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Integration of Ethnomathematics Teaching Materials in Mathematics Learning in Elementary School

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ABSTRACT

Objective: This research serves as a preliminary study to outline the framework and projection of ethnomathematics studies, particularly concerning the integration of ethnomathematics into mathematics curriculum and the development of mathematics learning objectives using an ethnomathematical approach. **Method:** The research employs a Systematic Literature Review (SLR) methodology involving identifying, evaluating, and interpreting relevant literature on the research topic. **Results:** The findings reveal that the ethnomathematical approach effectively enhances students' understanding of mathematics. Students exhibit higher motivation and satisfaction with mathematics learning when connected to their local culture. **Novelty:** This research shows that the ethnomathematics approach facilitates the development of teachers' competencies in integrating cultural elements into mathematics education. Both teachers' recommendations and research findings support the inclusion of ethnomathematics in mathematics curricula both directly in developing learning tools and materials and in curriculum policies. Additionally, there is potential for technology applications to support ethnomathematics learning, enabling students to study mathematics independently. In conclusion, integrating ethnomathematics holds significant potential in improving students' mathematical understanding, connecting mathematics with local culture, and motivating students to learn mathematics more enjoyable and relevantly.

INTRODUCTION

Given that Indonesia is a multicultural nation, there is good reason to remind future generations of the value placed on diversity as a national asset. It is also essential to introduce culture to reveal aspects that take time to be apparent, such as its underlying meanings or historical context. People's lives are significantly impacted by their culture. In Sukarismanti (2022), Koentjaraningrat makes the case that the Sanskrit word "buddayah," which is the plural of "buddhi," which signifies mind or reason, is where culture originated. Culture is all the knowledge people gain as members of a community. This complex knowledge comprises beliefs, art, law, morals, habits, and skills (Liliweri, 2019).

However, cultural components should be included in the curriculum, even when teaching arithmetic in elementary schools. Incorporating cultural components into instruction can inspire pupils and improve their comprehension of mathematical ideas (Nuraini et al., 2022). Students who comprehend the value of sustaining and conserving culture will benefit. In addition, mathematics in a cultural context may also be a teaching tool that creates an impression and helps with comprehension and memory because, in general, something intriguing will elicit a positive sensation that ignites excitement and impacts the learning process and outcomes. Given that teachers are one

factor determining whether or not students succeed in their studies, culturally relevant mathematics is crucial to making mathematics education more meaningful. Ethnomathematics is a recent trend that combines mathematics with culture (Appelbaum & Stathopoulou, 2023; Khalil, 2023; Mania & Alam, 2021; Pradana et al., 2022; Rosa & Orey, 2021b).

Since Ubiratan D'Ambrosio's opening address at the 1984 International Congress on Mathematics Education in Adelaide, Australia, which addressed the relationship between mathematics, culture, and society, research on ethnomathematics has advanced quickly (Lidinillah et al., 2022). The foundation for the study of ethnomathematics and its connections to pedagogy and history is laid by D'Ambrosio (1985). Borba (1990) offers a foundation for researching the connection between ethnomathematics and education while establishing ethnomathematics as an epistemic approach to mathematics. Representatives from over 20 nations have attended the six International Conferences on Ethnomathemathematics (ICEM) conducted every four years since 1984. The most recent conference took place in Colombia in 2018. This demonstrates how ethnomathematics is now a vibrant field of study.

Ethnomathematics is the anthropological study of mathematical reasoning and practices in cultural contexts. It also includes mathematical modeling, which aids students in translating different mathematical concepts and behaviors gleaned from cultural components. The product of human labor, ethnomathematics, reveals mathematics's social and cultural origins as they are represented in the vernacular of particular social groupings. Cultural groups that practice ethnomathematics include working groups, professional classes, indigenous people, and youngsters of particular age groups (Ningsih, 2022). As a result, ethnomathematics can be incorporated into the curriculum and is strongly tied to how society thinks about mathematics, which is tied to its culture. Ethnomathematics integrates mathematical ideas with local culture to enhance classroom instruction. Through science, ethnomathematics helps bridge the gap between indigenous knowledge, cultural preservation, and technological advancement (Permata et al., 2021; Nuryadi et al., 2020; Nur et al., 2020). In order to accomplish specific learning objectives or master particular mathematical skills, ethnomathematics becomes a beneficial strategy in the study of mathematics when combined with local wisdom (Muhammad et al., 2023).

Ethnomathematics is a branch of research focusing on the transmission, dissemination, and institutionalization of mathematical knowledge (concepts, procedures, and practices) rooted in historical cultural contexts. Four general areas of interest in ethnomathematics are identified by the International Study Group on Ethnomathematics (ISGE): (a) field research to gather information about mathematics in culture; (b) use of mathematics in cross-cultural contexts; (c) application of ethnomathematics in the classroom; and (d) theoretical, sociological, and ethnomathematics policy studies. Moreover, the socio-cultural origins of mathematics can be examined using the six primary dimensions of ethnomathematics: cognitive, conceptual, pedagogical, epistemological, historical, and political (Budiarto et al., 2022). Although they offer distinct but significant fields of study, both broad areas of interest and significant aspects of ethnomathematics are considered when choosing a research emphasis in the discipline.

Creating more culturally responsive mathematics classrooms is the focus of the theoretical framework of ethnomathematics. Like any other human activity, math instruction must consider various historically, culturally, socially, and politically placed

practices. In order to foster meaningful relationships and enhance students' understanding of mathematics, a pedagogical approach grounded in ethnomathematics studies can develop mathematics learning that considers culturally diverse everyday mathematics practices or mathematics learning based on students' perspectives (Nur, 2019). This paradigm can be used in schools as an ethnomathematics-based teaching strategy.

Mathematical epistemology, content, classroom culture, and mathematics teaching approaches are the five ethnomathematics curriculum models that incorporate elements of students' cultures into a comprehensive learning environment. These models include (a) presenting ethnomathematics as a meaningful context for the development of thinking skills, (b) presenting ethnomathematics as culturally specific content distinct from universal mathematical concepts, (c) as a stage in the mathematical thinking process that children go through; (d) designing classes that contain cultural context in the form of values, beliefs, and learning theories; and (e) presenting mathematical concepts and practices that originate from students' cultures. Students gain a deeper understanding of reality, culture, society, environmental challenges, and themselves when mathematics is taught in a way that is relevant to their experiences and culture (Acharya et al., 2021; Meaney et al., 2021; Orey & Rosa, 2021; Rosa & Orey, 2021a; Suh et al., 2021). Ethnomathematics introduces students to a wide range of new concepts and subjects that they may not have encountered in the past but that are present in global cultural practices.

From several previous studies, the following is the author's reason for making a literature study of ethnomathematics integrated teaching materials in mathematics learning in elementary schools. Several studies have studied the integration of ethnomathematics teaching materials in learning, such as previous research by Pathuddin & Raehana (2019), who conducted an empirical study regarding traditional Bugis food, which contains mathematical concepts, namely geometry, especially plane shapes and spatial shapes. Tumpi-tempi, decrepit-old, and bursa contain the concept of a flat shape, while barong ko, onde-onde, doko-doko, paso, and putu coppa contain the concept of a spatial shape. This traditional Bugis food can be used as a mathematics learning resource in elementary and middle schools.

The results of previous research by Kencanawaty et al. (2020) show that one of the lessons that use teaching aids, namely hiding, steamer, tempeh, and so on, has an impact on increasing student learning outcomes because of the application of learning with ethnomathematics concepts which can be seen from the test scores. Students' daily activities can also be seen from the students' enthusiasm when the teacher uses ethnomathematics as a source and teaching material for mathematics learning. According to research from Mulyasari et al. (2021), ethnomathematics' "engklek game" significantly influences students' understanding of geometric concepts. Apart from that, students gave enthusiastic responses based on the results of the interviews. This is supported by the results of observations of the implementation of the ethnomathematics learning "engklek game," which is in the excellent category as Ndiung & Jediut (2021) concluded that it is essential to develop ethnomathematics-based teaching materials according to the needs of teachers and students in Manggarai district and to shape the creative thinking skills of elementary school students by facilitating elementary school teachers with ethnomathematics knowledge by integrating products. Manggarai culture into mathematics learning. They have also produced ethnomathematics-based teaching materials oriented towards creative

thinking skills, which are suitable for use in improving the thinking process and forming creative thinking skills which are equipped with student worksheets and creative thinking questions (Agusdianita et al., 2021; Hendriana & Buyung, 2020; Mutaqin et al., 2021; Pardimin et al., 2021; Priyatna & Utami, 2023; Ristanti & Murdiyani, 2021).

The novelty of this article is collecting information in implementing the concept of ethnomathematics in developing teaching materials for mathematics learning in elementary schools that are adapted to the cultural background of origin on both a national and international scale. The aim of this research is in order to specifically address how to incorporate ethnomathematics into the teaching and curriculum of mathematics, as well as how to develop learning objectives for mathematics that can be based on an ethnomathematics-based approach; it is hoped that this research can serve as a preliminary study that outlines the framework and projections of ethnomathematics studies. The following questions are posed in this research, which employs a systematic review technique to investigate further how ethnomathematics has been conducted in various studies, particularly those connected to how ethnomathematics is integrated into the mathematics curriculum and instruction in schools.

RESEARCH METHOD

This type of qualitative research uses the Systematic Literature Review (SLR) method to answer research problems. As stated by Dixon in Wiryanto et al. (2023), SLR is used to summarize the results of descriptive studies. This research uses the SLR method, a scientific approach to identifying, evaluating, and interpreting all literature relevant to the research topic (Saphira, 2022). The steps taken in this research follow the SLR method guidelines, as explained by Maulida (2022). This research involved several stages, including formulation of research questions, literature search, determination of inclusion and exclusion criteria, literature selection, data presentation, data processing, and conclusion. Figure 1 is a flowchart of the research method.

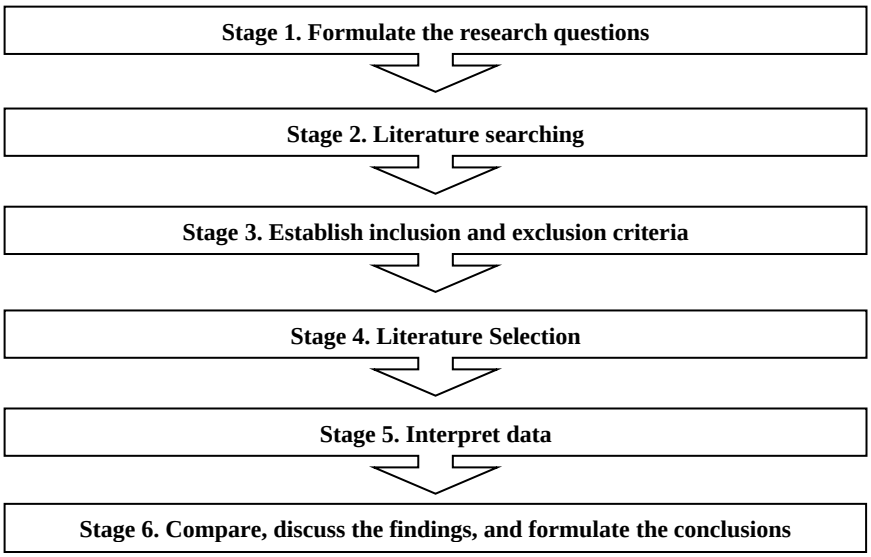

Figure 1. Research flowchart.

The first stage is formulating research questions, with several questions such as the type of teaching materials used to develop ethnomathematics, student responses to ethnomathematics-based teaching materials, and the application of ethnomathematics teaching materials at the educational unit level. The second stage is a literature search. This research data was collected by reviewing online journal databases: Google Scholar, Garuda Portal, Sinta, and Scopus Website. The literature search here uses the keywords "Ethnomathematics Teaching Materials ."The selected articles were relevant to this research and were analyzed with a focus on research published between 2018 and 2023. The third stage involved establishing inclusion and exclusion criteria, where the researcher only considered research related to developing ethnomathematics teaching materials. The criteria for the selected articles are that they come from journal publications indexed by Sinta Garuda or Scopus with updates in the last five years ranging from 2018 – 2023 and that the articles can be written in Indonesian or English. The fourth stage was literature selection, where the researcher selected 10 of the 15 articles that had been selected repeatedly after the first selection according to inclusion and exclusion criteria. These articles were then documented in tabular form and analyzed carefully, especially regarding research results. In the fifth stage, the researchers process the data interpretation to the question or purpose of this research. In the final stage, researchers compare and discuss the articles' findings and formulate conclusions based on their analysis. This research follows a very structured and systematic approach to present comprehensive insights regarding the development of ethnomathematics-based learning material (Astriani et al., 2021; Fitrianawati et al., 2020; Husna et al., 2021; Latif & Talib, 2021; Putra & Mahmudah, 2021).

RESULTS AND DISCUSSION

Results

The analysis results found have been presented in Table 1, which relates to the keywords used in this research. In the research process, researchers examined articles related to the development of ethnomathematics teaching materials in mathematics learning and their influence on students' mathematical thinking abilities. Further information about the reviewed articles can be found in Table 1.

Table 1. Article findings.

Researcher and Year	Research Result
Nur et al. (2020)	The results of this research show that contextual learning with ethnomathematics influences problem-solving abilities based on level of thinking. In addition, local cultural characteristics appear in each category of student thinking level. Students with a formal level of thinking have better problem-solving abilities than students at a transitional and concrete level of thinking. Contextual learning with ethnomathematics develops problem-solving abilities based on levels of thinking.
Yandani & Agustika (2022)	The results of this research indicate that ethnomathematics-based mathematics learning videos for introducing geometry material to first-grade elementary school students are suitable for use, with a high level of feasibility. This product can increase student competence, enable students to learn mathematics independently, meaningfully, and fully, and motivate teachers to develop other learning media.
Lestari et al. (2023)	The research results show that using miniature ethnomathematics

Researcher and Year	Research Result
	media effectively increases the understanding of two-dimensional figures in class III elementary school students, and the media is considered valid and practical.
Sulistyowati & Mawardi (2023)	The results of the analysis show that the effectiveness of using ethnomathematics-based learning on the mathematics abilities of elementary school students is significantly different. These results indicate that the ethnomathematics-based learning approach can effectively improve elementary school students' mathematics abilities.
Verner et al. (2019)	The results of this study indicate that an ethnomathematics approach can effectively teach geometry in a cultural context and highlight the importance of integrating cultural aspects in mathematics teaching. In addition, the results of this study identify four specific competencies teachers require to teach geometry in cultural contexts and suggest the need for in-depth training in this approach in mathematics teacher education.
Nugraha et al. (2020)	This research indicates that CTL based on Sundanese cultural ethnomathematics effectively increases students' understanding of mathematics, involves students in contextual play activities, facilitates group discussions, and provides meaningful learning. Compared with conventional learning, this approach is more effective. Ethnomathematics innovations can be applied again, and future research should pay attention to learning trajectories and ethnomathematics learning designs.
Mania & Alam (2021)	The results of this study indicate that the ethnomathematics approach improves students' mathematical understanding and helps them appreciate their own culture. Teachers supported this approach positively and recommended its inclusion in the Indonesian mathematics curriculum. Empirically, a positive correlation was found between students' motivation to learn mathematics and the use of ethnomathematics. Limitations of this study include limited data and ethnic diversity, which need to be further explored in the future.
Sunzuma et al. (2021)	The results showed that students taught with an ethnomathematics approach achieved significantly higher test scores than the traditional lecture approach in the consumer arithmetic course. Teachers appreciate ethnomathematics because students are more motivated, actively involved, and interested in understanding mathematical concepts. The ethnomathematics approach also improved students' understanding and retention of arithmetic concepts.
Sunzuma & Maharaj (2021)	The research results show that most teachers (60.00%) believe that geometry is closely related to culture, and most (92.50%) see a relationship between geometry and culture. Teachers who hold this view tend to relate geometry teaching to students' cultural backgrounds. In addition, teachers (80.00%) believe that understanding geometry can be gained through participation in traditional cultural activities. These results emphasize the importance of including cultural aspects in geometry teaching.
Nuryadi et al. (2023)	The research results show that students with low and good learning achievements responded positively to this application. They find the material in the application easy to learn and valuable and are satisfied with its use. Differences in learning achievement do not affect student

Researcher and Year	Research Result
	responses, and the doll characters in the application represent religious values, discipline, hard work, passion or spirit, and nationalism. These results show the potential application of character-based ethnomathematics in supporting character education in schools.

Discussion

How is Ethnomathematics Embedded in Mathematics Learning Activities?

Several concrete steps can be taken to embed ethnomathematics in mathematics learning activities. First, teachers can take everyday life examples closely related to local culture and traditions. For example, in teaching comparisons, teachers can use comparisons that often appear in traditional cooking or in various activities such as measuring ingredients in cooking. By utilizing these real-world examples, students can easily see the relevance and usefulness of mathematics in their cultural context (Verner et al., 2019).

Furthermore, it is essential to align the mathematics curriculum with local wisdom. This may include developing teaching materials that reflect mathematical patterns in art, music, or daily activities unique to the local community. This helps students feel that mathematics exists in their everyday lives and is not just a theoretical concept. Inviting parents and community members to participate in the learning process is also invaluable. They can share mathematical knowledge and practices from their culture, providing additional insight to students and strengthening ties between school and community. It also allows students to appreciate the contributions of different generations in the development of mathematics. The use of local folklore and myths in mathematics learning is another way to integrate ethnomathematics (Fachrur et al., 2021; Fauzi et al., 2022; Machaba & Dhlamini, 2021; Prahmana, 2022; Umbara et al., 2023). Students can learn how mathematical concepts have existed in these stories, illustrating how mathematics is integral to their culture and history.

In addition, using traditional tools in learning mathematics, such as traditional calculating tools, can help students understand mathematical concepts more concretely. This can help more visual or kinesthetic students understand and remember the material. Lastly, holding cultural celebrations at school that include mathematical elements can make learning more fun and meaningful. This creates a lively and exciting environment that encourages students to participate more in learning mathematics (Nuryadi et al., 2023). By implementing this approach, students can better understand mathematics and feel more connected to their culture. This can increase their interest in mathematics and make learning more meaningful and relevant (Sunzuma et al., 2021). In this research, there are difficulties and shortcomings, including those mentioned by Putriani et al. (2023), namely that the e-module developed has shortcomings in problem-solving steps. Students still need help following the learning process when solving problems because the e-module developed needs to improve steps. At the logical feasibility stage, the researcher experienced difficulties developing the material for the perimeter and area of a flat shape. It suited the characteristics of class IV students and matched the image of the bay that cake, a Bengkulu Traditional Cake. Putriani also suggested that for future researchers, it would be better to construct more closely between student characteristics, images, and the materials developed.

Ethnomathematics Teaching Materials

Teaching materials related to the local culture of the Cirebon community are a collection of mathematics teaching materials packaged using the local cultural content of the Cirebon community (Mahpudin & Yuliati, 2019). Students are introduced to various objects with cultural and mathematical elements in teaching materials, such as unique forms from Sundanese culture and objects related to mathematical elements. Ethnomathematics teaching materials are prepared systematically using sources from local culture and wisdom, which can be printed, audio, video, and multimedia (Arisetyawan, 2019). Creating instructional materials follows general guidelines; therefore, while creating resources for ethnomathematics, educators must consider and choose cultural components that will provide context for the mathematical topic students are studying. However, according to Supriadi et al. (2019), instructional materials must have three things at minimum: (a) mathematical problems with cultural relevance, (b) cultural values, and (c) contextual problems with mathematical solutions.

The application of media-based ethnomathematics is tailored to meet the needs of learners regarding learning designs and instructional resources, such as the use of artificial models of traditional cultural tools in the classroom, such as crafts, art, and household and agricultural implements. Media use as a learning component is a part of ethnomathematics learning, even though few texts show this approach. Several documents highlight the usage of media; one relates to teaching counting with sticks; the others demonstrate the use of computer-based technology to help depict the context of teaching materials based on ethnomathematics (Sudirman et al., 2020) for a more specific example of the use of technology in teaching materials, namely the use of flipbooks as research of Agustina (2023) which can facilitate students to explore local wisdom and practice ethno-conservation for students. This flipbook is also equipped with advantages that support student activities. Aside from instructional resources, traditional games are used and developed more in ethnomathematics education than media, particularly in light of the necessity for engaging and enjoyable teaching strategies in educational settings. Many classic games have been adapted, including the jumping rope-like game Engklek, the game Endogendogan (Supriadi & Arisetyawan, 2020), the gundu game (Pratiwi & Pujiastuti, 2020), and the gasing game. Play activities are intended to be the primary component of learning activities or added to existing learning activities to make learning enjoyable for students and help them fully appreciate their culture's diversity.

Effectiveness of Integration of Ethnomathematics Teaching Materials in Mathematics Learning in Elementary Schools

The effectiveness of the Ethnomathematics approach in teaching geometry in a cultural context was found by Verner et al. (2019), who also underlined the significance of including cultural elements in mathematics education. The findings of this study also point to four distinct abilities that educators must possess to effectively teach geometry in cultural contexts, underscoring the necessity of comprehensive training in this methodology in mathematics teacher preparation programs. A study by Nugraha (2020) shows that using an Ethnomathematics approach based on Sundanese culture effectively increases students' mathematical understanding. This approach engages students in contextual play activities, facilitates group discussions, and provides meaningfulness in learning. Compared to conventional learning, this ethnomathematics approach has proven more effective. Ethnomathematics innovations can be reapplied in

the future, and future research needs to pay attention to the learning trajectory and design of Ethnomathematics learning (Aristyasari et al., 2023; Fitiradhy et al., 2023; Sulistyowati, 2023).

Research by Mania and Alam (2021) also shows that the Ethnomathematics approach improves students' mathematical understanding and helps them appreciate their culture. Teachers supported this approach positively and recommended its inclusion in the Indonesian mathematics curriculum. Empirically, this research found a positive correlation between students' motivation to learn mathematics and the use of ethnomathematics. Sunzuma and Maharaj (2022) investigated the views of teachers in Zimbabwe towards geometry from an ethnomathematics perspective. The results show that most teachers believe that geometry is closely related to culture, and they relate geometry teaching to students' cultural backgrounds. Additionally, most teachers believe that an understanding of geometry can be gained through participation in traditional cultural activities. These results emphasize the importance of including cultural aspects in geometry teaching. Research by Nuryadi et al. (2023) investigated the use of character-based Ethnomathematics applications in mathematics learning. The results show that both students with low and good learning achievements responded positively to using this application. They find the material in the application easy to learn and valuable and are satisfied with its use. These results show the potential application of character-based ethnomathematics in supporting character education in schools (Ardianti et al., 2023; Lestari et al., 2021; Putri & Zaenuri, 2022; Sudarmin et al., 2023).

In order to compare the efficacy of the Ethnomathematics approach and traditional lectures in teaching consumer arithmetic, Sunzuma et al. (2021) undertook a study. The results demonstrated that, in the consumer arithmetic course, students taught using the Ethnomathematics approach scored much higher on tests than those taught using the traditional lecture method. Because students who employ ethnomathematics are more motivated, engaged, and interested in learning mathematical ideas, teachers also value this approach. Additionally, it was discovered that the ethnomathematics approach helped pupils retain and comprehend mathematical topics. Apart from that, according to Darmayanti et al. (2023), developing ethnomathematics teaching materials resulted in a feasibility criterion of 82.00% to improve students' mathematical understanding abilities. Complemented by research from Nirmala et al. (2023), using an e-module based on the RME model using the Bubunganlima traditional house produces a moderate gain score of 48.00%. The understanding of mathematical concepts of students who use e-modules based on the RME model using the Bubungan Lima traditional house is higher than students who only use textbooks from school, so they are declared effective. There was a significant increase in mathematics learning outcomes after using ethnomathematics-based teaching materials (Nuraini & Setyowati, 2023). There is an e-module for materials for building cubes and blocks based on ethnomathematics to train fifth-grade elementary school students to be independent. The practical summary of the N-Gain percent score is 85.13, which is classified as high for use as teaching material (Setiawan, 2023).

CONCLUSION

Fundamental Finding: In conclusion, the integration of Ethnomathematics teaching materials has great potential in increasing students' understanding of mathematics, connecting mathematics with local culture, and motivating students to learn

mathematics in a more fun and relevant way. **Implication**: Several studies show that the learning material using the ethnomathematics approach effectively improves students' understanding of mathematics and cultural insight because it links mathematics learning to their local culture. Students become more motivated, actively engaged, and satisfied with mathematics learning when they see connections between mathematical concepts and their cultural context. In addition, this approach encourages teacher competence development in integrating cultural elements into mathematics learning. Recommendations from teachers and research show positive support for the inclusion of ethnomathematics in the mathematics curriculum. The research also highlights the potential for technology applications to support ethnomathematics learning so that students can learn mathematics more meaningfully independently. **Limitation:** This study is limited to more than material learning integrated ethnomathematics in learning. Research also has limited article sources, year of publication, and other criteria. **Future Research:** For further research, the development of teaching materials integrated ethnomathematics that are adapted to the cultural assets of each region in Indonesia.

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