

Implementation of Ethnomathematics-Based Learning in Developing the Science and Mathematics Competencies of Muhammadiyah Students

¹⁾Tri Bangun Utami, ²⁾Heny Sri Astutik ³⁾Alman

^{1,2,3)} Pedagogy, Universitas Pendidikan Muhammadiyah Sorong, Sorong

Email: tribangunutami@unimudasorong.ac.id

*Correspondence Author: tribangunutami@unimudasorong.ac.id

Article Info

Keywords:

ethnomathematics,
culture-based learning,
science competencies,
mathematics
competencies, contextual
learning, elementary
school

ABSTRACT

This study aims to describe and analyze the implementation of ethnomathematics-based learning in developing students' science and mathematics competencies at Muhammadiyah Malawili Elementary School. The study was motivated by students' low conceptual understanding, which is attributed to instructional practices that remain predominantly abstract and lack contextual relevance. A qualitative approach with a case study design was employed. The research participants consisted of fourth-grade teachers, students from Classes 4A and 4B, and the school principal. Data were collected through semi-structured interviews, participant observation, and document analysis, and were analyzed using the interactive model developed by Miles, Huberman, and Saldaña.

The findings indicate that ethnomathematics-based learning effectively contextualizes mathematical and scientific concepts through the integration of local cultural practices, thereby enabling students to develop a more concrete understanding of these concepts. The major findings include: (1) the effective use of cultural artifacts as instructional media; (2) the pivotal role of teachers in mediating the relationship between local culture and scientific concepts; (3) increased student engagement and learning motivation; (4) the integrated development of science and mathematics competencies; and (5) challenges in implementation, particularly regarding teachers' preparedness and the availability of culturally relevant learning resources.

This study contributes to strengthening ethnomathematics as a contextual and pedagogically relevant approach to 21st-century education. The implications highlight the need to enhance teachers' professional capacity, develop culture-based instructional materials, and strengthen school policies that support the integration of local culture into classroom learning. Future research is recommended to investigate the implementation of ethnomathematics across broader and more diverse educational contexts.

Informasi Artikel

Kata Kunci:

etnomatematika,
pembelajaran berbasis
budaya, kompetensi
sains, kompetensi
matematika,
pembelajaran
kontekstual, sekolah
dasar

ABSTRAK

Penelitian ini bertujuan untuk mendeskripsikan dan menganalisis implementasi pembelajaran berbasis etnomatematika dalam mengembangkan kompetensi sains dan matematika siswa di SD Muhammadiyah Malawili. Penelitian ini dilatarbelakangi oleh rendahnya pemahaman konseptual siswa akibat pembelajaran yang masih bersifat abstrak dan kurang kontekstual. Pendekatan yang digunakan adalah kualitatif dengan desain studi kasus. Subjek penelitian terdiri dari guru kelas IV, siswa kelas 4A dan 4B, serta kepala sekolah. Data dikumpulkan melalui wawancara semi-terstruktur, observasi partisipatif, dan dokumentasi, kemudian dianalisis menggunakan model interaktif Miles, Huberman, dan Saldaña. Hasil penelitian menunjukkan bahwa pembelajaran berbasis etnomatematika mampu mengontekstualisasikan konsep matematika dan sains melalui budaya lokal, sehingga membantu siswa memahami konsep secara lebih konkret. Temuan utama meliputi: (1) penggunaan artefak budaya sebagai media pembelajaran yang efektif, (2) peran penting guru dalam memediasi hubungan antara budaya dan konsep ilmiah, (3) peningkatan keterlibatan dan motivasi belajar siswa, (4) pengembangan kompetensi sains dan matematika secara terpadu, serta (5) adanya tantangan dalam implementasi, terutama terkait kesiapan guru dan ketersediaan sumber belajar. Penelitian ini berkontribusi dalam memperkuat etnomatematika sebagai pendekatan pedagogis yang kontekstual dan relevan dengan pembelajaran abad ke-21. Implikasi penelitian ini mencakup perlunya penguatan kapasitas guru, pengembangan media berbasis budaya, serta dukungan kebijakan sekolah dalam mengintegrasikan budaya lokal ke dalam pembelajaran. Penelitian selanjutnya disarankan untuk mengkaji implementasi etnomatematika pada konteks yang lebih luas dan beragam.

Article History

Received : 15/03/2026
Revised : 28/05/2026
Accepted : 21/07/2026

✉ **Corresponding Author:** (1) Tri Bangun Utami (2) Department of Pedagogy, (3) Institution of Universitas Pendidikan Muhammadiyah Sorong, (4) Sorong, Indonesia, (5) Email: tribangunutami@unimudasorong.ac.id

1. Introduction

Twenty-first-century education requires the integration of cognitive, social, and cultural competencies into the learning process, particularly in science and mathematics education. Globally, mathematics instruction continues to be characterized by abstract teaching practices that are often disconnected from students' real-life contexts, resulting in limited conceptual understanding and low levels of numeracy literacy. International studies have demonstrated that culturally contextualized approaches, such as ethnomathematics, can bridge the gap between mathematical concepts and students' everyday experiences [1], [2].

In the Indonesian context, numerous reports indicate that students' mathematical literacy remains relatively low compared with that of students in many other countries. This situation is further reinforced by findings showing that mathematics instruction in elementary schools is predominantly procedure-oriented and emphasizes memorization rather than deep conceptual understanding [3], [4]. These conditions highlight the urgent need for more contextual and meaningful instructional approaches, particularly those capable of integrating local cultural values into classroom learning.

Ethnomathematics has emerged as an innovative pedagogical approach that connects mathematical concepts with the cultural practices of local communities. Beyond serving as an instructional strategy, it also functions as a means of preserving local cultural heritage. Previous studies have shown that integrating ethnomathematics into classroom instruction enhances students' mathematical understanding, critical thinking skills, and appreciation of cultural values [5], [6]. Within elementary education, this approach is particularly relevant because students at this developmental stage benefit from concrete and contextual learning experiences.

Furthermore, ethnomathematics-based learning is closely associated with science education. Scientific concepts are often embedded in cultural practices, including patterns, measurement systems, and numerical representations found in everyday community activities. Consequently, ethnomathematics has the potential to foster the simultaneous development of science and mathematics competencies through authentic learning experiences [2], [7].

Despite its potential, the implementation of ethnomathematics in classroom practice continues to face several challenges. Previous studies have reported that teachers often experience difficulties in identifying cultural elements relevant to mathematical concepts and in designing effective ethnomathematics-based instructional activities [2], [8]. In addition, most existing research has focused primarily on quantitative measures of learning outcomes, providing limited insight into the learning processes, experiences, and meanings constructed by students and teachers during ethnomathematics-

based instruction.

Empirical evidence from qualitative studies suggests that the implementation of ethnomathematics can significantly enhance student engagement in learning. For example, research conducted in Indonesia found that students became more active and enthusiastic when mathematical concepts were linked to local cultural practices, such as traditional crafts, dances, and community traditions [6], [9]. Classroom observations in several elementary schools also revealed that students were able to relate mathematical concepts to their real-life experiences, although they continued to require intensive guidance from teachers throughout the learning process.

Within Muhammadiyah schools, which emphasize Islamic values alongside cultural education, the integration of ethnomathematics becomes particularly relevant. Muhammadiyah schools possess considerable potential to develop instructional practices that promote not only cognitive achievement but also character development and cultural identity. Nevertheless, studies specifically examining the implementation of ethnomathematics in Muhammadiyah elementary schools remain limited.

A significant research gap also exists regarding the limited number of qualitative studies investigating the implementation of ethnomathematics-based learning. Most previous studies have concentrated on measurable outcomes, such as improvements in students' test scores, while paying relatively little attention to how learning interactions occur, how students interpret their learning experiences, and how teachers adapt ethnomathematics within authentic classroom settings [1], [8].

Based on these considerations, further investigation is needed to explore in depth the implementation of ethnomathematics-based learning in developing students' science and mathematics competencies. A qualitative approach was selected because it provides a comprehensive understanding of the learning process, participants' experiences, and the dynamics of classroom interactions, including the relationships among teachers, students, and the cultural contexts that shape the learning environment.

Therefore, this study aims to describe and analyze the implementation of ethnomathematics-based learning in developing the science and mathematics competencies of students at Muhammadiyah Malawili Elementary School, with particular attention to Classes 4A and 4B. The study focuses on the instructional process, students' learning experiences, and teachers' roles in integrating cultural values into classroom instruction. Theoretically, this research is expected to enrich the body of qualitative scholarship on ethnomathematics. Practically, its findings are anticipated to serve as a valuable reference for teachers and educational practitioners in designing contextual, meaningful, and culturally responsive learning environments.

2. Literature Review

Ethnomathematics serves as the primary theoretical foundation of this study, as it conceptualizes mathematics not as an isolated body of knowledge but as knowledge that emerges from the social practices, symbols, language, and cultural traditions of communities. Contemporary scholarship views ethnomathematics not merely as an effort to identify mathematical elements embedded within cultural practices, but also as a pedagogical approach for developing contextualized, meaningful, and experience-based learning environments [13], [14]. In the context of elementary education, this approach is particularly appropriate because students are at the concrete operational stage of cognitive development, enabling them to understand mathematical concepts more effectively when these are presented through familiar objects, activities, and cultural experiences.

Conceptually, ethnomathematics can be defined as an approach to understanding, representing, and teaching mathematics through local cultural practices. Recent literature suggests that ethnomathematics should not be regarded simply as the incorporation of local cultural content into the curriculum; rather, it represents an epistemological framework that bridges formal school knowledge with the knowledge systems embedded within local communities [14], [15]. Accordingly, the implementation of ethnomathematics-based learning in this study is understood as an instructional process that integrates local cultural activities, artifacts, values, and practices into science and mathematics learning, thereby enabling students to construct meaningful understandings of the concepts they learn.

From the perspective of learning theory, ethnomathematics is closely aligned with constructivism. Constructivist theory emphasizes that knowledge is actively constructed by learners through their interactions with the environment, personal experiences, and social dialogue. Within this framework, culture is not merely a background context for learning but rather a valuable source of learning experiences that enables students to interpret mathematical and scientific concepts in ways that are both personally meaningful and contextually relevant. Evidence from systematic reviews indicates that ethnomathematics-based instruction is most effective when teachers provide opportunities for students to establish connections between formal mathematical concepts and the cultural practices with which they are familiar [13], [16]. Thus, learning extends beyond the transmission of formulas and procedures toward the construction of meaningful conceptual understanding.

In addition to constructivism, this study is also informed by the perspective of culturally responsive teaching, which recognizes students' cultural identities as valuable pedagogical assets. This perspective is particularly relevant within Muhammadiyah elementary schools, where education emphasizes not only academic achievement but also the

development of values, character, and socio-religious identity. In culturally responsive classrooms, teachers function as mediators who connect formal school knowledge with students' cultural experiences, thereby fostering more inclusive, meaningful, and empowering learning environments [17], [18]. Consequently, ethnomathematics in this study is understood not merely as an alternative instructional strategy, but as a pedagogical approach that promotes appreciation of local culture while simultaneously supporting the development of students' academic competencies.

In relation to science education, the integration of ethnomathematics has become increasingly relevant because many local cultural practices embody concepts of measurement, classification, patterns, estimation, spatial relationships, observation of natural phenomena, and practical problem-solving. The Ethno-STEM literature emphasizes that local culture can serve as a bridge for fostering integrated scientific and mathematical literacy [19]. In other words, ethnomathematics-based learning enables students to recognize that science and mathematics are not merely school subjects but are also embedded in the everyday practices of their communities. Within the context of this study, this perspective is particularly important because the research seeks not only to examine mathematics as a learning outcome but also to explore how students' science and mathematics competencies develop through culturally grounded learning experiences.

The operational definition of the implementation of ethnomathematics-based learning in this study refers to the processes of planning, instructional delivery, classroom interaction, and reflection that connect science and mathematics content with relevant elements of local culture. Since this study adopts a qualitative approach, implementation is not examined through causal relationships among variables, as is common in quantitative research. Instead, it is explored through the processes, meanings, experiences, and instructional practices that emerge in the classroom. Accordingly, the analysis focuses on how teachers select cultural contexts, how students respond to these contexts, and how classroom interactions contribute to the development of students' science and mathematics competencies.

In this study, mathematical competence is defined as students' ability to understand concepts, recognize patterns, represent ideas, apply logical reasoning, and solve problems in meaningful contexts. Science competence, on the other hand, is understood as students' ability to observe, compare, classify, explain phenomena, and draw conclusions based on simple empirical experiences. Recent studies indicate that ethnomathematics-based learning can strengthen numeracy literacy, critical thinking, and conceptual understanding when instructional content is connected to authentic cultural contexts [20], [21]. Therefore, these two competencies are not treated as separate constructs in this study; rather, they are viewed as

interconnected learning outcomes that develop simultaneously through classroom practice.

The implementation of ethnomathematics-based learning was analyzed using four key indicators. First, cultural contextualization, referring to the extent to which teachers incorporate local cultural artifacts, activities, or practices as learning contexts. Second, teachers' pedagogical mediation, which encompasses how teachers explain concepts, facilitate discussions, and connect cultural contexts with formal science and mathematics concepts. Third, student engagement, reflected in students' participation, responses, curiosity, and ability to relate their own experiences to cultural contexts. Fourth, the emergence of science and mathematics competencies, demonstrated through students' abilities to identify concepts, reason logically, measure, observe, and solve problems. These indicators are consistent with evaluative findings concerning pedagogical quality in ethnomathematics practices [17].

Within a broader theoretical framework, this study is also informed by contextual learning theory. This theory argues that learning becomes more effective when instructional content is connected to students' real-world experiences. However, recent studies caution that the notion of 'context' should not be interpreted superficially as merely providing everyday examples; rather, it should be understood as a system of meanings embedded within students' cultural experiences [15], [18]. This criticism is significant because many instructional practices claim to be culturally based while merely attaching cultural labels to learning tasks without genuinely engaging with students' cultural meanings and lived experiences. This study seeks to move beyond such symbolic practices by examining the implementation of ethnomathematics-based learning in greater depth within authentic classroom settings.

The first previous study that serves as a primary reference is the research conducted by Larasati, Pramasdyahsari, and Harun (2025), which demonstrated that ethnomathematics-based learning contributes to improving elementary school students' numeracy skills [20]. This study is significant because it confirms the effectiveness of ethnomathematics at the elementary education level. However, its approach primarily focused on students' numerical learning outcomes and provided limited explanation of how the learning process unfolded, how students interpreted cultural contexts, and how teachers bridged local cultural practices with formal mathematical concepts. This gap is directly relevant to the qualitative focus of the present study.

The second study is the work of Effendi et al. (2025) on Ethno-STEM in science education, which argues that the integration of cultural contexts has considerable potential to enhance science learning by making it more meaningful and relevant [19]. This study provides an important theoretical foundation by demonstrating that culture can serve as a point of convergence between science, mathematics, and students' lived experiences.

Nevertheless, as a systematic literature review, it does not provide detailed descriptions of classroom implementation, particularly within elementary schools or faith-based educational settings such as Muhammadiyah schools. Therefore, the present study seeks to provide more contextualized and in-depth empirical evidence regarding the implementation of ethnomathematics-based learning.

The third study is the meta-analysis conducted by Putri et al. (2025), which found that multicontextual learning approaches—including ethnomathematics—have a positive effect on students' mathematical skills [21]. These findings reinforce the assumption that cultural contexts can serve as effective instructional media. However, because the study synthesized findings across multiple studies, it did not capture the concrete experiences of teachers and students during classroom instruction. In other words, previous studies have provided substantial evidence regarding the positive impacts of ethnomathematics but have offered relatively limited insight into how ethnomathematics-based learning is implemented, negotiated, and experienced by participants within authentic classroom settings.

Based on the foregoing discussion, the theoretical and empirical gaps addressed by this study can be identified in three areas. First, qualitative studies that examine the implementation of ethnomathematics-based learning in depth at the elementary school level remain limited. Second, relatively few studies have simultaneously examined the development of science and mathematics competencies within a single culture-based learning process. Third, Muhammadiyah schools have rarely been selected as the setting for ethnomathematics research, despite their distinctive educational philosophy, which integrates academic excellence, moral values, and character development. Accordingly, this study seeks to address these gaps by exploring the processes, experiences, and meanings associated with the implementation of ethnomathematics-based learning among students in Classes 4A and 4B at Muhammadiyah Malawili Elementary School.

Accordingly, the conceptual framework of this study positions ethnomathematics-based learning as a pedagogical process that connects local cultural contexts, teachers' pedagogical mediation, students' active engagement, and the development of science and mathematics competencies. Within this framework, culture functions as an epistemic context, teachers serve as mediators of meaning, and students act as active learners who construct knowledge through concrete learning experiences. This conceptual framework provides the foundation for the analysis of the study, particularly in interpreting how ethnomathematics-based learning is implemented, experienced, and understood at Muhammadiyah Malawili Elementary School, and how it contributes to the development of students' science and mathematics competencies.

3. Research Method

This study employed a qualitative approach using a case study design. This approach was selected because the research aims to gain an in-depth understanding of the implementation of ethnomathematics-based learning within an authentic classroom setting, including the interactions, experiences, and meanings constructed by teachers and students. A case study design enables researchers to explore a phenomenon holistically and contextually within a specific setting, making it particularly suitable for investigating the dynamics of classroom learning at Muhammadiyah Malawili Elementary School [23], [24].

The case study approach is also appropriate because the purpose of this research is not to generalize findings but rather to obtain an in-depth understanding of ethnomathematics-based instructional practices within a specific educational context. Accordingly, this study seeks to uncover the complexity of empirical realities from the perspectives of the participants, including how students make sense of their learning experiences and how teachers integrate cultural elements into classroom instruction [25].

The research was conducted at Muhammadiyah Malawili Elementary School, with a particular focus on Classes 4A and 4B. The site was selected because it possesses characteristics relevant to the objectives of the study, particularly its potential to integrate local cultural values and Islamic principles into classroom learning. Data collection was carried out during the second semester of the 2025/2026 academic year, allowing the researcher to observe the instructional process over an extended period.

The participants consisted of fourth-grade classroom teachers, students from Classes 4A and 4B, and supporting informants, including the school principal. Participants were selected using purposive sampling, whereby individuals who possessed the greatest knowledge of and direct involvement in the implementation of ethnomathematics-based learning were intentionally chosen. The selection criteria included: (1) teachers actively responsible for mathematics and science instruction, (2) students who participated in the learning activities, and (3) school administrators with an understanding of instructional policies and practices [24], [26].

Data were collected through three primary techniques: semi-structured interviews, participant observation, and document analysis. Semi-structured interviews were conducted to explore teachers' and students' experiences, perceptions, and understandings of ethnomathematics-based learning. This technique was selected because of its flexibility and its capacity to facilitate in-depth exploration of participants' responses [27].

Participant observation was employed to examine classroom learning processes directly, including teacher-student interactions, the use of cultural contexts during instruction, and students' responses to learning activities. The researcher

assumed the role of a limited participant observer, allowing natural classroom interactions to be observed without disrupting the instructional process. This method was essential for obtaining contextual and factual data regarding classroom practices [23], [28].

Document analysis was also used as a complementary source of data. The documents examined included lesson plans and teaching modules, students' learning products, photographs of classroom activities, and school records. These documentary sources served to corroborate findings obtained from interviews and observations while providing a more comprehensive understanding of the implementation of ethnomathematics-based learning.

To ensure the trustworthiness of the findings, the study employed both source triangulation and methodological triangulation. Source triangulation involved comparing information obtained from different participants, including teachers, students, and the school principal, whereas methodological triangulation involved comparing findings derived from interviews, observations, and document analysis. In addition, member checking was conducted by confirming the research findings with participants to ensure the accuracy and credibility of the researcher's interpretations [26], [29].

Beyond triangulation and member checking, the study also maintained an audit trail by systematically documenting every stage of the research process, from data collection through data analysis. This procedure was intended to enhance the transparency and credibility of the study while enabling readers to trace the research process in a logical and systematic manner.

Data were analyzed using the interactive model proposed by Miles, Huberman, and Saldaña, which consists of three major stages: data reduction, data display, and conclusion drawing and verification. Data reduction involved selecting, focusing, and simplifying information relevant to the research objectives. The reduced data were then organized and presented in the form of narrative descriptions, matrices, and thematic categories. Finally, conclusions were drawn iteratively and continuously verified throughout the research process to ensure the consistency and validity of the findings [24], [30].

Using this approach, data analysis was conducted as a cyclical and interactive process rather than a linear sequence of procedures. This iterative process enabled the researcher to continuously reflect on the collected data, identify emerging patterns, and develop in-depth interpretations of the implementation of ethnomathematics-based learning. Ultimately, the analysis was expected to provide a comprehensive understanding of how ethnomathematics-based instruction was implemented and how it contributed to the development of students' science and mathematics competencies.

4. Results and Discussion

Based on the analysis of data collected through interviews, participant observations, and document analysis, this study identified several major themes that characterize the implementation of ethnomathematics-based learning in developing students' science and mathematics competencies at Muhammadiyah Malawili Elementary School. These findings not only reveal patterns of instructional practice but also illustrate how learning meanings are constructed through the interactions among teachers, students, and the local cultural context.

The first emerging theme is **cultural contextualization as a bridge to conceptual understanding**. The findings indicate that the use of local cultural elements, such as traditional houses and handicrafts, helped students understand abstract concepts in mathematics and science, particularly those related to three-dimensional geometry. Rather than serving merely as supplementary illustrations, these cultural artifacts functioned as concrete instructional media that enabled students to connect abstract concepts with their everyday experiences.

This finding is supported by teachers' accounts indicating that the use of traditional houses as representations of three-dimensional geometric figures enabled students to develop conceptual understanding through direct observation. Students also confirmed that learning became easier when real objects were incorporated into classroom activities. These findings suggest that local culture functions as an epistemic resource that facilitates students' contextual construction of knowledge.

The second theme concerns **teachers' pedagogical mediation in connecting culture and academic concepts**. Teachers played a strategic role in designing and implementing ethnomathematics-based instruction. This process was carried out systematically throughout the instructional sequence, beginning with lesson introduction and prior knowledge activation, continuing through classroom activities, and concluding with reflection. Such instructional practices enabled students to relate abstract mathematical and scientific concepts to their empirical experiences.

The findings demonstrate that the success of ethnomathematics-based learning depends largely on teachers' ability to mediate meaning. Teachers functioned not only as providers of subject matter but also as facilitators who connected formal academic knowledge with students' cultural experiences. This interpretation is further supported by the school principal's perspective, which emphasized that contextualized instructional approaches contribute significantly to improving the effectiveness of classroom learning.

The third theme is **enhanced student engagement and learning motivation**. The data indicate that ethnomathematics-based learning promoted greater student participation throughout the instructional process. Students became more enthusiastic, actively asked questions, engaged in discussions,

and participated more fully in classroom activities.

Students' positive responses suggest that connecting learning materials to local cultural contexts creates a more meaningful and enjoyable learning environment. Because the instructional content was closely related to their everyday lives, students perceived the learning experience as more relevant and accessible. Consequently, their intrinsic motivation to learn increased substantially.

The fourth theme concerns **the integrated development of science and mathematics competencies**. The findings reveal that ethnomathematics-based learning not only enhanced students' understanding of mathematical concepts but also fostered the development of science competencies, including observation, classification, and scientific reasoning.

Both teachers and the school principal observed improvements in students' critical thinking abilities and conceptual understanding following the implementation of this instructional approach. These findings indicate that ethnomathematics has considerable potential as an integrative pedagogical approach that meaningfully connects mathematics and science within a unified learning experience.

The fifth theme addresses **the challenges of implementing ethnomathematics-based learning**. Despite its positive educational impact, teachers encountered several challenges, including difficulties in identifying cultural contexts that were relevant to curriculum content, limited availability of instructional resources, and variations in students' conceptual understanding.

Furthermore, teachers' pedagogical readiness emerged as a critical factor influencing the successful implementation of ethnomathematics-based instruction. Teachers were required to demonstrate creativity and innovation in designing learning activities that were not only aligned with curriculum objectives but also contextualized and meaningful for students. These findings indicate that the effective implementation of ethnomathematics requires sustained support through professional development programs, adequate instructional resources, and school policies that encourage culturally responsive teaching practices.

Overall, the findings demonstrate that ethnomathematics-based learning has substantial potential to promote the contextual, meaningful, and integrated development of students' science and mathematics competencies. Nevertheless, the successful implementation of this approach depends largely on teachers' pedagogical competence, the availability of appropriate learning resources, and continuous support from the broader educational system.

5. Conclusion

This study demonstrates that the implementation of ethnomathematics-based learning at Muhammadiyah Malawili

Elementary School plays a significant role in developing students' science and mathematics competencies through a contextualized and meaningful instructional approach. The findings reveal that the integration of local cultural elements, such as traditional houses and cultural artifacts, serves as an epistemic bridge that enables students to understand abstract concepts through concrete learning experiences. Furthermore, teachers' roles as pedagogical mediators emerged as a key factor in connecting cultural contexts with formal academic concepts, allowing learning to extend beyond the transmission of knowledge toward the construction of meaningful understanding.

The findings also indicate that ethnomathematics-based learning enhances students' engagement and learning motivation, as reflected in their active participation in discussions, observations, and exploratory learning activities. Moreover, this instructional approach facilitates the integrated development of science and mathematics competencies, particularly in terms of conceptual understanding, reasoning skills, and critical thinking. These findings suggest that ethnomathematics can be positioned as an integrative pedagogical approach that is well aligned with the demands of twenty-first-century education.

Despite these positive outcomes, the study also identified several challenges associated with the implementation of ethnomathematics-based learning. These challenges include teachers' preparedness to identify culturally relevant learning contexts, the limited availability of instructional resources, and the need for creativity in designing contextualized learning experiences. These findings indicate that the successful implementation of ethnomathematics depends not only on the pedagogical approach itself but also on broader systemic support, including teacher professional development, adequate learning resources, and supportive school policies.

From a theoretical perspective, this study reinforces the position of ethnomathematics as a pedagogical approach grounded in constructivist learning theory and culturally responsive teaching while extending current understanding of cultural integration in science and mathematics education. From a practical perspective, the findings provide valuable implications for teachers and schools seeking to design learning environments that are more contextualized, culturally responsive, and student-centered. At the policy level, stronger institutional support is needed to encourage the integration of local culture into curricula and classroom practices.

This study was conducted within a single school context; therefore, its findings are not intended to be generalized to broader educational settings. Future research is recommended to investigate the implementation of ethnomathematics across diverse cultural contexts and to employ mixed-methods approaches that combine qualitative and quantitative designs in order to provide a more comprehensive understanding of the

effectiveness of ethnomathematics-based learning in enhancing students' science and mathematics competencies.

Daftar Pustaka

- [1] R. D. L. Iffah, S. Subanti, B. Usodo, and F. Nurhasanah, "Systematic Literature Review: Ethnomathematics Research in Indonesia," *Journal on Mathematics Education*, 2025. [Online]. Available: <https://eric.ed.gov/?id=EJ1462980>
- [2] E. Effendi, I. Sriyanti, K. Wiyono, and L. Marlina, "Ethno-STEM in science education: A systematic literature review (2020–2025)," *Jurnal Penelitian Pendidikan IPA*, vol. 11, no. 1, 2025. doi: 10.29303/jppipa.v11i1.12281
- [3] W. Hidayat, U. Aripin, and S. A. Widodo, "Integration of ethno-modelling and 3N: An innovative digital worksheet framework to enhance students' mathematical critical thinking skills," *Infinity Journal*, vol. 14, no. 1, 2025. doi: 10.22460/infinity.v14i1.6562
- [4] M. S. K. Batiibwe, "The role of ethnomathematics in mathematics education: A literature review," *SAGE Open*, 2024. doi: 10.1177/27527263241300400
- [5] Y. H. Pongoliu, "The Effectiveness of Gorontalo Local Wisdom-Based Ethnomathematics in Enhancing Mathematics Understanding," *Journal La Edusci*, 2025. [Online]. Available: <https://ipv6.newinera.com/index.php/JournalLaEdusci/article/view/2161>
- [6] A. Merliana, D. A. M. Lidinillah, and P. M. Setiadi, "Improving Social Skills and Mathematics Understanding through Ethnomathematics-Based Learning," *ABDIMAS: Jurnal Pengabdian Masyarakat*, 2026. [Online]. Available: <https://journal.umtas.ac.id/ABDIMAS/article/view/7410>
- [7] K. Novferma and A. Maison, "Integrating the Profile of Pancasila Students into Ethnomathematics: A Project-Based Learning Approach," *Edumatica*, vol. 15, no. 1, 2025. doi: 10.22437/edumatica.v15i1.48309
- [8] G. Sunzuma and U. Umbara, "Ethnomathematics-based technology in Indonesia: A systematic review," *International Journal for Mathematics Education*, 2025. doi: 10.1177/27527263241305812
- [9] Z. Zainal and I. Irmayani, "Ethnomathematical exploration in cultural traditions," *ARJI: Journal of Indonesian Education*, 2025. [Online]. Available: <https://journal.nahnuinisiatif.com/index.php/ARJI/article/view/471>
- [10] M. Mutmainna and G. Gunarhadi, "Flat Shape Concept in Kaddo' Masingkulu: An Exploration of Bugis-Makassar Culture-Based Ethnomathematics," *European Journal of Education Studies*, 2025. [Online]. Available: <http://www.ejeset.saintispub.com/ejeset/article/view/736>
- [11] L. I. Putri, H. Retnawati, A. Jaedun, and A. Murfi,

“Enhancing mathematical skills through multicontextual approaches: A meta-analysis,” *Cogent Education*, vol. 12, no. 1, 2025. doi: 10.1080/2331186X.2025.2548648

[12] I. Larasati, A. S. Pramasdyahsari, and L. Harun, “Enhancing elementary students' numeracy skills through ethnomathematics-based learning,” *Journal of Honai Math*, vol. 8, no. 1, 2025. doi: 10.30862/jhm.v8i1.861

[13] R. D. L. Iffah, S. Subanti, B. Usodo, and F. Nurhasanah, “Systematic Literature Review: Ethnomathematics Research in Indonesia,” *Journal on Mathematics Education*, 2025. [Online]. Available: <https://eric.ed.gov/?id=EJ1462980>

[14] F. I. Setiaputra, S. Subanti, and B. Usodo, “A systematic review of ethnomathematics research (2019–2023): Cultural integration in mathematics teaching and learning,” *Jurnal Pendidikan MIPA*, 2025. [Online]. Available: <https://jpmipa.fkip.unila.ac.id/index.php/jpmipa/article/view/213>

[15] S. H. Rusminati and A. Fanani, “The Integration of Ethnomathematics in Enhancing Numeracy Literacy: A Literature Review,” *Inventa: Jurnal Pendidikan Guru Sekolah Dasar*, 2025. [Online]. Available: https://jurnal.unipasby.ac.id/jurnal_inventa/article/view/11228

[16] G. Sunzuma and U. Umbara, “Ethnomathematics-based technology in Indonesia: A systematic review,” *International Journal for Mathematics Education*, 2025. doi: 10.1177/27527263241305812

[17] Marsigit, M. Irfan, and H. Sukoco, “Evaluation of pedagogical quality in ethnomathematics learning practices,” *Discover Education*, vol. 4, 2025, Art. no. 281. doi: 10.1007/s44217-025-01026-z

[18] A. Solihin, N. Mariana, and I. Rahmawati, “Cultural exploration as realistic context in mathematics learning: An ethnomathematics perspective in Indonesian elementary education,” *Proceeding of International Conference in Elementary Education*, 2025. [Online]. Available: <https://journal.unesa.ac.id/index.php/GPrEEc/article/view/45603>

[19] E. Effendi, I. Sriyanti, K. Wiyono, and L. Marlina, “Ethno-STEM in science education: A systematic literature review (2020–2025) on trends, classroom challenges, and teacher capacity in a multicultural context,” *Jurnal Penelitian Pendidikan IPA*, vol. 11, no. 1, 2025. doi: 10.29303/jppipa.v11i1.12281

[20] I. Larasati, A. S. Pramasdyahsari, and L. Harun, “Enhancing elementary student's numeracy skills through ethnomathematics-based learning: An analysis of minimum competency assessment results,” *Journal of Honai Math*, vol. 8, no. 1, 2025. doi: 10.30862/jhm.v8i1.861

[21] L. I. Putri, H. Retnawati, A. Jaedun, and A. Murfi, “Enhancing mathematical skills through multicontextual

approaches: a meta-analysis of realistic mathematics, ethnomathematics, and technology integration,” *Cogent Education*, vol. 12, no. 1, 2025. doi: 10.1080/2331186X.2025.2548648

[22] R. A. Pratama and T. Y. Yelken, “Effectiveness of ethnomathematics-based learning on students' mathematical literacy: a meta-analysis study,” *Discover Education*, vol. 3, 2024. doi: 10.1007/s44217-024-00309-1

[23] D. H. F. Astuti and T. Haryati, “Teachers' Role in Enhancing Students' Literacy and Numeracy: A Qualitative Case Study at Elementary School,” *Sosioedukasi*, 2025. [Online]. Available: <https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/article/view/5893>

[24] N. Samosir, W. G. Mulawarman, and A. Akhmad, “Strategic Management of School Principals in Strengthening Character Education,” *Journal of Education*, 2025. [Online]. Available: <https://sarcouncil.com/download-article/SJES-117-2025-1-11.pdf>

[25] N. N. A. K. Yanti et al., “Principal Leadership and Educational Quality Management: A Case Study,” *Journal of Innovation in Primary Education*, 2026. [Online]. Available: <https://ejournal.papanda.org/index.php/jirpe/article/view/2850>

[26] M. Rifaldi, S. N. Kaharu, and P. Pahriadi, “Teachers' Understanding of the Merdeka Curriculum: A Qualitative Study,” *Journal of Innovation in Primary Education*, 2026. [Online]. Available: <https://ejournal.papanda.org/index.php/jirpe/article/view/3076>

[27] F. N. Farhansyah and N. P. Putra, “Fostering Cooperation Through Project-Based Learning: A Qualitative Investigation,” *Journal of Innovation in Primary Education*, 2025. [Online]. Available: <https://ejournal.papanda.org/index.php/jirpe/article/view/2356>

[28] M. E. Firdaus, “School Principal Leadership Practices in the Implementation of School-Based Management: A Case Study,” *Journal of Education and Applied Teaching*, 2026. [Online]. Available: <https://journal.horizonedukaspublisher.com/jeat/article/view/101>

[29] S. Syamsidar, N. Rahmah, and M. A. R., “Implementation of the Merdeka Curriculum in Elementary School: A Qualitative Study,” *Journal of Innovation in Primary Education*, 2025. [Online]. Available: <https://ejournal.papanda.org/index.php/jirpe/article/view/2322>

[30] K. M. Y. Resintia, R. Rizal, and S. Wilade, “Strategic Management in Elementary Education: A Qualitative Case Study,” *Journal of Innovation in Primary Education*, 2026. [Online]. Available: <https://ejournal.papanda.org/index.php/jirpe/article/view/3055>

