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Ethnomathematical Exploration of the Javanese Adrem Cake

Muhammad Mahlil Aliman Maba[1], Deny Hadi Siswanto[2], Muhammad Yusuf Rambe[3]*

[1]Mercu Buana Yogyakarta University, Yogyakarta, Indonesia
[2]Yogyakarta State University, Yogyakarta, Indonesia
[3]Al-Wasathiyah University, Husaisa, Yemen
*Correspondence: E-mail: denyhadi.2024@student.uny.ac.id

A B S T R A K

Mengungkap keterkaitan antara praktik budaya dan konsep matematika yang tertanam di dalamnya adalah suatu hal yang sangat penting. Tujuan utama penelitian ini adalah untuk menelusuri bagaimana aktivitas budaya dapat mencerminkan pemikiran matematis yang sistematis dan terstruktur. Penelitian ini merupakan penelitian etnomatematika yang menggunakan metode deskriptif kualitatif dengan pendekatan etnografi pendidikan untuk mengungkap dan mendeskripsikan konsep-konsep matematika yang terkandung dalam praktik budaya pembuatan kue tradisional Adrem masyarakat Jawa. Data dikumpulkan melalui observasi langsung, wawancara mendalam, dan dokumentasi visual terhadap pengrajin kue, guru matematika, serta siswa sekolah dasar yang mengikuti pembelajaran berbasis budaya. Keabsahan data dijamin melalui teknik triangulasi sumber dan metode, sedangkan analisis data mengikuti model interaktif Miles dan Huberman yang meliputi reduksi, penyajian, dan penarikan kesimpulan. Hasil penelitian menunjukkan adanya penerapan nyata konsep geometri (simetri dan lipatan), perbandingan dan proporsi, volume bangun ruang, serta pola urutan dan repetisi dalam setiap tahap pembuatan Adrem cake. Temuan ini menegaskan bahwa pembelajaran matematika berbasis budaya lokal dapat meningkatkan pemahaman konseptual, kemampuan berpikir analitis, serta apresiasi terhadap kearifan lokal. Dengan demikian, etnomatematika berperan sebagai jembatan antara matematika formal dan praktik sosial budaya masyarakat.

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A B S T R A C T

Uncovering the links between cultural practices and the mathematical concepts embedded within them is crucial. The main objective of this research is to examine how cultural activities reflect

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systematic and structured mathematical thinking. This study was an ethnomathematical study employing a qualitative descriptive method with an educational ethnography approach to explore and describe the mathematical concepts embedded in the cultural practice of making the traditional Adrem cake among the Javanese community. Data were collected through direct observation, in-depth interviews, and visual documentation involving traditional cake artisans, mathematics teachers, and elementary school students engaged in culture-based learning. The validity of the data was ensured through source and method triangulation, while the data analysis followed the interactive model of Miles and Huberman, which includes data reduction, data display, and conclusion drawing. The findings reveal the practical application of several mathematical concepts such as geometry (symmetry and folding), ratio and proportion, spatial volume, and sequence and repetition patterns in each stage of the Adrem cake-making process. These results emphasize that culture-based mathematics learning enhances students' conceptual understanding, analytical thinking skills, and appreciation of local wisdom. Therefore, ethnomathematics serves as a bridge between formal mathematics and the social-cultural practices of the community.

Geometry
Volume
Sequence Pattern

1. INTRODUCTION

Mathematics learning has often been perceived as an abstract field, detached from everyday life. However, in various cultural practices, many activities inherently contain mathematical elements often without conscious awareness such as in cooking, weaving, or crafting. Regarding culture and mathematics, the term ethnomathematics, according to Rosa and D'Ambrosio (2016), refers to an effort to understand how different cultural groups develop and apply mathematical ideas, concepts, and practices within their own life contexts. In the context of Indonesian education, the implementation of ethnomathematics is essential to foster contextual conceptual understanding, strengthen character, and instill appreciation for local culture (Siswanto et al., 2025). Thus, integrating local culture into mathematics learning not only serves as an instructional aid but also as a means of preserving local wisdom values.

One form of local culture that embodies ethnomathematical values is traditional cake-making. Across various regions in Indonesia, traditional cakes are not only culinary products but also reflect the community's philosophy, social symbolism, and practical knowledge (Rosa & Orey, 2020). Adrem cake is one of the traditional cakes from Bantul Regency, Yogyakarta, characterized by its unique shape resembling a blooming flower or folded triangle. Its traditional production process involves numerous mathematical aspects such as measuring ingredients, comparing proportions, geometric forms, and sequential patterns in the cooking process. These characteristics make Adrem cake a potential object of study in ethnomathematics, as it demonstrates a close relationship between culture and mathematical concepts.

Bantul Regency is known as one of the regions that continues to preserve Javanese culinary traditions, including the making of Adrem cake. Local communities often

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prepare this cake for traditional ceremonies, communal feasts, and other social events. Within these practices, mathematical reasoning is applied across generations for example, calculating ingredient quantities based on the number of guests or adjusting the size of each cake for uniformity (Fatmawati, Mariana, & Ekawati, 2025). This phenomenon shows that mathematical knowledge does not always originate from formal education but can also develop naturally through social and cultural experiences (Siswanto et al., 2025). Therefore, studying the Adrem cake production process can provide new insights into how local communities apply mathematical concepts in their daily lives.

Beyond its cultural significance, the ethnomathematical exploration of Adrem cake also holds educational relevance. Culturally based mathematics learning has been proven to enhance students' learning motivation and conceptual understanding, as it connects abstract concepts with their lived experiences (Risdiyanti & Prahmana, 2018). Teachers can utilize Adrem cake as a contextual medium to teach various mathematical topics such as geometry (through shape and symmetry), arithmetic (through ratios and proportions of ingredients), and number patterns (through sequential steps in the cooking process). In this way, students not only grasp formulas and symbols but also realize their practical applications in meaningful, culturally rich activities.

Furthermore, the ethnomathematical approach to Adrem cake aligns with the Merdeka Belajar paradigm, which emphasizes contextual, collaborative, and value-based learning grounded in local wisdom (Risdiyanti & Prahmana, 2018). Through this research, teachers and students can utilize local culture as a dynamic and living source of learning. Moreover, ethnomathematical exploration can support the development of numeracy and cultural literacy, two key competencies emphasized in the Merdeka Curriculum. This approach is expected to yield learning models that not only enhance academic achievement but also strengthen students' cultural identity.

Therefore, the study entitled "Ethnomathematical Exploration of the Traditional Adrem Cake" is essential to uncover the interconnection between cultural practices and the mathematical concepts embedded within them. This research is expected to contribute to the development of ethnomathematics theory in Indonesia and enrich culturally based mathematics teaching strategies. Additionally, the findings may inspire educators to design contextual learning materials that harmoniously integrate cultural values, scientific reasoning, and mathematics (Apriwulan et al., 2025; Syah, Siswanto, & Purwanti, 2025).

2. METHOD

The research method employed in this ethnomathematical study of the Adrem cake was a qualitative descriptive approach with an educational ethnography design. The study aims to reveal and describe the mathematical concepts embedded in the cultural practices of traditional Javanese cake-making. The research was conducted through several stages, including direct observation, in-depth interviews, and visual documentation of the Adrem production process in traditional manufacturing centers. The research instruments include

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observation, interviews, and documentation guidelines. The participants of the study consisted of cake artisans, mathematics teachers, and elementary school students involved in culture-based learning activities. Data were collected using triangulation of sources and methods to ensure the validity and reliability of the information obtained (Naufal et al., 2025).

Data analysis was carried out interactively following the Miles and Huberman (2020) model, which includes data reduction, data display, and conclusion drawing. The analytical focus was directed toward identifying mathematical elements such as symmetry, proportion, volume, and sequential patterns that emerged throughout the Adrem cake-making process. Furthermore, the analysis explored the relevance of these mathematical concepts to the development of contextual mathematics learning based on local culture. This methodological approach not only reveals the implicit presence of mathematical reasoning in traditional practices but also provides a framework for integrating cultural heritage into mathematics education.

3. RESULTS AND DISCUSSION

Geometric Concepts: Symmetry and Folding

The Adrem cake, a traditional Javanese delicacy shaped like a blooming flower or a folded triangle, exemplifies the geometric concepts of reflectional and rotational symmetry. When observed from above, its structure displays a balanced composition that reflects mirrored symmetry between the right and left sides (Siswanto, et al., 2024). This distinctive form is not coincidental but rather the result of the artisan's craftsmanship, which unconsciously applies mathematical reasoning to achieve visual harmony and proportionality. According to Barton (2020), such cultural artifacts embody implicit mathematical structures that demonstrate how traditional practices naturally incorporate mathematical logic and aesthetic order. Therefore, the artistic process behind Adrem cake-making reflects the integration of cultural creativity with systematic geometric thinking.

In the educational context, the Adrem cake provides an authentic and tangible medium for introducing students to the concepts of symmetry, folding, and spatial reasoning. Through direct observation and exploration, learners can identify the number of folds, axes of symmetry, and proportional relationships embedded in the cake's shape. This experience connects mathematical abstraction to real-life cultural practices, allowing students to perceive mathematics as a living, contextualized discipline rather than a purely theoretical construct. As affirmed by Rosa and D'Ambrosio (2016), embedding mathematics in cultural settings fosters deeper conceptual understanding because learners engage through familiar and meaningful experiences that bridge traditional knowledge and formal education.

Moreover, incorporating cultural objects such as the Adrem cake into geometry lessons strengthens students' appreciation of local wisdom while promoting mathematical

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literacy. Fauzi et al. (2022) and Siswanto et al. (2024) emphasize that culturally responsive mathematics learning enhances student engagement, critical thinking, and long-term retention of concepts. By exploring mathematical ideas through the Adrem cake, educators not only preserve cultural heritage but also develop pedagogical models that integrate ethnomathematics with modern curriculum standards. This synergy between culture and mathematics education highlights the potential of local traditions as powerful tools for conceptual learning and identity formation in the classroom.

In addition to symmetry, the Adrem cake can also be used to teach the concepts of area and perimeter. If modeled as an isosceles triangle, students can calculate the area using the formula

$$A = \frac{1}{2} \times base \times height$$

For example, if the cake's base measures 6 cm and the height 5 cm, then the area is 15 cm². Such activities strengthen students' spatial abilities and foster appreciation for the beauty of natural forms. These findings are consistent with Rochmat et al. (2025), who demonstrated that the use of contextual objects in geometry learning significantly improves students' spatial understanding. Thus, learning mathematics through the form of the Adrem cake not only introduces geometric concepts but also integrates local cultural and aesthetic values. This supports the argument of Ramadhani et al. (2023), who stated that ethnomathematics plays an important role in bridging formal mathematics with social and cultural practices, enabling students to both understand mathematical concepts and appreciate the cultural wisdom from which those concepts originate.

Concepts of Ratio and Proportion: Ingredient Measurement

In the process of making Adrem cake, achieving the ideal balance of flavor and texture depends greatly on the precise proportion of ingredients, particularly the ratio between glutinous rice flour and palm sugar, which is traditionally maintained at 2:1. This means that two parts of flour are combined with one part of palm sugar to produce a harmonious blend of sweetness and consistency. Such proportional relationships illustrate a real-world application of mathematical reasoning deeply embedded in daily cultural practices. As noted by Gerdes (2018), traditional artisans often perform complex mathematical operations intuitively, without formal training, demonstrating how local knowledge systems embody practical mathematics through experience and observation. This proportional balance in Adrem cake-making thus represents a tangible form of ethnomathematics that connects cultural identity with mathematical precision.

In the context of mathematics education, the proportional concept inherent in Adrem cake-making can serve as a concrete learning medium for teaching ratios and proportional reasoning. Teachers can engage students in hands-on activities such as adjusting ingredient quantities when scaling up or down the number of cakes while maintaining the original ratio. This contextualized approach transforms abstract

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numerical relationships into meaningful real-life scenarios, allowing students to grasp mathematical ideas through experiential learning (Heryuriani et al., 2025; Nugroho et al., 2025). According to Rosa & Orey (2016), integrating local cultural practices into mathematics education enhances students' cognitive engagement and helps them relate mathematical principles to their everyday environment. Consequently, cultural contexts like traditional cooking become powerful pedagogical tools for fostering deeper mathematical understanding.

Moreover, applying culinary ethnomathematics in the classroom nurtures both cognitive and cultural competencies among learners. Kintoko (2024) emphasizes that incorporating familiar cultural activities, such as traditional food preparation, significantly improves students' comprehension of proportional reasoning because it connects symbolic mathematical representations with authentic daily experiences. By exploring the proportional logic behind Adrem cake-making, educators not only contextualize mathematics instruction but also promote appreciation for local wisdom and heritage. This synergy between mathematics and culture underscores the importance of ethnomathematical approaches in creating relevant, engaging, and culturally sustaining mathematics education.

For example, if 10 cakes require 400 grams of flour and 200 grams of palm sugar, then producing 25 cakes would require 1,000 grams of flour and 500 grams of palm sugar. Through such exercises, students learn to apply proportional reasoning and think logically within a real-world context. This aligns with Pramesworo et al. (2023) findings, which suggest that culture-based learning strengthens functional numeracy skills because students realize that mathematics is embedded in daily activities such as cooking, trading, and farming. Overall, the application of ratio concepts in Adrem cake making demonstrates how mathematics emerges from the community's practical needs. This reinforces Hartoyo et al. (2024) view that ethnomathematics serves as a bridge between formal mathematics and social experience, making learning more contextual, reflective, and culturally grounded.

Concepts of Volume and Three-Dimensional Forms: Dough Expansion

When Adrem cakes are fried, the initially dense dough undergoes a remarkable transformation as hot air penetrates its structure, causing it to expand and increase in volume. This physical process exemplifies the mathematical concept of volume expansion and the principles of three-dimensional geometry. As the batter swells, it forms a rounded shape that reflects natural spatial growth, showcasing how heat and air interact to create geometric transformations. According to Yanti (2025), traditional cooking methods often illustrate fundamental mathematical and scientific laws that can be explained through measurable patterns of change in shape, size, and volume. Thus, the frying process of Adrem cake not only represents a culinary art but also demonstrates an implicit application of geometric and physical reasoning in everyday life.

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The final form of the Adrem cake, often resembling a hemisphere or truncated cone, provides an excellent example for introducing the concept of solid geometry in mathematics education. Students can observe and model the cake's shape to explore geometric elements such as surface area, volume, and curvature. By analyzing this transformation, learners can connect theoretical formulas to tangible cultural products, making abstract mathematical ideas more concrete and engaging. Barton (2020) asserts that contextualizing mathematical concepts through cultural artifacts enables students to perceive mathematics as an integrated aspect of their environment, thereby promoting deeper conceptual understanding. Consequently, the Adrem cake serves as a meaningful bridge between local culture, science, and mathematical education.

Furthermore, incorporating phenomena like the frying expansion of Adrem cakes into classroom instruction fosters inquiry-based and culturally relevant learning experiences. Students can conduct experiments by varying frying time, temperature, or ingredient composition to observe corresponding changes in shape and volume, thereby applying mathematical reasoning to real-world contexts. Efendi et al. (2025) and Syah et al. (2025) highlight that culturally grounded and experimental learning enhances critical thinking and problem-solving skills by engaging students in observation, measurement, and reflection. Therefore, the Adrem cake frying process embodies a practical ethnomathematical example where cultural practice, scientific understanding, and mathematical modeling converge to enrich educational outcomes.

In classroom practice, this phenomenon can serve as a medium for introducing the concept of solid volume. Teachers may ask students to model the cake as a half-sphere and calculate its volume using the formula.

$$V = \frac{1}{2} \times \frac{4}{3} \times \pi r^3$$

For example, if the cake's radius is 3 cm, the volume is approximately 56.52 cm^3. Such activities strengthen students' ability to connect mathematical theory with empirical experience. This finding is consistent with Prahmana & D'Ambrosio (2020), who noted that using local phenomena as a learning context significantly enhances students' mathematical modeling skills.

Furthermore, this expansion process highlights the relationship between mathematics and science, particularly regarding heat and changes in volume. Teachers can relate it to physical principles, creating an interdisciplinary connection between mathematics and science. Yulanda et al. (2023) supports this view, asserting that interdisciplinary integration based on local contexts improves students' analytical thinking and holistic problem-solving abilities. Hence, the Adrem cake is not merely a traditional delicacy but a tangible representation of mathematical concepts in daily life. Culture-based learning of this kind makes mathematics more relevant, contextual, and grounded in students' real-world experiences.

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Concepts of Pattern and Repetition: The Making Process

The process of making Adrem cakes follows a systematic and repetitive sequence that begins with ingredient preparation, followed by mixing, shaping, and frying. Each of these stages must be executed in a specific order to produce the ideal texture, flavor, and form of the cake. This structured process embodies the mathematical concept of sequencing, where every action logically connects to the next to achieve a coherent outcome. According to Barton (2020), such ordered patterns within traditional practices reflect inherent mathematical organization and procedural logic found in cultural activities. Thus, the Adrem cake-making sequence demonstrates that local artisans unconsciously apply algorithmic thinking, even without formal exposure to mathematical notation or symbolic representation.

From a mathematical perspective, the sequential stages in Adrem cake-making resemble a problem-solving algorithm, where each procedure directly influences the final result. When the number of cakes produced increases progressively in each frying batch, the relationship can be modeled as an arithmetic sequence representing growth through consistent repetition. This real-life example allows learners to connect algorithmic steps with tangible cultural experiences, bridging procedural understanding and abstract reasoning. As noted by Lestari et al. (2024), learning based on repetitive cultural activities strengthens students' logical reasoning and fosters a deeper comprehension of arithmetic progression and sequencing concepts. Consequently, the Adrem cake-making process provides a relevant and authentic context for teaching mathematical patterns through lived cultural experiences.

Moreover, the recognition of sequencing and repetition in cultural practices such as Adrem cake production highlights the value of ethnomathematics in education. Integrating these cultural algorithms into classroom learning not only enhances students' cognitive understanding but also promotes appreciation for local wisdom and heritage. Akbar et al. (2021) and Fitriana et al. (2025) emphasize that mathematical learning grounded in community practices cultivates critical and creative thinking while validating students' cultural identities. Therefore, studying the procedural logic in Adrem cake-making demonstrates how traditional craftsmanship can serve as a foundation for developing algorithmic and mathematical thinking, making mathematics more meaningful and culturally inclusive.

As an example, if the first frying yields 5 cakes and each subsequent frying adds 3 more, then after the sixth frying, the total number of cakes produced would be 75. Through this exercise, students can understand that the concept of arithmetic sequences exists not only in numbers but also in real-life activities such as cooking. This approach supports Susanti et al. (2023) research, which shows that local cultural patterns can provide strong contexts for teaching the concepts of pattern and mathematical regularity. Thus, the process of making Adrem cakes teaches order, precision, and discipline values that align closely with mathematical logic. Such learning supports Nur et al. (2021) and

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Purnami et al. (2022) assertion that ethnomathematics not only teaches formal concepts but also instills systematic thinking values reflected in the cultural practices of society.

4. CONCLUSION

Based on the analysis of various mathematical concepts embedded in the process and shape of the Adrem cake, it can be concluded that ethnomathematics plays a crucial role in connecting local culture with formal mathematics education. Through the Adrem cake, students can understand geometric concepts (symmetry and folding), ratios and proportions, the volume of three-dimensional shapes, as well as patterns and sequences in a concrete, contextual, and meaningful way. These activities not only strengthen students' conceptual and numerical abilities but also foster appreciation for local wisdom and develop systematic and analytical thinking skills. Therefore, it is recommended that teachers utilize cultural objects such as traditional cakes in mathematics learning, as culture-based approaches can enhance the relevance of learning materials, motivate students, and make mathematics more closely connected to everyday life. Therefore, the researcher also suggests that future researchers conduct more research on cultural aspects and elements related to mathematics so as to further increase the knowledge base related to ethnomathematics.

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