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# PROFILE OF ETHNOMATEMATICS IMPLEMENTATION IN MATHEMATICS LEARNING TO STIMULATE STUDENTS' COGNITIVE DEVELOPMENT

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**ABSTRACT**

The negative perception that mathematics is abstract and rote-oriented leads to low student engagement and cognitive development. This study examines ethnomathematics as a contextual approach that connects formal mathematics with student culture. This study aims to describe the implementation of ethnomathematics, changes in student perceptions, and stimulation of cognitive development. This study uses a descriptive qualitative approach with the study location in the seventh grade of Khairunnas Junior High School. Data were collected through in-depth participatory observation, field notes, interviews, and analysis of learning artifacts. Data analysis was conducted using Spradley's qualitative analysis model. The findings show that the success of implementation is influenced by the teacher's readiness to adapt a contextual approach. Through mentoring, teachers successfully deconstructed the perception that mathematics and culture cannot dialogue, shifting from simply matching formulas to contextual learning adjustments relevant to students' experiences. Students showed more positive changes in their perceptions of mathematics. Students saw mathematics as a skill relevant to their daily experiences. Empirically, ethnomathematics has been proven to improve students' cognitive levels. Cognitive abilities increased from C2 to C3–C4, as observed and confirmed by final assessment results. Ethnomathematics not only increased interest and motivation to learn but also fundamentally stimulated students' cognitive development toward higher-level thinking skills. The results of the study indicate that the integration of local culture has the potential to improve the quality of mathematics learning.



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## 1. INTRODUCTION

Mathematics education still faces challenges related to students' perceptions that mathematics is abstract and irrelevant, thereby hindering learning interactions and cognitive development (Afrianti et al., 2025). Mathematics education should be an exercise in deeply understanding life concepts and encouraging cognitive development (Putri & Prasetyo, 2024). As a result, students are only able to solve basic procedural math problems, but are less able to apply mathematical reasoning in complex and contextual situations (Nuryami, 2024). This shows that students' cognitive development is still low and requires new concepts and strategies in learning activities to improve their ability to understand mathematics.

To overcome negative perceptions, education experts in the field of mathematics continue to develop innovative learning styles. One of the main focuses of development is the shift from old learning styles to contextual learning (Fauzan et al., 2025). Contextual learning is learning that can stimulate students' interest by relating the subject matter to their experiences and surroundings (Suciati et al., 2024). Meanwhile, the goal of contextual learning is to give deeper meaning to learning in the classroom by relating academic material to the knowledge and experiences that students have had in the real world. The development of this learning aims to solve abstract problems in mathematics learning, so that the material is more relevant and functional for students to understand (Saputra et al., 2025).

One implementation of the concept of contextual learning that is relevant and continuously adapted to the changing times and digital developments in mathematics learning is Ethnomathematics. Ethnomathematics is a learning approach that integrates mathematical concepts with local culture to create more contextual and meaningful learning for students (Rahmi et al., 2025). Ethnomathematics, which takes the form of contextual learning utilizing cultural heritage, is can develop and instill the character values contained in each culture in students' understanding (Alghar et al., 2023). It can be concluded that ethnomathematics is contextual learning that provides real efforts in understanding concepts as part of cultural heritage, with the aim that students are able to understand, process, sort, and utilize ideas, procedures, and mathematical learning practices in solving various problems that can trigger the cognitive development of students.

The ethnomathematics learning process involves a system of assimilation and accommodation, in which the learning context helps change students' thinking from concrete thinking based on cultural heritage experiences to abstract thinking connected to mathematics learning (Tohir et al., 2023). This is in line with Piaget's theory of cognitive development as explained by Sukirwan dan Muhtadi (2017), which emphasizes that active interaction between individuals and their socio-cultural environment is an important prerequisite in the formation of new knowledge schemes through a dynamic mental adaptation process. The integration of local cultural elements into teaching materials serves as a cognitive bridge that facilitates students in balancing formal mathematical concepts that were originally unfamiliar with informal knowledge that is embedded in their daily lives. Thus, this approach not only strengthens conceptual understanding but also improves students' mathematical disposition because mathematics is seen as an activity that is relevant and close to the realities of life (Risdiyanti & Prahmana, 2020).

Although various studies have shown the effectiveness of ethnomathematics in improving learning outcomes, research that describes in depth the implementation process and its impact on stimulating students' cognitive development is still limited. Previous studies have concluded that the mathematical problem-solving abilities of students who learn using teaching modules equipped with integrated ethnomathematics worksheets and the Problem-Based Learning model are higher than the mathematical problem-solving abilities of students who learn using teaching modules with conventional learning models (Nurhadi

et al., 2025). In addition, other studies related to ethnomathematics concluded that the integration of Jambi batik ethnomathematics with AR technology in the form of an educational e-magazine proved to be an effective learning medium that could improve students' mathematics learning outcomes (Kamid et al., 2025).

There have not been many studies that reveal the profile of the implementation process of ethnomathematics by teachers and the cognitive dynamics of students during learning. This is because previous studies have focused on novelty-based ethnomathematics strategies. Meanwhile, analysis of the profile of pedagogical implementation carried out by teachers using ethnomathematics evenly and acceptably by all students in the classroom is still rarely studied. To explore this implementation, this study focuses on an in-depth exploration of the process of implementing ethnomathematics by teachers and its influence on improving student cognition in the classroom.

This study aims to describe the profile of ethnomathematics implementation in mathematics learning and analyze student perceptions and their impact on cognitive development. This study does not focus on measuring student learning outcomes, but rather on understanding the dynamics of ethnomathematics implementation in the classroom through qualitative descriptions. This study contributes to the empirical description of cultural integration practices in mathematics learning and their implications for ethnomathematics-based learning planning.

## 2. METHOD

Based on the problems and objectives described, this study uses a descriptive qualitative method. This method is very suitable because it is in line with describing the use of various cultural practices through ethnomathematics in learning. The descriptive qualitative approach is used to naturally describe the process of implementing ethnomathematics as recommended by Creswell (2018). In addition, this method can also be used by researchers to conduct a comprehensive investigation of aspects of classroom interaction, practices, and artifacts used in building and developing cognitive levels through ethnomathematics learning.

This study was conducted in the seventh grade of Khairunnas Junior High School, which acted as a purposively selected informant to assist in data collection and research description. The research was conducted at Khairunnas Junior High School in the first semester of the 2025/2026 academic year from the third week of August to the first week of October. The research informants consisted of: (1) mathematics teachers as implementers of ethnomathematics learning; (2) seventh-grade students as participants; and (3) researchers as participatory observers. The selection of informants was done purposively by considering the active involvement of teachers in learning and the availability of students to fully participate in the process. Meanwhile, the researcher acted as a participant observer, involved to a limited extent to understand classroom dynamics without intervening in the learning process.

Data collection techniques were carried out through participatory observation, field notes, interviews, and the collection of artifacts used and produced in learning activities. Observations were conducted during six meetings, with two meetings devoted to the teacher's approach to understanding ethnomathematics and four meetings devoted to classroom observation. Semi-structured interviews were conducted with teachers and 20 students to determine the transformation of teachers and the influence of ethnomathematics that impacted changes in the character of learning in the classroom. The researchers also collected various artifacts in the form of student worksheets, student notes, and ethnomathematics-based learning media. In addition, the research instruments used included observation guidelines, interview guidelines, and documentation sheets.

The data obtained was then analyzed cyclically and continuously, both during the field process and after the research activities had been carried out. The analysis was conducted following Spradley's model, which included: (1) domain analysis to identify the profile of ethnomathematics implementation applied by teachers, (2) taxonomic analysis to classify the improvement in students' cognitive abilities before and after receiving ethnomathematics treatment, (3) component analysis to compare the transformation of teacher performance before and after the implementation of ethnomathematics and changes in students, and (4) theme analysis (synthesis) to conclude the influence of ethnomathematics on teacher transformation and improvement in students' cognitive abilities. Data validity was tested through source triangulation, technique triangulation, and member checking.

The research flow is shown in Figure 1 below, which illustrates the stages from pre-fieldwork to conclusion.

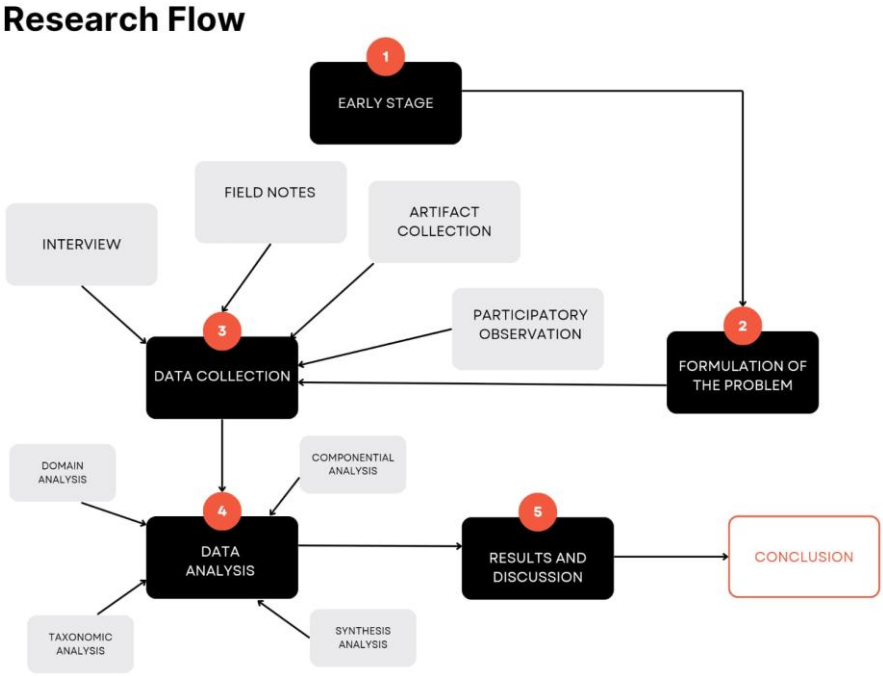


**Figure 1.** The research flow

## 3. RESULTS AND DISCUSSION

### 3.1 Results

This section presents various findings obtained through data collection using descriptive qualitative methods containing domains, taxonomies, components, and synthesis to thoroughly discuss the implications contained in the research objectives. The data collection and analysis process produced several key findings to describe the integration of ethnomathematics, analyze student perceptions, and identify the cognitive impact on students.

#### 3.1.1 Teacher transformation in the adaptation of ethnomathematics-based contextualized learning

Initial findings based on artifacts, observations, and interviews describe that the teachers who were the subjects of the study experienced difficulties in adapting the formal learning curriculum to the ethnomathematics learning framework. These difficulties arose because of the perception that mathematics is too abstract and rigid, making it difficult to combine with cultural elements in the surrounding environment. As a result of this

perception, teachers found it difficult to develop an ethnomathematics framework and to analyze the compatibility of the surrounding culture with mathematics. After identifying the problems experienced by teachers, the researchers assisted by giving various references and videos through in-depth participatory observation.

This paradigm shift made things significantly easier for teachers. Teachers showed a change in their perspective on ethnomathematics integration. The aspects observed showed that there were various improvements in teachers' perceptions in the classroom. The aspects observed include: (1) confidence in teaching; (2) the influence of teachers in the classroom on student learning activity; (3) independence in creating good lesson plans that are in line with student learning needs; (4) completion of teaching materials that have been compiled and designed; (5) the use of media and technology in learning; (6) student-centered learning in the learning process; (7) upgrading learning from fully utilizing textbooks to actively utilizing students' technology; and (8) the existence of in-depth learning that focuses on students. The results observed in these aspects can be seen in Figure 2.

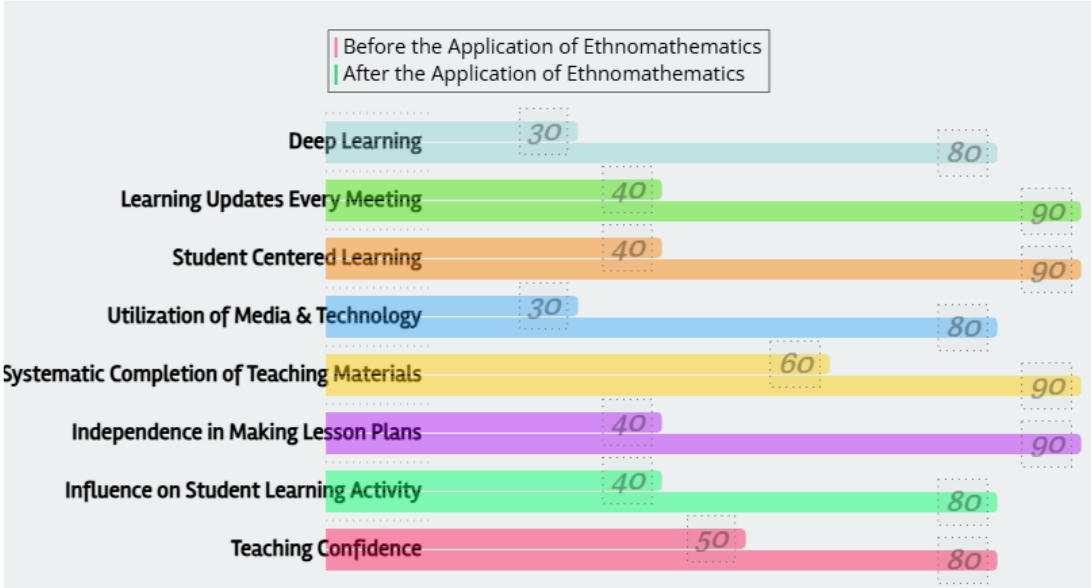


**Figure 2.** Observation Results and Field Notes on the Comparison of Teacher Percentages Before and After Implementing Ethnomathematics

### 3.1.2 Changes in students' perceptions and responses to mathematics

Researchers observed a phenomenon that can be described as passive silence in the classroom. During traditional mathematics lessons, participatory observation captured images of students in the back rows physically turning their bodies away from the blackboard, propping their chins up, or busily scribbling random notes in their notebooks. Brief contextual interviews with several students during breaks captured a uniform participant perspective that led to the conclusion that mathematics was perceived as a dry subject full of formulas that was far removed from their lives. A student with the initials SA (Interview, 03/09/2025) said, “That's how math is, sir. It's all numbers. The important thing is to memorize the formulas for the exam, and after that, it's enough to just forget about it.” This perspective confirms the perception of mathematics as an abstract

procedural burden that must be completed, rather than a useful cognitive tool..

After the emergence of this perspective, researchers and teachers discussed implementing a new learning style. A new idea emerged to explore and utilize ethnomathematics learning tailored to the social environment of the students. Field notes taken in class on student behavior, learning styles, and activity and collaboration in ethnomathematics-based learning showed a drastic change in the perception of mathematics learning. Students showed positive changes in their perception of mathematics with increased enthusiasm and involvement when ethnomathematics-based mathematical problems were integrated. In fact, in previous meetings, many students were lazy in participating in mathematics learning activities and were bored because they were always related to solving mathematical formulas.

Field notes show a striking change in terms of activity and classroom life. When the teacher brought in cultural artifacts in the form of a barter system in trade, students who were previously passive became more dominant in learning. In-depth observations captured new things, such as students whispering to each other, not to chat about topics outside the lesson, but to relate the material to their experiences. Phrases such as, “Oh, this is like the barter system at my grandfather's house” or “I just learned how to calculate it that way” were heard. From the participants' perspective, this moment was a turning point that made mathematics no longer an abstract concept, but a concrete concept that was relevant to the students' daily lives. Engagement increased as students connected the material to their personal experiences.

In addition, researchers observed a shift from isolated individual work to spontaneous and fluid group discussions. In these groups, the quality of dialogue changed. Students no longer asked the teacher, “What formula do we use for this?” but instead debated among themselves, with comments such as “I don't think this is the way to measure the algebraic pattern; it's faster to use the method my father taught me,” to which another student replied, “But can your method be used for all algebraic barter processes?” This shows an increase in the use of mathematical reasoning. The debates, which had never occurred before, show that students now view mathematics as a language for analyzing, testing, and validating cultural reality, not just for answering questions in a math book.

This is reinforced by a comparison of the results of interviews in the classroom with 20 students before and after the observation. The aspects observed and questioned by the researcher included changes in responses to the latest mathematics learning, interest in learning changes, the ability to analyze mathematical problems, interest in preparing for learning in advance, completeness in solving mathematical problems, and student activity in discussing and asking questions. The results observed in the interviews can be seen in Figure 3 below.

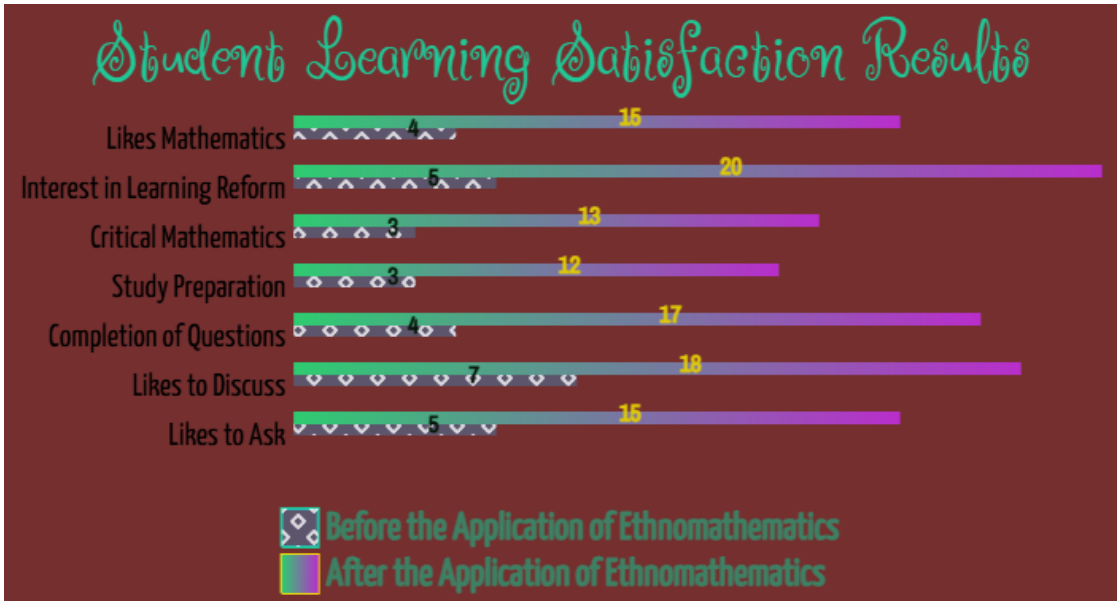


**Figure 3.** Results of Learning Satisfaction Interviews with 20 Students

### 3.1.3 The impact of ethnomathematics on students' cognitive levels and learning completeness

Teachers showed a change in perception after the intervention. Observations showed that students felt bored and lazy in mathematics learning. From the participants' perspective, mathematics was perceived as a procedural burden that was far removed from students' lives, limited to solving dry formulas. As a result, in previous activities, students often stopped at the level of understanding the material (C2) and immediately lost interest in learning when faced with problems that required application (C3) or analysis.

The class, which was previously passive, is now filled with active collaboration. Students are no longer afraid to ask questions, but instead raise critical questions and engage in productive debates. Students have begun to dare to use mathematical logic, both among students and with teachers, to solve authentic problems raised from their cultural reality.

The most significant finding based on this influence is an increase in students' cognitive abilities in the classroom. Quantitative data based on final assessment artifacts in the form of daily tests shows that out of 20 students, 16 students (80%) achieved scores above the minimum passing grade of 70. In addition, analysis based on portfolio artifacts and field notes from class discussions shows a shift in cognitive levels that are increasingly developing. Students began to be able to apply C4 skills, aka the ability to analyze and dissect various problems and mathematical structures in cultural objects presented by teachers in ethnomathematics-based learning. This clearly shows that the impact of ethnomathematics on students' cognitive levels and learning completeness greatly influences the success of mathematics learning when applied in the deep learning curriculum. Ultimately, these holistic findings show that the success of ethnomathematics in stimulating students' cognitive development is highly dependent on the success of the teachers' paradigm shift. The results of the comparison of student averages can be seen in

Figure 4.

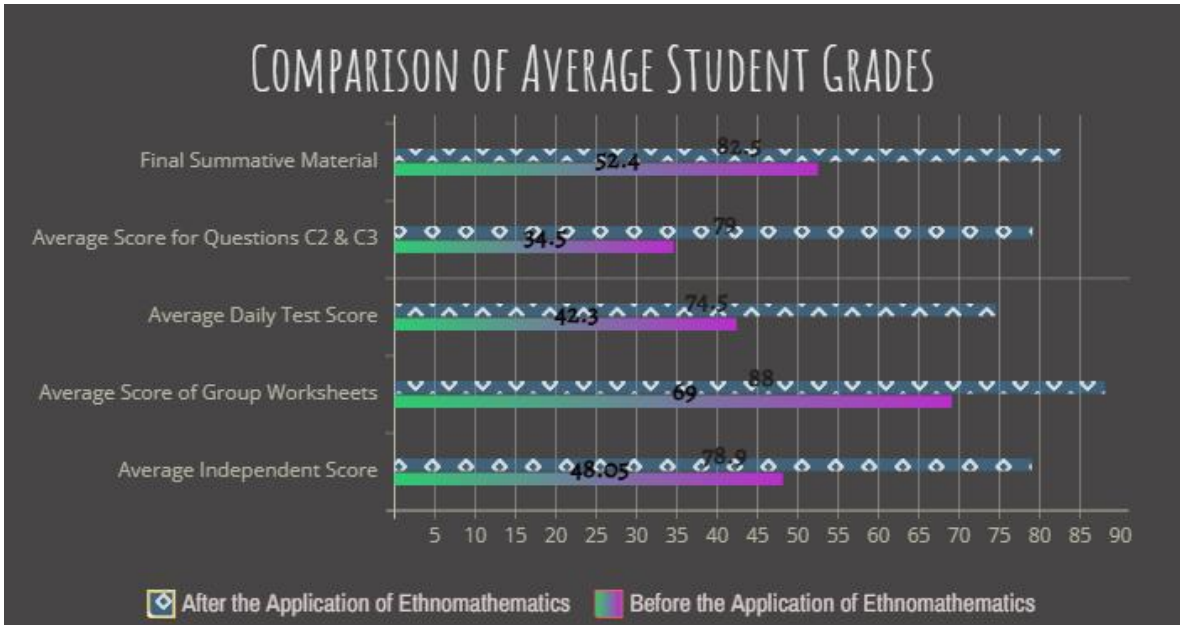


**Figure 4.** Comparison of Average Student Scores

## 3.2 Discussion

### 3.2.1 Teacher transformation in the adaptation of ethnomathematics-based contextualized learning

The main challenge in mathematics learning stems from the lack of contextual learning adaptation. Students are unable to perceive the reality and contextualization of mathematics learning because complex mathematics learning is not yet available. Based on this, the deconstruction of the perception that mathematics is rigid must begin with teachers first (Khasanah et al., 2025). Furthermore, Aulia & Sutiarso (2025) explain that the turning point experienced by teachers in the process of adapting ethnomathematics provides awareness that contextual mathematics learning based on student experience and reality can be the key to the successful implementation of student cognitive level development goals. Therefore, teachers can begin to use contextual activities as a source of learning for students by combining artifacts created to solve mathematical problems.

The process of teacher transformation with the main objective of developing students' cognitive abilities is gradual but holistic. First, by making learning relevant and comfortable (contextual), it can drastically trigger students' interest in learning. This is in line with the opinion of Fairus et al. (2025) who stated that when students are interested and feel psychologically secure, their understanding of mathematical concepts increases because they can relate them to existing knowledge. This increase in interest and understanding then becomes the foundation for triggering the development of higher cognitive levels in students, such as the ability to analyze, evaluate, and create. The focus of teachers, who initially taught by looking for objects to provide a deeper understanding, has now shifted to observing students' learning activities based on cultural experiences learned through ethnomathematics.

After identifying the problems experienced by teachers, the intervention carried out by researchers through participatory observation and provision of references became a catalyst for solving the problems experienced by teachers. This is in line with the opinion of Prahmana et al. (2021) that assistance and provision of references help teachers

understand alternative cultural integration in learning. This process slowly deconstructed the teachers' perception by renewing the meaning that mathematics and culture can dialogue harmoniously. Furthermore, Irawan et al. (2025) emphasized that in-depth participatory observation allows for reflective dialogue, where teachers do not feel judged for their difficulties but are guided to find common ground themselves. Providing these references validates that ethnomathematics is a serious field, while also encouraging teachers to begin analyzing their surroundings through new lenses and perspectives.

This marks a turning point in the paradigm shift of ethnomathematics. Teachers begin to analyze cultural elements in their surroundings using mathematics that is suitable for classroom learning materials (Harding, 2021). Wulandari et al. (2024) mention that teachers began to realize one essence of ethnomathematics, namely that ethnomathematics is not merely matching and applying standard mathematical formulas, but rather deep learning adjustments with adaptations to the comfort and contextuality of students to learn through their cultural experiences. Thus, teachers have a better understanding of how to integrate ethnomathematics and adapt it to teaching objectives to increase students' interest in learning and understanding, thereby triggering the development of students' cognitive levels. This new understanding has directly given rise to transformative pedagogical practices (Putri et al., 2024). Teachers are now able to adapt to students' comfort and context as the main foundation of their learning. Mathematics is no longer introduced as a foreign concept that only involves formulas, but is explored from the students' own realistic cultural experiences.

### 3.2.2 Changes in students' perceptions and responses to mathematics

In line with previous research, Prahmana, et al. (2021) argued that ethnomathematics is capable of providing a new perspective with the emergence of the latest contextual learning offerings based on the realities of students' lives, thereby triggering in-depth exploration of historical life and mathematical life. Furthermore, Octaria et al. (2025) add that the most significant impact is seen in the improvement of students' cognitive abilities through ethnomathematics. This is empirical evidence that by seeing mathematics learning as relevant to life, students are able to derive abstract concepts from the mathematics they learn. The findings of this study support the urgency of a paradigm shift from textual to contextual-cultural learning. Critically, this indicates that students' cognitive abilities will be much stronger when they can construct their own knowledge through direct interaction with cultural realities, rather than simply passively receiving knowledge transfer. Therefore, learning is no longer abstract but becomes more contextual and complex through cultural integration.

When contextual and complex ethnomathematics was implemented, there was a drastic change in classroom activity. Student enthusiasm and engagement skyrocketed because students finally realized that mathematics could be used as a very relevant tool in everyday life. This shows that the level of student learning completeness with ethnomathematics-based learning is very high and affects the cognitive development of almost all students in the class (Sulistyowati & Mawardi, 2023). In contrast, in previous activities, students only reached the level of understanding mathematical material, always stopping and showing no interest in learning when given application problems (Maharani & Waluya, 2023).

### 3.2.3 The impact of ethnomathematics on students' cognitive levels and learning completeness

The implementation of complex ethnomathematics and contextualization of

students can bring about significant changes and spark new ideas in the classroom. In line with Permana's (2023) opinion that mathematics can be a tool in students' daily lives and is highly relevant to them. This implementation can bring about changes in students by changing the way they learn, often collaborating to analyze the connection between teaching materials and real life based on students' cultural experiences (Naja et al., 2022). This has a positive impact on students who were previously passive and had low interest in learning, becoming more active by raising questions and debates with both teachers and fellow students, using mathematical logic to solve the problems given.

The new idea that mathematics is highly relevant to students is not just a slogan, but a reality observed in classroom practice. Based on the results, students view mathematics as a relevant skill, not just memorization. Students are now active participants in debates and collaboration, not because of teacher instructions, but because they can find deep cognitive and personal relevance in the learning process, which directly stimulates their cognitive development to a higher level. This is in line with the opinion of Lubis et al. (2021) that, holistically, the in-depth description carried out by researchers validates that the implementation of ethnomathematics has succeeded in fundamentally changing the meaning of mathematics in the eyes of students. Furthermore, Santika et al. (2025) emphasize that from the participants' perspective, mathematics is transformed from a foreign object of formula memorization into a relevant and empowering everyday tool.

Thus, ethnomathematics is an effective strategy for improving the quality of mathematics learning and students' cognitive development. This is in line with the findings that students begin to associate mathematical concepts with family/environmental experiences. These results are in line with research conducted by Prahmana & D'Ambrosio (2020) that ethnomathematics can influence and utilize values such as moral, historical, and philosophical values, which can be felt, reflected, and applied in daily life, such as values that teach leadership, good deeds, and so on for learning activities. This success overcomes the problem of minimal interaction in the classroom and offers contextual learning that triggers in-depth exploration. The practical implications of this research indicate that teachers need to be trained to integrate cultural contexts into learning.

Teachers play an important role in designing contextual and environment-based learning. This success provides practical insights for teachers and curriculum developers to update learning schemes in Indonesia towards a Deep Learning curriculum, with an emphasis on improving teachers' ability to integrate ethnomathematics evenly and sustainably. For curriculum development, this study provides empirical evidence that flexibility in integrating local content is an absolute prerequisite for supporting the Deep Learning paradigm. The curriculum should not only focus on accelerating the completion of dense teaching materials, but should also provide autonomy for schools to insert time for in-depth cultural exploration.

This study has major limitations in terms of the relatively small scope of participants and the highly specific local cultural context, so the findings must be generalized with caution. The cultural artifacts and social norms raised in ethnomathematics learning in this study are closely tied to the demographics of the local area, which may not have the same relevance or impact when applied to students from different cultural backgrounds or in multicultural areas. Furthermore, the success of this intervention is highly dependent on the personal closeness and intensity of mentoring between the researcher and model teachers through participatory observation, which may be difficult to replicate on a large scale without a structured and sustainable training system.

## 4. CONCLUSION

This study shows that integrating ethnomathematics into mathematics learning can increase students' interest and motivation, as well as have a positive impact on their cognitive development. Ethnomathematics as a contextual approach allows teachers to design learning that is relevant to the local culture. Teachers who are skilled and have sufficient knowledge of ethnomathematics can design and integrate ethnomathematics into contextual and environment-based mathematics learning.

The application of ethnomathematics in mathematics learning can also improve student learning completeness, where 80% of students achieved learning completeness in the final assessment. In addition, there was a shift in cognitive level from memorization and understanding to application and analysis, indicating that students were able to understand mathematical concepts more deeply. Students showed an increase in cognitive abilities compared to their previous learning achievements. This shows that ethnomathematics can be one strategy to improve the quality of mathematics learning. Therefore, efforts need to be made to improve teachers' ability to integrate ethnomathematics into mathematics learning, so as to improve student learning outcomes and the overall quality of mathematics education.

Meanwhile, for further research, it is recommended that the study be expanded to include more diverse demographic variations in order to test ethnomathematics on a larger scale in different or mixed (heterogeneous) cultural contexts. Future researchers need to explore how the teacher transformation framework found in this study can be formulated into a standardized yet flexible professional training model so that it can be applied without full dependence on intensive researcher assistance. Further research could use standardized instruments to measure improvements in higher-order thinking skills to assess improvements in critical thinking and non-routine problem-solving integrated into cultural contexts. Longitudinal studies are needed to assess the sustainability of ethnomathematics practices in practice. This aims to identify factors that support or hinder teacher independence in implementing and developing ethnomathematics, so that these findings do not merely remain as case studies.

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