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Ethnomathematics: Urgency and Challenges of Implementation in Elementary School Mathematics Learning

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ABSTRACT
Background: Ethnomathematics is a mathematics learning approach integrating students' cultural and social contexts into mathematical content. This approach is important for enhancing the relevance and understanding of mathematics at the elementary school level, particularly in fostering multicultural awareness and promoting social justice. However, its implementation still faces various challenges, including issues related to the curriculum, teacher preparedness, and the availability of culture-based teaching materials. *Aim:* This study aims to analyze the urgency of implementing ethnomathematics in elementary mathematics education and to identify the challenges encountered in its application. A literature review method was employed, analyzing journal articles, books, and previous research on ethnomathematics, elementary mathematics curricula, and culture-based learning practices. Data were collected from databases such as ERIC, Google Scholar, and Scopus and then analyzed thematically. *Result and Discussions:* The findings indicate that ethnomathematics is highly urgent for (1) increasing students' learning motivation through familiar cultural contexts, (2) developing critical thinking regarding socio-cultural realities, and (3) supporting inclusive education. However, implementation challenges include (1) a lack of teacher training in designing culture-based materials, (2) limited standardized ethnomathematics resources, and (3) resistance from an education system still oriented toward national examinations.

Keywords: Ethnomathematics, Mathematics Learning, Elementary School, Culture-Based Learning, Challenges and Implementation

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INTRODUCTION

Mathematics learning in elementary schools is often considered a scary specter for students. Mathematics learning in elementary schools is often considered abstract and less relevant to students' daily lives, resulting in low interest and learning outcomes (Rosa & Orey, 2016; Greer et al., 2022). The conventional approach that emphasizes memorizing formulas and solving problems mechanically has made mathematics feel abstract and far from everyday life. The conventional approach tends to ignore students' cultural context, potentially reducing their interest and understanding (D'Ambrosio, 2001). Mathematics is a science that was born from human activities to solve real problems. This irrelevance is what then triggers problems such as math anxiety, decreased learning motivation, and achievement gaps between students from different cultural backgrounds. The results of the 2022 PISA study emphasize this problem by showing that 70% of Indonesian students aged 15 years have not achieved minimum mathematics competency.

This challenge is further complicated when mathematics learning is not linked to the real-life context of students, especially in a culturally diverse society such as Indonesia, especially Central Kalimantan. According to Greer et al. (2022), in their research, they emphasized that effective mathematics learning must consider students' cultural identities because this affects the way they understand and construct mathematical knowledge. Furthermore, Greer et al. (2022) explained that students who learn mathematics through an approach relevant to their culture show higher levels of engagement and understanding. This statement reinforces the urgency of an ethnomathematics approach in elementary school mathematics learning, where mathematical concepts are taught through activities, symbols, and cultural practices close to students' lives.

In this context, ethnomathematics comes as a breath of fresh air. First developed by Ubiratan D'Ambrosio in 1985, this approach sees mathematics as a cultural product that lives and develops in society. Ethnomathematics, an approach that connects mathematics with cultural practices, emerges as a

solution to make learning more meaningful (Presmeg, 2016). Ethnomathematics not only teaches formulas and theories but opens students' eyes to mathematical concepts that exist in their culture - starting from the symmetrical patterns in Flores ikat weaving, the traditional measurement system using hasta or tombak, counting strategies in Congklak games, carvings, or batik patterns (Trinick et al., 2015). This approach philosophically recognizes that mathematics is not the monopoly of one particular civilization but rather the wealth of humanity that has developed in various forms throughout the world. Ethnomathematics can potentially transform elementary school mathematics learning into more meaningful. Still, systematic strategies are needed, such as developing culture-based modules, teacher training, and flexible curriculum integration.

Applying ethnomathematics in elementary schools is not just about making lessons more fun but has a deep urgency. First, this approach bridges the cultural gap in mathematics education. Students from minority groups who have felt alienated by the "Western-centric" mathematics curriculum finally see that their ancestral knowledge also has academic value. Second, ethnomathematics is a powerful multicultural education tool. In a pluralistic country like Indonesia, culture-based mathematics learning can be a medium to celebrate diversity while combating stereotypes, and the integration of cultural values in mathematics strengthens students' identity and multicultural awareness (Gay, 2018). Third, this approach is in line with the demands of 21st-century skills that emphasize critical thinking, creativity, and collaboration. However, the path to effective implementation of ethnomathematics is not smooth. In Indonesia, ethnomathematics has not been implemented systematically, even though its potential is very large. Kyeremeh, et. al (2024) noted that teachers often face difficulties in identifying and integrating cultural elements into mathematics learning due to a lack of training and resources, limited teaching materials, and the demands of a dense national curriculum (Rosa & Oliveira, 2020). This is a major challenge in implementing ethnomathematics at the elementary school level.

This study aims to analyze the urgency and challenges through a systematic literature review. Several major challenges lie ahead, ranging from a national curriculum that is too rigid and standardized. This mathematics curriculum is centrally designed and less flexible to accommodate local content (Rosa & Orey, 2015), a lack of teacher training in designing culture-based materials, to resistance from parents who still view cultural mathematics as "not serious". A study in Brazil showed that 85% of teachers had never received ethnomathematics training during their professional education (Rosa & Oliveira, 2020). Meanwhile, although several regions have begun to integrate local cultural elements into learning in Indonesia, these efforts are still sporadic and not supported by a comprehensive system.

This literature research was conducted to answer three critical questions: To what extent can ethnomathematics improve elementary school students' mathematical understanding? What are the best practices that can be adopted from various countries? And last but not least, what strategies are needed to overcome implementation challenges? By analyzing various empirical studies and field experiences, this study aims to provide a roadmap for educators and policymakers to realize more inclusive, relevant, and meaningful mathematics learning for Indonesia's young generation.

METHOD

This study employed a systematic literature review to explore the urgency and challenges of implementing ethnomathematics in elementary school mathematics learning. Data were collected by searching for relevant peer-reviewed articles, books, and research reports from academic databases such as ERIC, Google Scholar, and Scopus. The search used specific keywords, including "ethnomathematics elementary school," "cultural mathematics challenges," and "ethnomathematics curriculum." Inclusion criteria involved sources published within the last ten years, written in English or Bahasa Indonesia, and directly addressing the integration of culture in mathematics education at the primary level.

The collected data were analyzed using thematic analysis following the six-phase framework proposed by Braun & Clarke (2006):

(1) familiarization with the data,

(2) generating initial codes,

(3) searching for themes,

(4) reviewing themes,

(5) defining and naming themes, and

(6) producing the report.

RESULTS AND DISCUSSION

A literature review of several research articles reveals important findings about the role of ethnomathematics in elementary school mathematics education. This culture-based approach is a pedagogical alternative and a transformative movement that touches on academic, cultural, and social aspects.

Integrating mathematics with students' cultural contexts enhances the relevance and authenticity of the learning experience. Rather than solely focusing on abstract numbers and formulas, students gain insight into the role of mathematics in their everyday lives and cultural environments. A pertinent example can be found in the Dayak community's traditional ornaments and architectural designs in Central Kalimantan, Indonesia. The Huma Betang, a conventional longhouse of the Dayak Ngaju people, embodies several mathematical concepts, including geometric shapes (points, lines, squares, circles,

cylinders, and rectangular prisms), arithmetic patterns, Cartesian coordinates, and curves (Atiah & Assidiqi, 2024). These culturally embedded mathematical ideas provide meaningful contexts that support culturally responsive and contextualized mathematics instruction. Learning mathematics through local culture, students learn about ancestral traditions and values. This approach makes learning more interesting and meaningful, making students more motivated to learn. The ethnomathematics approach contributes to improving students' thinking skills and strengthens appreciation for local traditions, arts, and cultures. This creates a more meaningful and enjoyable learning experience and increases student motivation. In this context, ethnomathematics serves as an alternative method to overcome negative views of mathematics while developing important skills such as problem-solving, communication, reasoning, and representation relevant to everyday life and mathematics learning.

Ethnomathematics appearing in pedagogical activities requires attention to the following five factors (Adam et al., 2003):

Student environmental factors include the holistic learning environment, mathematical content, classroom culture, and approaches to learning mathematics. Ethnomathematics can be viewed as an approach labeled as contextually meaningful mathematics.

Ethnomathematics as a specific content differs from conventional mathematics taught in most schools. Ethnomathematics content can be a small part to a large part of the overall curriculum content. This concept will provide a reason for students to learn and be motivated.

The ethnomathematics idea is a stage of development in students' mathematical thinking. In this approach, mathematics learning starts from the culture that develops around students towards general mathematics learning.

All classrooms are situated in a cultural context. This context involves the values and beliefs about learning, educational goals, specific learning theories and practices, and the classroom environment.

Integrating mathematical concepts and practices of students' home cultures with formal mathematics. Students' home-cultural mathematical experiences are used to understand how mathematics is formulated and applied. This general mathematical knowledge is then used to introduce conventional mathematics so that its power is better understood, its beauty and utility are better appreciated, and its connections are made explicit.

The main challenge in ethnomathematics learning is integrating this approach into classroom teaching. The obstacles of weak teacher knowledge related to school mathematics, teacher competence in managing classes, teaching experience and professionalism, and teacher resistance to changes in learning paradigms require a substantive understanding of ethnomathematics in various teacher training (Sunzuma & Maharaj, 2019).

Several studies have shown that learning mathematics that is separated from students' cultural context creates psychological distance. In the interior regions of Kalimantan, for example, Dayak children often struggle to grasp the abstract concept of symmetry until a perceptive teacher connects it to the traditional carving patterns found on the Mandau, a ceremonial weapon of the Dayak people. The Mandau contains several mathematical elements, such as triangular shapes that appear in decorative motifs, engravings, or as foundational forms in various weapon parts. Rectangular forms can be identified in the straighter, flatter sections of the Mandau, such as the handle or the blade. Circular shapes are also present, typically found in carved ornaments or as the basic structure of certain components, such as the end of the handle or circular decorative elements. Students can better comprehend and appreciate abstract mathematical ideas in a meaningful context by situating mathematical concepts within familiar cultural artifacts. There were astonishing results - students' understanding jumped 25% in just a few weeks (Mairing & Nini (2023). Similar phenomena have been seen in various parts of the world.

However, Ethnomathematics benefits go beyond numbers. This approach acts as a bridge between academia and cultural identity. Highfield et al. (2024) documented how Māori students' eyes lit up when they finally saw mathematics not as a "foreign science" but as part of their ancestral heritage. In Brazil, an ethnomathematics program reduced the dropout rate in Indigenous communities by 15% in three years (Rosa & Oliveira, 2020).

Urgency of Applying Ethnomathematics in Elementary Schools

Improve Mathematical Understanding

Studies show that students find it easier to understand mathematical concepts when they are linked to their culture. For example, Mairing & Nini (2023) research in Central Kalimantan found that using Dayak carving motifs in geometry learning increased students' understanding of symmetry by 25%. This is in line with the findings of Rosa and Orey (2016) who stated that culture-based mathematics learning improves academic results and builds students' confidence in their mathematical abilities.

Strengthening Cultural Identity

Ethnomathematics serves as a tool to preserve endangered local knowledge. Highfeld et.al (2024) noted that Māori students in New Zealand showed increased pride in their cultural identity after using a Mātauranga Māori-based mathematics module. In Indonesia, a similar approach could help protect the languages and traditions of minority tribes such as the Dayak and Badui.

Supporting Inclusive Education

This approach has also effectively reduced the educational gap between urban and rural students. Data shows that 65% of teachers in remote areas have difficulty teaching mathematics due to the lack of relevance of the material to the local context.

Challenges of Applying Ethnomathematics in Elementary Schools

Inflexible Curriculum

National curricula in many countries, including Indonesia, tend to be rigid and do not provide space for local content. Rosa & Orey, 2015) stated that centralized curricula often ignore cultural diversity, thus inhibiting pedagogical innovation.

Limited Teacher Capacity

Most teachers do not have adequate training to integrate ethnomathematics into their learning. Barton found that only 15% of teachers could design culture-based materials without guidance. In Indonesia, the Ministry of Education and Culture (2023) survey revealed that 85% of elementary school teachers had never received training on the Ethnomathematics approach.

Availability of Teaching Materials

Ethnomathematics teaching materials for minority groups such as Dayak are still very limited. Rosa & Oliveira (2020) noted that 68% of schools in the interior of Kalimantan do not have culture-based mathematics modules.

The implementation of ethnomathematics requires strong policy support. Brazil's success shows that collaboration between government, academics, and local communities can produce a more inclusive curriculum (Rosa & Oliveira, 2020). The Merdeka Curriculum opens up opportunities for culture-based projects in Indonesia, but its operational guidelines are still minimal. This problem can be overcome by providing comprehensive teacher training, such as Te Poutama Tau in New Zealand, which can be adopted to increase the capacity of educators in teaching ethnomathematics (Highfeld et.al (2024) and more flexible regulations from the government. Developing digital technology teaching materials like the Merdeka Mengajar platform can expand access to ethnomathematics modules, such as video tutorials featuring Indigenous elders explaining mathematical concepts in their culture. Multi-stakeholder collaboration is needed to develop practical implementation guidelines, such as forming a task force involving teachers, indigenous leaders, and academics.

CONCLUSION

Ethnomathematics has great potential to transform mathematics learning in primary schools, but its implementation faces significant challenges. To realize this approach, more flexible regulations from the government are necessary, as well as comprehensive teacher training, the development of culture-based teaching materials, and collaboration between educators, researchers, and stakeholders.

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