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Nusantara Cultural Artifacts in Mathematics Education: A Systematic Literature Review on Ethnomathematics Integration

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Abstract
This study presents a systematic literature review exploring the integration of Nusantara cultural artifacts into mathematics education through the lens of ethnomathematics. The purpose of this review is to identify the forms and characteristics of Indonesian cultural artifacts that contain mathematical concepts, analyse their utilisation in learning, and map existing research gaps. A systematic review method was employed, synthesising literature published between 2020 and 2025 from reputable databases. The review process followed standard inclusion criteria focusing on empirical and theoretical studies within the Indonesian context. The results indicate that artifacts such as Batik motifs, traditional weaving (Anyaman), and the Pinisi ship embody complex mathematical concepts, including geometric transformations, arithmetic sequences, and ratios. Pedagogically, these artifacts serve as effective bridges between abstract mathematical formalism and students' cultural realities, enhancing literacy and character development. However, significant gaps remain, particularly the lack of longitudinal experimental studies and the underutilisation of digital technologies (AR/VR). This review concludes that future research must pivot towards developing integrative digital ethnomathematics models to foster global competence while preserving local wisdom.

Keywords: *Ethnomathematics; Nusantara Artifacts; Mathematics Education; Cultural Literacy; Systematic Literature Review*

1. Introduction

The diversity of Nusantara culture harbours a wealth of values, symbols, and mathematical thinking patterns concealed within various artifacts. These cultural assets reflect that mathematics is not merely a product of formal schooling but is intrinsically interwoven with the social activities and daily lives of the Indonesian people. This perspective aligns with the paradigm of *ethnomathematics*, defined as the study of the relationship between mathematics and culture, emphasising that mathematical knowledge evolves from specific social and cultural contexts.

In the Indonesian context, extensive research has uncovered mathematical concepts embedded in a wide array of cultural artifacts. For instance, sophisticated geometric concepts have been identified in historical structures such as the Borobudur Temple and Sanggrahan Temple (Jayanti & Puspasari, 2020; Utami et al., 2020), as well as in the architecture of forts and mosques which demonstrate the application of plane geometry (Istifada et al., 2023; Khayat, 2020). Beyond architecture, mathematical elements are prevalent in traditional games like marbles and *engklek*, which facilitate the understanding of counting and probability (Pratiwi & Pujiastuti, 2020;

Wulantina et al., 2020). Furthermore, studies on royal inscriptions in East Java reveal the use of measurement systems and numeric symbols (Cahyani & Budiarto, 2020), while exploration of historical artifacts in East Nusa Tenggara (NTT) highlights indigenous geometric logic (Litik & Argarini, 2023).

Moreover, the intersection of culture and mathematics extends to daily traditions. Recent studies have explored the symbolic geometry in traditional food arrangements like *Tabir Lamo* and the *Haroa* tradition of the Buton society, revealing algebraic and geometric principles (Jainuri et al., 2025; Sardin & Rosjanuardi, 2024). Similarly, the modelling of volume in traditional Buginese and Makassarese foods demonstrates the application of calculus concepts in local culinary practices (Busrah & Pathuddin, 2021). In the realm of craft, Javanese *Batik* serves as a profound medium for understanding geometric transformations and symmetry (Prahmana & D'Ambrosio, 2020; Risdiyanti & Prahmana, 2020; Sari & Nugroho, 2021), while traditional weaving (*Anyaman*) in Kalimantan and Kebumen exhibits complex arithmetic sequences and proportions (Mubarok, 2024; Rahayu et al., 2023; Rinda, 2023).

Despite this richness, a systematic synthesis of how these artifacts are integrated into pedagogy remains fragmented. A recent systematic review by Hendriyanto et al. (2023) highlighted the growing trend of ethnomathematics but noted inconsistencies in methodological rigour. Additionally, while digital learning is advancing, meta-analyses suggest that the integration of ethnomathematics with digital tools remains an emerging field requiring further validation (Mauladaniyati et al., 2025). Most existing studies are descriptive-explorative, often lacking a cohesive theoretical framework connecting artifacts to cognitive outcomes or character formation as mandated by the *Kurikulum Merdeka* (Supriadi & Andayani, 2022).

Most existing studies are descriptive-explorative, often lacking a cohesive theoretical framework connecting artifacts to cognitive outcomes or character formation as mandated by the *Kurikulum Merdeka*. Unlike recent reviews that broadly map ethnomathematics trends (Hendriyanto et al., 2023), this study specifically isolates 'physical artifacts' as a distinct variable. The novelty of this review lies in its synthesis of how these artifacts function dually: as cognitive scaffolds that visualize abstract mathematical formalism (e.g., geometry, ratio) and as cultural anchors that foster character development. This specific intersection has not been comprehensively mapped in previous literature.

Therefore, this article aims to provide a systematic review of the relationship between Nusantara cultural artifacts and mathematics learning. Specifically, this review seeks to: (1) identify the characteristics of artifacts containing mathematical concepts; (2) analyse their pedagogical utilisation; (3) highlight critical research gaps; and (4) discuss the implications for mathematical literacy and character formation.

2. Method

2.1. Research Design

This study adopts a Systematic Literature Review (SLR) design. The review protocol follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement to ensure transparency, accuracy, and reproducibility of the findings (Page et al., 2021). This method allows for the rigorous identification, evaluation, and synthesis of all available research relevant to the integration of Nusantara artifacts in mathematics education.

2.2. Search Strategy

A comprehensive search was conducted across major academic databases, primarily Scopus, Google Scholar, and SINTA (Science and Technology Index) accredited journals. The search focused on literature published between 2020 and 2025 to ensure the relevance and currency of the findings. The search strings utilised Boolean operators, including: ("Ethnomathematics" OR "Culture") AND ("Mathematics Education" OR "Learning") AND ("Indonesia" OR "Nusantara" OR "Artifacts")

2.3. Inclusion and Exclusion Criteria

To ensure the quality of the review, the following criteria were applied:

- Inclusion: Peer-reviewed journal articles and conference proceedings; studies explicitly discussing Indonesian cultural artifacts; papers written in English or Indonesian; and studies focusing on pedagogical implications.
- Exclusion: Non-empirical opinion pieces; studies predating 2020 (unless seminal); and research unrelated to mathematics education.

2.4. Data Analysis

Data extraction focused on the type of artifact, mathematical concepts involved, pedagogical approach, and key findings. A thematic synthesis approach was used to categorise findings into distinct themes: visual-geometric characteristics, structural-proportional characteristics, and pedagogical impacts.

3. Results and Discussion

3.1. Characteristics of Nusantara Cultural Artifacts in Mathematics

The synthesis of the literature reveals that Nusantara artifacts possess multidimensional characteristics that embody mathematical concepts. These can be categorised into visual-geometric, structural-proportional, and functional-practical characteristics.

Table 1. Synthesis of Key Studies on Artifacts and Mathematical Concepts

No	Researcher (Year)	Cultural Artifact	Mathematical Concepts	Key Findings
1	Prahmana & D'Ambrosio (2020)	Yogyakarta Batik Motifs	Geometric transformation, symmetry, tessellation	Batik motifs facilitate the learning of translation, rotation, and reflection through ethnography-based contextual learning.
2	Rinda (2023)	Dayak Taman Weaving	Number patterns, ratio, proportion	Weaving activities involve arithmetic sequences and geometric proportions naturally developed by the community.
3	Akbar, Herman, & Suryadi (2023)	Pinisi Ship	Ratio, proportion, similarity, angles	The construction of Pinisi ships involves precise ratios and geometric similarity essential for hydrodynamic stability.
4	Mubarok (2024)	Pandan Weaving	Social arithmetic, measurement	Crafting involves social arithmetic (cost, profit) and measurement efficiency.
5	Suryani & Pratama (2025)	Digital Artifacts	3D Visualisation, Geometry	Integration of AR and VR allows for the interactive visualisation of cultural artifacts.

3.2. Pedagogical Utilisation and Implications

The review indicates that artifacts serve as a bridge between tradition and modernity. For instance, *Batik* is not merely decorative but represents a formal mathematical structure involving tessellation and transformation functions. To properly contextualize this in a mathematical setting, consider the *Pinisi* ship. In the classroom, this artifact serves as more than a historical reference; it acts as a practical medium for teaching Ratio and Proportion. As highlighted by Akbar et al. (2023), the construction requires precise geometric ratios for stability. Teachers can utilise this by presenting the ratio of the *Pinisi* mast height to its keel length as a problem-solving task in Similarity (*Kesebangunan*). Students are tasked to calculate scale factors and verify geometric angles, thereby transforming a cultural narrative into a rigorous mathematical analysis. Similarly, the *Pinisi* ship offers a tangible context for teaching trigonometry and similarity, proving that traditional practices contain applied mathematics.

3.2.1. Implication for Mathematical Literacy

Using artifacts allows students to formulate, employ, and interpret mathematics within a familiar context. This process, known as *mathematisation*, fosters reasoning that transitions from concrete cultural observation to abstract symbolic generalisation. *Batik* is not merely decorative but represents a formal mathematical.

3.2.2. Implication for Character and Cultural Literacy

Integration of these artifacts supports the *Profil Pelajar Pancasila* (Pancasila Student Profile). Learning through culture instils values such as cooperation (*gotong royong*), perseverance, and respect for local wisdom. It fosters cultural awareness, allowing students to appreciate the intellectual heritage of their ancestors.

3.3. Research Gaps and Future Directions

Despite the progress, this review identifies significant gaps in the existing literature.

Table 2. Identification of Research Gaps

No	Domain	Identified Gap	Implication for Future Research
1	Methodological	Predominance of descriptive-explorative studies; lack of experimental designs.	Need for quasi-experimental and longitudinal studies to measure learning outcomes quantitatively.
2	Conceptual	Lack of integrative theoretical models linking culture, cognition, and mathematics.	Development of a comprehensive 'Ethno-Based Mathematical Learning Model'.
3	Technological	Limited implementation of digital tools (AR/VR) in ethnomathematics.	Design and testing of digital ethnomathematics applications (e.g., AR-based artifact exploration).
4	Evaluative	Absence of standardised assessment instruments for ethno-mathematical literacy.	Creation of valid rubrics assessing both mathematical competency and cultural values.

The analysis suggests that while the "what" (content) of ethnomathematics is well-documented, the "how" (effectiveness and mechanism) requires more rigorous investigation. The current body of work establishes a strong foundation but necessitates a shift towards *Design and Development Research* (DDR) and digital integration to remain relevant in the 21st century.

4. Conclusion

This systematic review confirms that Nusantara cultural artifacts—ranging from *Batik* and weaving to maritime architecture—are rich repositories of mathematical knowledge, encompassing geometry, arithmetic, and proportion. The integration of these artifacts into education serves a dual purpose: enhancing mathematical conceptual understanding through contextualisation and fostering cultural identity and character.

However, the field is currently characterised by a preponderance of qualitative explorations. To advance, future research must bridge the identified gaps by: (1) developing integrative pedagogical models that are empirically tested; (2) leveraging digital technologies like Augmented Reality to visualise artifacts; and (3) conducting comparative studies across the diverse cultures of the Indonesian archipelago. By addressing these areas, ethnomathematics can evolve from a pedagogical alternative to a central pillar of a humanistic and culturally grounded mathematics education system.

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Ethical Statement

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Conflict of Interest Statement

The authors declare no conflict of interest.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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