential strategy for fostering holistic student development in primary schools. Literacy and numeracy are globally recognized as the foundational competencies that underpin lifelong learning and active citizenship [1]. However, conventional teaching approaches often neglect cultural contexts that shape students' cognitive and social development. This gap necessitates the incorporation of local values and traditions to strengthen not only academic skills but also cultural identity and social cohesion [2].

Local wisdom, defined as the collective knowledge, values, and practices rooted in a community's historical and cultural experience, has increasingly been acknowledged as a rich pedagogical resource [3]. In the Indonesian context, East Java provides an abundance of cultural heritage, folklore, oral traditions, and numerical practices embedded in daily life, such as traditional games, market interactions, and communal rituals. These practices contain implicit forms of literacy and numeracy that can be systematically integrated into school curricula [1]. Scholars emphasize that embedding indigenous knowledge into classroom practices promotes contextualized learning, improves student engagement, and nurtures cultural pride [3], [4].

Global research has shown that education anchored in local culture improves critical thinking, problem-solving, and creativity [5]. For instance, studies in New Zealand highlight the success of incorporating Māori traditions into literacy learning, which not only strengthens academic achievement but also revitalizes indigenous identity [6]. Similarly, in Canada, the integration of First Nations' numeracy practices has enhanced mathematical understanding by linking abstract concepts to community-based experiences [7]. These findings resonate strongly with the Indonesian context, where cultural richness offers untapped opportunities for literacy and numeracy instruction.

Integrating East Javanese local wisdom into literacy and numeracy learning also aligns with global education goals, particularly the UNESCO Sustainable Development Goal 4 (SDG 4), which emphasizes inclusive, equitable, and quality education [8]. The emphasis on cultural relevance in education supports not only academic outcomes but also broader goals such as social sustainability, resilience, and intercultural understanding [9]. Moreover, localized pedagogy ensures that students' lived experiences are recognized as valid knowledge systems, reducing the alienation often caused by culturally distant curricula [3], [4].

Despite these promising perspectives, the integration of local wisdom into primary education faces challenges. Teachers often lack training in culturally responsive pedagogy, curriculum frameworks may undervalue indigenous knowledge, and standardized assessments rarely measure cultural competencies [8], [10]. To address these challenges, collaborative strategies involving educators, communities, and policymakers are essential. By engaging local communities in curriculum development, schools can ensure that learning materials are both culturally relevant and academically rigorous [11].

This study builds on the growing body of international scholarship advocating for culturally grounded education. It specifically explores how East Javanese cultural practices—ranging from folklore and proverbs to numerical concepts embedded in traditional activities can be integrated into literacy and numeracy learning in Indonesian primary schools. By doing so, it contributes to the broader discourse on contextualized education and highlights practical pathways for realizing inclusive, culturally sustaining pedagogy.

2 Methods

This study employed a qualitative research design with a descriptive-analytical orientation to explore how local wisdom, ethnomathematics, and digital media can be integrated into sustainable numeracy literacy learning. The methodological framework was developed to ensure cultural relevance, technological accessibility, and alignment with sustainability principles.

2.1 Research Setting and Participants

The research was conducted in elementary schools located in regions with strong traditions of local wisdom, particularly in weaving, traditional games, and agriculture-based practices. Participants included classroom teachers, curriculum developers, and students from grades 4 to 6. Purposeful sampling was used to select participants who were directly engaged with local cultural practices and open to technology-based instruction.

2.2 Data Collection Techniques

Data were gathered through multiple sources:

1. **Classroom observations**, focusing on how local wisdom-based activities were incorporated into mathematics lessons.
2. **Semi-structured interviews** with teachers and students to explore perceptions of cultural integration and digital media use.
3. **Document analysis**, including lesson plans, digital learning modules, and educational policies supporting sustainability and digital literacy.

2.3 Data Analysis

Thematic analysis was applied to identify recurring patterns related to ethnomathematical practices, sustainability values, and digital integration. Coding was conducted in three stages: open coding to capture initial concepts, axial coding to link themes, and selective coding to refine categories into a coherent framework.

2.4 Validity and Reliability

Credibility was ensured through triangulation of data sources, member checking with teachers, and peer debriefing with educational experts. Dependability was strengthened by maintaining an audit trail of observations, interview transcripts, and coding decisions.

2.5 Ethical Considerations

Ethical approval was obtained from the institutional review board, and informed consent was secured from all participants. Pseudonyms were used to protect confidentiality.

3 Final and Discussion

3.1 Results

Figure 1 illustrates the conceptual relationship between local wisdom, ethnomathematical practices, and digital media in promoting sustainable numeracy literacy. This integration aligns with global education goals (SDG 4) and environmental sustainability (SDG 13)

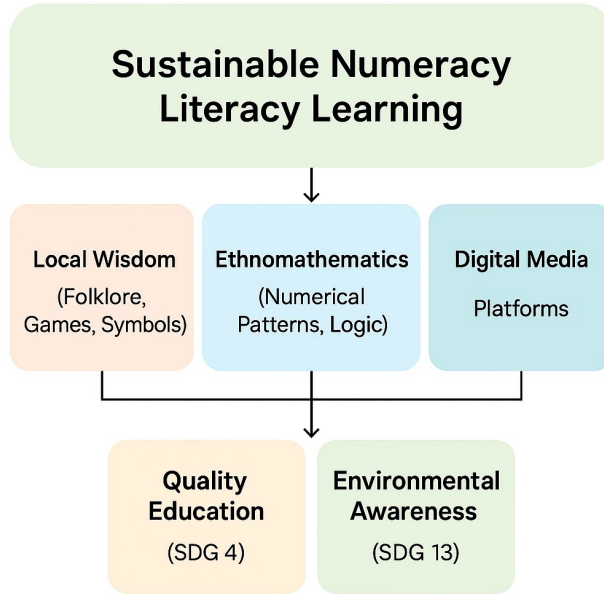


Fig. 1. Research Framework

Table 1. highlights the connections between East Javanese local wisdom, mathematical concepts, and their digital integration for sustainable numeracy learning.

Local Wisdom Element	Mathematical Concept	Digital Media Integration	Sustainability Impact
Traditional games (<i>engklek</i>)	Counting, geometry, sequencing	Interactive learning apps, gamification	Strengthens numeracy and cultural identity
Batik patterns	Symmetry, transformation, fractions	Virtual design tools, AR/VR	Promotes creativity and environmental themes
Market transactions	Arithmetic, budgeting, statistics	E-commerce simulation, digital storyboards	Develops financial literacy and eco-awareness
Folklore & proverbs	Logic, word problems	Multimedia storytelling platforms	Embeds cultural values in literacy practices

Table 2. Summarizes the dual benefits of an ethnomathematical approach, showing its impact on student learning outcomes and broader social-environmental goals.

Dimension	Benefits for Students	Benefits for Environment & Society
Cultural relevance	Increases motivation and engagement	Preserves cultural heritage
Numeracy skills	Enhances contextual problem-solving	Promotes practical applications in daily life
Digital literacy	Encourages 21st-century skills	Reduces paper-based learning, eco-friendly
Sustainability awareness	Connects math with environmental contexts	Supports SDGs (Education & Climate Action)

The findings reveal that integrating local wisdom into numeracy literacy learning significantly enhanced students' engagement and comprehension of mathematical concepts. Three main results emerged:

1. **Contextualization of Numeracy Through Local Practices**

Students demonstrated greater interest when mathematical lessons were linked to familiar cultural activities such as weaving, traditional games (*engklek*), and agricultural measurement systems. For example, learning fractions through batik patterns encouraged not only mathematical understanding but also cultural appreciation.

2. **Digital Media as a Bridge Between Tradition and Innovation**

Teachers effectively used mobile applications, digital storytelling, and interactive simulations to translate cultural practices into modern learning experiences. This integration enabled students to see connections between traditional practices and contemporary problem-solving. Digital media also improved accessibility by providing reusable, eco-friendly resources.

3. **Emergence of Sustainability Awareness**

Activities designed around traditional resource management, such as agricultural cycles or communal trading systems, nurtured students' awareness of ecological responsibility. Students began to connect mathematical learning with issues of waste reduction, resource conservation, and environmental stewardship.

3.2 Discussion

The results highlight the transformative potential of combining ethnomathematics and digital pedagogy in creating a sustainable approach to numeracy literacy.

First, this approach directly supports SDG 4 (Quality Education) by providing inclusive and equitable learning opportunities. Culturally relevant pedagogy reduces alienation often caused by standardized, decontextualized curricula and promotes meaningful learning outcomes. This echoes previous studies emphasizing that indigenous knowledge can foster deeper engagement and identity affirmation [5], [6], [12].

Second, the incorporation of cultural heritage into mathematics instruction contributes to SDG 11 (Sustainable Cities and Communities). Preserving traditional practices such as weaving patterns or agricultural calendars ensures that cultural knowledge remains alive in future generations while being adapted to modern educational systems. As [3], [13] argue, culturally sustaining pedagogy is essential to resilient and inclusive communities.

Third, connecting mathematics learning to ecological practices aligns with SDG 13 (Climate Action). By introducing students to sustainable resource management through numerical analysis of farming, trading, and communal rituals, the curriculum fosters ecological literacy. Students not only improve numeracy skills but also internalize environmental responsibility, a competency crucial for addressing climate challenges in the 21st century.

Finally, the use of digital technology ensures scalability and innovation. Interactive platforms transform traditional knowledge into engaging and accessible formats, reducing dependence on paper-based materials and thus supporting eco-friendly education systems. This dual focus on tradition and technology aligns education with both cultural preservation and environmental sustainability, positioning it as a catalyst for broader social transformation.

4 Conclusion

4.1 Conclusion

This study has demonstrated that the integration of local wisdom, ethnomathematics, and digital media can transform numeracy literacy learning into a culturally relevant and sustainability-oriented educational practice. By embedding traditional knowledge into mathematics instruction, students not only acquire essential numeracy skills but also develop cultural pride and ecological awareness. The findings highlight three critical outcomes: (1) contextualized numeracy enhances engagement and comprehension, (2) digital platforms effectively bridge cultural traditions with modern learning needs, and (3) sustainability awareness emerges when mathematics is linked to environmental and community-based practices.

Importantly, this approach contributes to multiple Sustainable Development Goals (SDGs). It advances SDG 4 (Quality Education) through inclusive and culturally responsive pedagogy, supports SDG 11 (Sustainable Cities and Communities) by preserving cultural heritage, and aligns with SDG 13 (Climate Action) by fostering ecological literacy and responsibility among young learners. Thus, the ethnomathematical approach not only enhances pedagogy but also strengthens education's role as a driver of sustainability and social resilience.

4.2 Policy Implications

The implications of this study extend to curriculum design, teacher training, and educational policy:

1. **Curriculum Development:** National and regional curricula should explicitly include local wisdom as a pedagogical foundation for literacy and numeracy learning. Embedding ethnomathematics within official frameworks ensures cultural continuity while strengthening contextual learning outcomes.
2. **Teacher Professional Development:** Teachers require training in culturally responsive pedagogy and digital literacy. Capacity-building programs should emphasize how to integrate traditional practices with digital tools, enabling educators to design engaging, eco-friendly learning experiences.
3. **Technology Integration:** Investment in digital platforms that support localized content creation is essential. Governments and schools should collaborate with local communities to digitize cultural practices—such as traditional games, batik patterns, and agricultural systems—into interactive learning resources.
4. **Sustainability-Oriented Education Policy:** Policymakers should recognize education as a central strategy for achieving sustainability goals. By connecting mathematics education to environmental awareness and cultural heritage, policies can promote both educational equity and long-term ecological resilience.
5. **Community Involvement:** Collaborative partnerships between schools and local communities are crucial. Active participation of cultural practitioners, parents, and local leaders ensures that educational practices remain authentic, sustainable, and responsive to societal needs.

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