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Exploring Mathematical Concepts in Traditional Javanese Cakes

Mayang Nabila[1*], Rusydi Ananda[2]
[1*,2]Mathematics Education Program, Universitas Islam Negeri Sumatera Utara
Jalan IAIN No. 1, Medan, Indonesia
[1*]mayang0305212056@uinsu.ac.id; [2]rusydiananda@uinsu.ac.id

ABSTRAK

Penelitian ini bertujuan mengeksplorasi konsep-konsep matematika yang terkandung dalam proses pembuatan dan karakteristik kue tradisional suku Jawa. Metode penelitian menggunakan pendekatan kualitatif deskriptif dengan teknik observasi, wawancara mendalam kepada pembuat kue tradisional, dan analisis dokumentasi. Sampel penelitian meliputi sepuluh jenis kue tradisional Jawa yaitu klepon, cenil, wajik, onde-onde, getuk, lupis, kue lapis, putu Bambu, nagasari, dan serabi. Hasil penelitian menunjukkan bahwa terdapat berbagai konsep matematika yang terintegrasi dalam kue tradisional Jawa meliputi geometri (bentuk lingkaran, bola, prisma segitiga, balok, belah ketupat, tabung, persegi panjang, silinder kecil), konsep pecahan dan rasio dalam komposisi bahan, pola simetri pada hiasan kue, konsep volume dan kapasitas dalam takaran, transformasi geometri pada teknik pembentukan, serta konsep bilangan dan operasi hitung dalam resep. Temuan ini mengindikasikan bahwa kue tradisional Jawa dapat dijadikan media pembelajaran matematika kontekstual yang bermakna. Matematika seringkali dipersepsikan sebagai mata pelajaran abstrak dan sulit dipahami oleh peserta didik. Pengintegrasian konteks budaya lokal, khususnya kue tradisional, dapat menjembatani kesenjangan antara konsep abstrak dengan pengalaman nyata siswa. Penelitian ini memberikan kontribusi terhadap pengembangan etnomatematika dan pembelajaran matematika berbasis budaya lokal, sekaligus upaya pelestarian warisan kuliner tradisional.

Kata Kunci: etnomatematika; geometri; kue tradisional Jawa; pembelajaran kontekstual; kearifan lokal.

ABSTRACT

This study aims to explore the mathematical concepts contained in the process of making and the characteristics of traditional Javanese cakes. The research method uses a descriptive qualitative approach with observation techniques, in-depth interviews with traditional cake makers, and documentation analysis. The research sample includes ten types of traditional Javanese cakes, namely klepon, cenil, wajik, onde-onde, getuk, lupis, kue lapis, putu Bambu, nagasari, and serabi. The results show that there are various mathematical concepts integrated in traditional Javanese cakes including geometry (circle, sphere, triangular prism, cuboid, rhombus, tube, rectangle, small cylinder), the concept of fractions and ratios in ingredient composition, symmetry patterns in cake decorations, the concept of volume and capacity in measurements, geometric transformations in forming techniques, and the concept of numbers and arithmetic operations in recipes. These findings indicate that traditional Javanese cakes can be used as a meaningful contextual mathematics learning medium. Mathematics is often perceived as an abstract subject and difficult for students to understand. Integrating local cultural contexts, especially traditional cakes, can bridge the gap between abstract concepts and students' real experiences. This research contributes to the development of ethnomathematics and local culture-based mathematics learning, as well as efforts to preserve traditional culinary heritage.

Keywords: ethnomathematics; geometry; traditional Javanese cakes; contextual learning; local wisdom.

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1. INTRODUCTION

Mathematics, as a universal science, has been an integral part of human life since ancient times. However, a prevailing perception in society views mathematics as abstract, rigid, and disconnected from everyday life (Ali, Lestari, & Rahayu, 2023). This perception contributes to students' difficulties in understanding mathematical concepts, as they struggle to relate mathematics to their lived experiences (Sirate, 2021).

In the context of mathematics education in Indonesia, the conventional approach remains predominantly teacher-centered and seldom integrates students' local cultural backgrounds. This stands in contrast to the goals of the national curriculum, which emphasize the importance of culturally based learning to enhance students' understanding and appreciation of cultural heritage (Kemendikbud, 2022; Mellawaty et al., 2023).

In the context of mathematics learning in Indonesia, the integration of local cultural values is an urgent need, in line with the mandate of the national curriculum to develop learning based on local wisdom. Local culture-based learning effectively enhances conceptual understanding while providing contextual and meaningful learning, and supports the achievement of quality education goals as mandated by the Sustainable Development Goals. The use of traditional Javanese cakes as a medium for mathematics learning allows students to recognize geometric shapes in a familiar and meaningful context (Maulida and Ghufron, 2025).

Ethnomathematics, as a field of study that connects mathematics with cultural contexts, offers a promising solution to address this issue. The term ethnomathematics was first introduced by D' Ambrosio in 1985, referring to mathematical concepts practiced within specific cultural groups, such as urban and rural communities, laborers, children of certain age groups, and Indigenous populations (Nurhayati, 2020; Afriansyah & Sugiarti, 2025).

Mathematical concepts are highly relevant to the Indonesian educational context, given the nation's rich cultural diversity. Each region in Indonesia possesses unique traditions and local wisdom, including in the culinary domain. Traditional kueh (Indonesian traditional desserts) are part of the country' s culinary heritage, carrying not only historical and social significance but also embedded mathematical concepts that can serve as effective learning media (Wahyuni, 2019; Vrasetya & Nasution, 2024).

According to Arnasih & Hartaya in the journal Khoirunnisah & Rusydi (2024), self-concept in mathematics learning refers to students who have a positive attitude toward mathematics and are enthusiastic about learning. Students with a good self-concept are more confident in expressing opinions, manage situations calmly, and consistently think positively and creatively, resulting in satisfaction with their achievements.

According to Utomo in Rismawati, Mara and Tanti (2024), ethnomathematics-based learning has advantages, namely students create their own knowledge, so students do not easily

forget their knowledge, the learning atmosphere is fun because it uses real life that is closely related to the surrounding culture so that students do not get bored quickly in learning mathematics. Students feel appreciated and more open, because every answer received is valuable, prioritizes teamwork and trains students' courage in solving problems, educates students to be accustomed to thinking and persuades students to express their opinions.

Several previous studies have explored ethnomathematics in various Indonesian cultural contexts. Haryanto et al.'s (2022) study examined ethnomathematics in Javanese batik motifs and discovered various geometric transformation concepts. Meanwhile, Supriadi et al. (2023) identified mathematical concepts in Javanese traditional house architecture.

However, ethnomathematics studies specifically exploring mathematical concepts in traditional Javanese cakes are still very limited, particularly those conducted outside Java, such as in Medan, North Sumatra. The ethnomathematical study of Medan' s traditional kueh holds great According to Albanese and Perales (2024), exploring ethnomathematics in a traditional culinary context is highly significant because culinary practices are universal activities experienced by all cultural groups and involve the practical application of various mathematical concepts. Furthermore, Meaney et al. (2021) stated that mathematics learning that integrates traditional culinary contexts can increase student motivation because it is concrete, contextual, and meaningful. This opinion is supported by Palhares (2023), who found that students showed high enthusiasm when learning mathematics through the exploration of cultural practices familiar to their lives.

The traditional Javanese cakes that are the focus of this research were chosen because of their unique characteristics in terms of shape, manufacturing process, ingredient composition, and presentation techniques, which incorporate interesting mathematical concepts worth exploring. The ten types of traditional cakes selected, Klepon, Wajik, Serabi, Putu Bambu, Naga Sari, Onde-Onde, Kue Lapis, Lupis, Getuk, and Cenil, represent the diversity of geometric shapes and the complexity of their manufacturing processes (Nugroho & Darmawan, 2024).

The perfectly spherical shape of klepon embodies the concept of spherical geometry and consistent diameter measurements.Wajik, the geometric principles of proportion and volume, particularly the properties of the rhombus, are applied in traditional culinary arts.Serabi, molded into a flat circle, demonstrates the concepts of plane geometry and rotational symmetry. Putu Bambu, molded in a bamboo tube, reflects the concepts of cylinders and volume. Naga Sari, wrapped in a rectangular banana leaf, embodies the concepts of surface area and proportion. Onde-Onde, covered in sesame seeds on a spherical surface, embodies the concepts of spherical surface area and density. Kue Lapis (Lapis cake) with its colorful layers illustrates the concepts of patterns, number sequences, and thickness. Lupis, shaped like a triangle or rhombus, embodies the concepts of plane geometry. Getuk, shaped rectangular or molded with a specific pattern,

embodies the concepts of plane geometry and symmetry. Cenil, shaped like a small cone or short cylinder, embodies the concepts of plane geometry and proportion (Permatasari et al., 2025). Medan was chosen as the research location because it is an area with high ethnic diversity, including a sizable Javanese community that still maintains Javanese culinary traditions (Siahaan & Situmorang, 2023).

An interesting phenomenon is that, despite being located outside of Java, the Javanese community in Medan continues to preserve traditional cake-making traditions using techniques and recipes passed down through generations. This makes Medan a strategic location to explore how mathematical knowledge in traditional Javanese cakes is maintained and practiced in diverse geographic and sociocultural contexts.

From a mathematics education perspective, this research has significant pedagogical implications (Fauzi et al., 2023). According to Verner et al. (2022), integrating ethnomathematics into mathematics learning can improve students' mathematical literacy by connecting abstract concepts with familiar, concrete contexts. Furthermore, François and Pinxten (2021) emphasized that ethnomathematics-based mathematics learning can enhance students' appreciation of local culture while developing a deeper understanding of mathematics. These findings indicate that the results of this exploratory research into mathematical concepts in traditional Javanese cakes have the potential to be developed into an innovative and contextual mathematics learning resource.

Beyond pedagogical aspects, this research also holds significance in the context of cultural preservation. In the era of globalization and modernization, traditional cake-making practices face a serious challenge in the form of declining interest among the younger generation in learning and preserving them (Kusumawati & Wibowo, 2024). By uncovering the mathematical values inherent in traditional cakes, it is hoped that this will increase public appreciation, especially among the younger generation, for local wisdom and encourage efforts to preserve traditional culinary culture (Arwanto et al., 2023).

Based on the description above, this research is important and urgent given the limited ethnomathematics studies on traditional Javanese cakes, particularly in the Medan region, and the significant potential of this research to contribute to the development of culture-based mathematics learning and the preservation of traditional culinary heritage. This research is expected to fill the gap in the literature on Javanese culinary ethnomathematics while also providing practical contributions to education and cultural preservation.

2. METHOD

This study employs a qualitative research approach using ethnographic methods. This approach enables the researcher to deeply examine ethnomathematical phenomena within the

context of local culture. The research is descriptive in nature, aiming to illustrate and analyze data collected from traditional kueh artisans.

The data analysis technique used is thematic analysis. Data obtained through observation and interviews will be categorized into relevant themes, such as measurement, patterns, and geometry found in the traditional kueh. Once categorized, the researcher will conduct data reduction to filter the most pertinent information and interpret the findings within the framework of ethnomathematics.

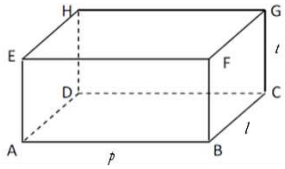
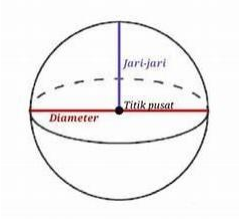
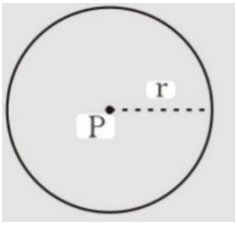
3. RESULT AND DISCUSSION

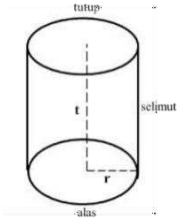
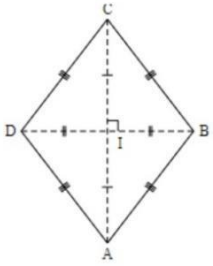
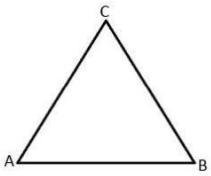
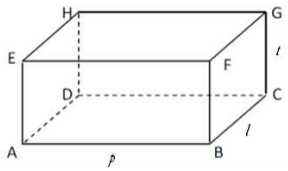
Based on in-depth analysis of ten types of traditional kueh from Medan, a variety of mathematical concepts were identified. These include plane geometry, solid geometry, measurement, comparison, and other mathematical principles (See Table 1 & 2).

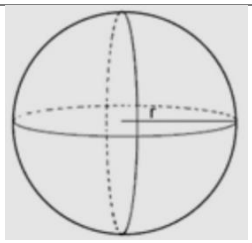
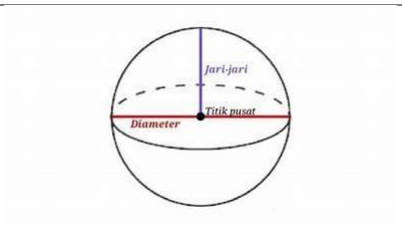
Table 1. Mathematical Concepts in Traditional Javanese Cakes

No	Name of *Kueh*	Geometric Shape	Mathematical Concepts	Formulae
1	*Klepon*	Sphere	Volume, Surface Area, Diameter, Radius	$L = 4\pi r^2$, $V = \frac{4}{3}\pi r^3$
2	*Serabi*	Flat circle	Diameter, Surface Area, Circumference, Radius	$L = \pi r 2$, $K = 2\,\pi r$
3	*Putu Bambu*	Tube	Diameter, Height, Volume, Surface Area, Radius	$V = \pi r^2 t$, $L = 2\pi r^2 + 2\pi r t$
4	*Nagasari*	*Rectangle*	Volume, Length, Width, Height	$V = p \times l \times t$, $L = 2(pl + pt + lt)$
5	*Wajik*	Rhomb	Surface Area, Diameter, Circumference, Side	$K = 4 \times s$ $L = \frac{1}{2} \times d_1 \times d_2$
6	*Onde-onde*	Sphere	Volume, Surface Area, Layers, Thickness	$V = \frac{4}{3}\pi r^3$, $L = 4\pi r^2$
7	*Lapis*	Bar	Volume, Length, Width, Height, Surface Area, Circumference	$V = p \times l \times t$, $L = 2(pl + pt + lt)$, $K = 4(p + l + t)$
8	*Lupis*	triangle	Side, Area, Circumference, Base, Rib, Height	$L = \frac{1}{2} \times a \times t$ $K = Sisi\,A + Sisi\,B + Sisi\,C$
9	*Cenil*	Small ball	Radius, Height, Volume, Area	$V = L_a \times t = \pi r^2 t$, $L_p = 2 \times L_a + L_s = 2\pi r^2 + 2\pi r t$, $L_{selimut} = k \times t = 2\pi r t$
10	*Getuk*	Bar	Volume, Length, Width, Height, Surface Area, Circumference	$V = p \times l \times t$, $L = 2(pl + pt + lt)$, $K = 4(p + l + t)$

Table 2. Geometric Concepts in Traditional Medan Kueh

No	Ethnomathematics	Geometry	Description
1	*Lapis* 	 Bar	This concept is excellent for introducing fractions. Each layer can represent one portion of a whole cake, and students can visualize how a single cake is divided into equal portions (e.g., 1/2, 1/3, etc.).
2	*Klepon* 	 Sphere	A round cake filled with brown sugar, symbolizing the sweetness of life behind its simple appearance. Students can identify the spherical shape, calculate the approximate volume or surface area of klepon (for advanced students), and use whole numbers when counting the number of klepon in a serving.
3	*Serabi* 	 Circle	A flat cake made from rice flour, cooked in a small pan, often served with coconut milk and brown sugar sauce. Its round shape symbolizes perfection or wholeness. Students can learn about the diameter, radius, circumference, and area of a circle.

No	Ethnomathematics	Geometry	Description
4		 Cylinder	Traditional cakes steamed in bamboo tubes make a distinctive sound when cooked. The bamboo tube shape symbolizes simplicity and closeness to nature. Students can calculate the tube's volume and surface area using measurements from a real bamboo mold.
5	*Wajik* 	 rhomb	A traditional ceremonial dish, its sticky texture symbolizes a strong and lasting unity. Wajik is cut into a rhombus shape. Students can learn about symmetry, area, and volume, as well as the concept of fractions, by dividing a single wajik tray into equal pieces.
6	*Lupis* 	 Triangle	This form allows exploration of the concepts of triangles, lines of symmetry, and calculations of plane shapes.
7	*Getuk* 	 Beam	In the form of a cuboid that is cut into neat pieces. Students can learn the concepts of: right-sided solid shapes (cubes/cubes), volume, surface area, symmetry, and even division.

No	Ethnomathematics	Geometry	Description
8	*Cenil* 	 Small ball	Shaped like small balls or irregular spheres. Students can learn concepts like basic circle/sphere shapes, counting, comparison (large-small), and quantity estimation.
9	*Nagasari* 	 Rectangular Prism	Banana cakes made with rice flour and coconut milk, wrapped in banana leaves, are often served at celebrations. The banana leaf wrapping is often neatly folded to form a geometric shape. Students can analyze the shape of a prism and its relationship to the net of the geometric shape (banana leaf used as wrapping).
10	*Onde-onde* 	 Sphere	In the shape of a ball. Students can learn the concepts of: curved- sided geometric shapes (balls), radius, diameter, volume, and surface area, similar to klepon.

According to Gerdes (2018), measurement in ethnomathematics reflects a deep understanding of proportion and balance in everyday life. Rosa and Orey (2021) argue that comparison and proportion in ethnomathematics demonstrate the application of mathematical ratios within authentic cultural contexts. Presmeg (2018) suggests that calculating volume and surface area in ethnomathematical contexts provides a more concrete spatial understanding than abstract instruction.

Table 3. Comparison of Geometry and Mathematical Concepts in 10 Types of Cakes

Kueh	Geometry Form	Mean of Dimension	Volume / Area	Key Concepts
Lapis	Layered Cuboid	20 × 20 × 4 cm	V total = 1600 cm³; V per lapis = 228 cm³	Repeating patterns, sequences, proportional distribution
Klepon	Sphere	d = 2,7 cm r = 1,35 cm	V = 10,3 cm³; A = 22,9 cm²	Spherical geometry, nested structures, volume estimation
Serabi	Circle	d = 9 cm; r = 4,5 cm; t = 1 cm	A = 63,6 cm²; V = 63,6 cm³	Circle, flattened cylinder, random pore distribution
Putu Bambu	Cylinder	d = 3,5 cm; h = 5,5 cm	V = 52,9 cm³; A = 60,5 cm²	Cylinder, vertically layered structure, thickness proportion
Nagasari	Rectangular Prism	p = 11 cm; l = 4,5 cm; t = 2,5 cm	V = 124 cm³; A = 194 cm²	Prism, 2D→3D transformation, bilateral symmetry
Lupis	Triangle	Sisi 6 cm; tinggi 3,5 cm	A = 10,5-28 cm²	Triangle, cone, shape transformation
Cenil	Small ball	p = 2,5 cm; d = 1 cm	V = 1,31 cm³	Ellipsoid, dimension ratio, distribution
Getuk	Rhombus	d = 3,5 cm, h = 5,5 cm; Balok: 3 × 3 × 5 cm	V = 45-53 cm³	Cylinder/cube, color proportion distribution
Wajik	Rhombus	d_1 = 6,5 cm; d_2 = 6,2 cm; t = 2,75 cm	A = 20,15 cm²; V per potong = 55,4 cm³	Rhombus, tessellation, geometric transformation
Onde-onde	Ball	d = 4,5 cm; r = 2,25 cm	V = 47,7 cm³; A = 63,6 cm²	Layered sphere, volume expansion, surface density

The findings demonstrate how volume and surface area concepts are applied in traditional kueh geometry (See Table 3). Each shape exhibits varying levels of spatial efficiency, which can be analyzed through its volume-to-surface ratio.

According to Moore et al. (2018), descriptive statistical analysis provides a comprehensive overview of data characteristics in ethnomathematical research.

Contribution to D' Ambrosio' s Theory

1. According to D' Ambrosio (2020), ethnomathematics refers to mathematical practices observed within identifiable cultural groups, such as national societies, labor communities, children of specific age groups, and professional classes.
2. Implicit Mathematics: The people of Medan apply complex mathematical concepts in the making of traditional kueh without consciously recognizing them as mathematical practices.
3. Cultural Context: Each geometric form of kueh carries specific cultural meaning beyond its practical function.

4. Knowledge Transmission: Mathematical knowledge is passed down through cultural practices across generations, rather than through formal education.

Curriculum Integration Recommendation

According to Gerdes (2021), integrating ethnomathematics into the curriculum can make mathematics learning more relevant and meaningful for students. The following Table 4 outlines recommended integration of mathematical concepts derived from traditional kueh into various educational levels.

Table 4. Integration of Mathematical Concepts from Traditional Kueh into the Curriculum

Grade Level	Mathematical Concept	Traditional *Kueh*	Learning Activity
Elementary Grades 1 – 3	Basic Geometric Shapes	Klepon, Serabi, Onde-onde, Cenil	Identifying ball shapes (klepon, Onde-onde, and cenil) and circles (serabi) in the context of traditional food
Elementary Grades 4-6	Measurement and Area	Nagasari, Wajik, Lapis	Measuring the actual dimensions of a prism-shaped nagasari, calculating the surface area of a diamond with a rhombus shape, and analyzing the layered structure of a layered cake to understand the concept of flat surface area.
Junior High-Grade 7	Volume of Solid Shapes	*Putu Bambu, Nagasari, Getuk*	Calculating the volume of various geometric shapes using kueh as a concrete model: the volume of a cylinder in bamboo putu, the volume of a prism in nagasari, and the volume of a block in getuk using traditional food as a concrete medium.
Junior High-Grade 8	Surface Area of a Geometric Shape	*Lupis, Lapis, Getuk*	Calculating the surface area of a geometric shape by analyzing the triangular prism-shaped Lupis net, and comparing the surface area of lapis and getuk.
Junior High-Grade 9	Comparison and Proportion	*Klepon, Onde- onde, Getuk, Cenil*	Analyze the ratio of ingredient composition in traditional cake recipes and calculate the ratio in the production process.
Senior High-Grade 10	Advanced Geometry and Symmetry	Wajik, Lupis, Serabi	Analyzing the line and rotational symmetry of diamonds, calculating the angles of triangular lupis, and exploring the properties of circles in serabi.
Senior High-Grade 11	Statistics and Data Analysis	All Traditional Cakes	Collecting and analyzing data on dimensions, weight, and composition of various traditional cakes using descriptive statistics.
Senior High-Grade 12	Optimization and	Getuk, Nagasari, Klepon	Optimizing production costs, calculating maximum profits, and analyzing the efficiency of traditional cake production using advanced mathematical

Grade Level	Mathematical Concept	Traditional *Kueh*	Learning Activity
	Mathematical Applications		concepts.

4. CONCLUSION

An ethnomathematics exploration of mathematical concepts in traditional Javanese cakes reveals an extraordinary wealth of mathematical knowledge embedded in the region's culinary heritage. These concepts include: (1) Geometry of plane and solid shapes—spheres, cylinders, rectangular prisms, rhombuses, circles, triangles, and small spheres; (2) Measurement in various aspects—volume, mass, length, time, using standard and non-standard units; (3) Comparison and proportion of ingredients that determine product quality; (4) Repeating patterns and layered structures that reflect the concepts of sequences and rows; (5) Geometric transformations in product formation; (6) Geometric optimization and efficiency in cutting and shaping; (7) Distribution and density in layering complementary ingredients.

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AUTHOR BIOGRAPHY

Full Name of the First Author accompanied by their Title (11 PT, Bold)

Born in Medan, on 26 June 2002. Faculty member at FITK. Completed undergraduate studies in Mathematics Education at Universitas Islam Negeri Sumatera Utara, Medan, in 2025.

Rusydi Ananda

Born in Tanjung pura, on 01 january 1972. Lecturer at FITK in Mathematics Education at Universitas Islam Negeri Sumatera Utara.