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Exploration of Ethnomathematics in Traditional Javanese Cakes

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Abstract

Mathematical concepts are used to explore the existence of mathematics in Javanese culture, expecially in traditional Javanese food. Given the current research that discusses traditional Javanese food/cakes is very rare and there is still a lack of public knowledge about ethnomathematics. This study aims to explore the concept of geometry contained in traditional Javanese cakes. This study is qualitative research was conducted in Prapat Janji Village, Buntu Pane District. The instruments used are human instruments. Researchers communicate directly with the object of research and actively participate in data collection, both in literature studies, interviews, documentation, surveys, and observations. The results of this study showed that the traditional Javanese cake there is the concept of flat Geometry on *Getuk* (Rhombus), *Wajik* (Parallelogram), *Serabi* (Circle), *Lupis* (Triangle), *Kue Lumpur* (Cylinder), *Lemper* (Cylinder), *Kue Jadah* (Cube), *Klepon* (Sphere), *Kue Lapis* (Cuboid). Ethnomathematics in traditional Javanese cakes can be used as a source of learning mathematics geometry material.

1. Introduction

Education is very important and is a right for everyone (Batubara & Reflina, 2022). Education is a process to nurture and develop potential in accordance with the cultural values present in society (Sujana, 2019). Education functions to develop potential as well as knowledge mastery and the development of functional personality attitudes in accordance with the values present in society and culture (Rahman, 2022).

One form of education provided in schools is learning mathematics. Mathematics is a subject taught at every level of education, both formal and non-formal (Wahyudi & Nasution, 2023). Mathematics is one of the mandatory subjects in school (Dosinaeng et al., 2020). Mathematics is a comprehensive science and very beneficial for life (Rudyanto, 2019). Mathematics is one of the branches of science that plays a role in enhancing critical, logical, and mathematical thinking skills (Maysarah, Saragih, et al., 2024). Mathematics is a science that has many applications in everyday life. (Maysarah et al., 2023). Therefore, mathematical proficiency is very important due to its connection with various fields of science (Maysarah, Armanto, et al., 2024).

In the implementation of learning, there should be a learning strategy that supports the achievement of learning objectives (Simangunsong et al., 2022). In the process of lesson planning, educators are tasked with preparing teaching materials that can support the learning process, thereby achieving the learning objectives optimally (Yahfizham et al., 2023). Educators are also required to be skilled in utilizing learning media that will be used in the learning process to achieve active, effective, and efficient learning (Machrani et al., 2023). The use of good learning media can have a positive impact on students (Liesandra & Nurafni, 2022).

Ethnomathematics is an approach to mathematics education based on local culture (Sabon et al., 2021). Ethnomathematics is a form of mathematics influenced by or based on culture (Soebagyo & Rohim

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Andriono, Muhammad Razfy, 2021). The existence of ethnomathematics encourages the realization of a learning process connected with culture (Naja et al., 2021).

Mathematics and culture are two things that are interconnected with each other. (Putri et al., 2023). When culture, mathematics, and education are combined, this is called ethnomathematics (Sa'o et al., 2022).

Ethnomathematics is an abnormal and dynamic representation that produces mathematical habits in the use of that culture (Wahyuni, 2021). Hardiati defines ethnomathematics as a branch of mathematics suitable for understanding certain social cultures (Suripah et al., 2021). Mathematical concepts found in culture contribute to formal mathematics education in schools (Nursyeli & Puspitasari, 2021). Ethnomathematics is a mathematical practice or mathematical activity specifically carried out by a cultural group (Khairunnisa et al., 2022).

Ethnomathematics is a mathematical concept found within a culture (Pratiwi & Pujiastuti, 2020). Ethnomathematics is a form of mathematics influenced by or based on culture (Soebagyo & , Rohim Andriono, Muhammad Razfy, 2021) and is a special method in mathematical activities (Mei et al., 2021). Ethnomathematics presents mathematical concepts by embedding concepts related to the culture of the community (Situmorang, 2020). Ethnomathematics has become a study that shows the reciprocal relationship between culture and mathematics (Fitriza et al., 2022). Ethnomathematics is the study of the relationship between culture and mathematics (Rawani, D. dan D. F, 2022). Culture is practiced in the daily lives of society, while mathematics is a branch of science for solving everyday problems (Dinda Jasaputri, Fibri Rakhmawati, 2022). Ethnomathematics is also referred to as a science that helps to understand how mathematics can be adapted to culture, showing the relationship between culture and mathematics (Sinaga & Yahfizham, 2023).

The Javanese are the largest ethnic group in Indonesia, originating from Central Java, East Java, and the Special Region of Yogyakarta. In 2010, at least 40.05% of Indonesia's population was of Javanese ethnicity (Statistik Indonesia, 2019). Besides the three provinces, the Javanese people also reside in Lampung, Jakarta, North Sumatra, Riau, South Sumatra, Banten, and East Kalimantan. The cultures of the various tribes in Indonesia are deemed necessary to be introduced to the community, especially to students in schools. One form of culture that needs to be introduced to students is traditional Javanese cakes. In these traditional Javanese cakes, there are geometric concepts that students need to learn to make classroom learning more engaging.

Some previous studies have conducted research on ethnomathematics (Rusmayanti & Sutirna, 2021; Isnaningrum, 2023). Although researchers have found many ethnomathematics studies, none of these studies have discussed Traditional Javanese Cakes. Therefore, the researchers believe that further research is needed on "Exploration of Ethnomathematics in Traditional Javanese Cakes." This research is expected to provide input, motivation, and innovation related to mathematics education, especially in geometry. The purpose of this study is to explore the geometric concepts found in traditional Javanese cakes in order to explain the ethnomathematics from of the cake so that it can become a learning resource for teachers when teach in the classroom.

2. Methods

This research was a qualitative study (Murdiyanto, 2020) with the approach taken being an ethnographic approach. This research method aims to study, understand the worldview, and describe the culture of a particular community group (Astuti et al., 2023).

The instrument used is a Human Instrument. The researcher communicates directly with the research subjects and actively participates in data collection, whether through literature studies, interviews, documentation, surveys, or observations. This research was conducted in Dusun VII Bangun Rejo, Prapat Janji Village, Buntu Pane District, Asahan Regency, North Sumatra Province, and involved interviews with the Javanese community in Dusun VII, Prapat Janji Village, Buntu Pane District, Asahan Regency, North Sumatra Province. In the research process conducted, the time required is approximately 3 months, from June to August 2024. This research aims to describe the results of exploring the forms of ethnomathematics in traditional Javanese cakes related to geometric shapes.

Data collection was carried out using three techniques, namely observation, interviews, and documentation. Interviews were conducted to understand the history, types, and forms of traditional

Javanese cakes. Documentation was carried out to obtain data and information. Data and research sources use primary and secondary data.

Data analysis was a process of systematically searching for and organizing data obtained from observations, interviews, and documentation. (Fauzi et al., 2022). The data analysis technique used in this research is taxonomic analysis. Taxonomic analysis is conducted to reveal the geometric elements in traditional Javanese cakes that can be used in mathematics education in schools. The analysis is based on interviews with research subjects and observations of traditional Javanese cakes, including *Getuk, Wajik, Serabi, Kue Jada, Putu Ayu, Lupis, Lemper, Kue Lumpur, klepon,* and *Kue Lapis*, with a focus on the similarities between the mathematical elements in these traditional cakes and the geometric concepts taught in schools.

3. Results & Discussions

3.1. Results

Ethnomathematics is an approach in mathematics education that is influenced by or based on culture. Mathematics and culture are two interconnected aspects, with mathematics shaped by culture and mathematics used as a tool in daily life. Ethnomathematics serves as a bridge between culture and mathematics as well as mathematics and culture. When culture, mathematics, and education are combined, this is called ethnomathematics. Researchers conclude that ethnomathematics is a cultural activity of society tied to the science of mathematics, thus becoming an idea for learning and applying mathematics in community life, especially among the Javanese ethnic group.

The Javanese are the largest ethnic group in Indonesia, originating from Central Java, East Java, and the Special Region of Yogyakarta. In 2010, at least 40.05% of Indonesia's population was of Javanese ethnicity. Besides the three provinces mentioned, the Javanese also reside in Lampung, Jakarta, North Sumatra, Riau, South Sumatra, Banten, and East Kalimantan.

Traditional Javanese cakes are not only found on the island of Java, but they can also be found among a group of people in Prapat Janji Village, Buntu Pane District, Asahan Regency, North Sumatra. The community that engages in making traditional cakes to meet their livelihood needs. Traditional Javanese cakes, when viewed and observed directly, appear in shapes resembling flat and three-dimensional forms, which are concepts of geometry.

Geometry is a branch of mathematics that deals with the properties of shapes. Geometry is the understanding of the concepts of various geometric shapes in two-dimensional and three-dimensional forms. Flat shapes are terms for various two-dimensional shapes. Flat shapes are two-dimensional geometry or a shape bounded by straight or curved lines that have perimeter and area. Solid shapes are three-dimensional geometry or space that studies the form, position, size, and properties of various geometric shapes such as cubes, rectangular prisms, prisms, pyramids, cylinders, and so on.

Based on the results of data analysis during interviews, observations, and documentation, the researcher found several research findings regarding ethnomathematics in traditional Javanese cakes within the discussion of geometry, resulting in the following outcomes.

Based on the analysis in Table 1, it can be concluded that there is a geometric concept of a rhombus shape in the *Getuk*.

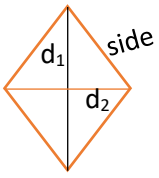


Figure 1. Rhombus

A rhombus is a type of two-dimensional flat shape that has equal-length sides and four edges, and has two pairs of opposite angles that are not right angles but are equal to each other. The properties of a rhombus are as follows.

- ✓ Has 4 pairs of equal-length sides
- ✓ Has 4 opposite and equal-sized angles.
- ✓ Has 2 diagonals of different lengths

- ✓ Has 2 lines of reflectional symmetry
- ✓ Has 2 lines of rotational symmetry
- ✓ Has non-perpendicular sides
- ✓ Has 2 pairs of adjacent angles that sum up to 180°
- ✓ Formula for finding the area of a rhombus: $L = \frac{1}{2} \times d_1 \times d_2$

  Description:
  L: Area of a rhombus or kite
  d_1: First diagonal (length of one diagonal)
  d_2: Second diagonal (length of the other diagonal)
- ✓ Formula for the perimeter of a rhombus: $K = 4s$

  Description:
  $K: Circumference$
  $s: Side$

Table 1. *Getuk* and *Wajik*

Types of cakes	Geometric analysis	Geometric concepts
		Rhombus
		Parallelogram

Based on the analysis of Figure 1, it can be concluded that there is a geometric concept of a parallelogram shape in the *wajik*.

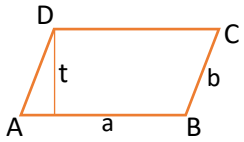


Figure 2. Parallelogram

A parallelogram is is a two-dimensional flat shape that has four sides, where each side is paired with the opposite side and parallel to each other. The main properties of a parallelogram are that the pairs of opposite sides are of equal length and the opposite angles are also equal. In addition, the diagonals of a parallelogram bisect each other in equal lengths. The properties of a parallelogram are as follows:

- ✓ Opposite Sides are Parallel: Every pair of opposite sides in a parallelogram are parallel to each other.
- ✓ Opposite Sides Equal Length: The lengths of opposite sides in a parallelogram are equal.
- ✓ Opposite Angles Are Equal in Magnitude: The magnitudes of opposite angles in a parallelogram are equal.
- ✓ Sum of Adjacent Angles 180 Degrees: The sum of two adjacent angles in a parallelogram is always 180 degrees.

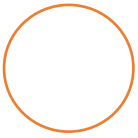
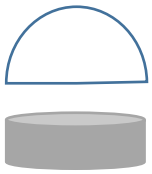
- ✓ Diagonals Divide Two Equal Lengths: The diagonals in a parallelogram bisect each other into two equal length parts
- ✓ Formula for finding the area of a parallelogram: $L = a \times t$

  Description:

  a: $Base$

  t: $Height$
- ✓ Formula for finding the perimeter of a parallelogram: $K = 2\ (a + b)$

Table 2. *Serabi* and *Putu Ayu*

Types of cakes	Geometric analysis	Geometric concepts
		Circle
		Semi-circle and Cylinder

Based on the analysis in Table 2, it can be concluded that there is a geometric concept of the circular shape in *Kue Serabi*.

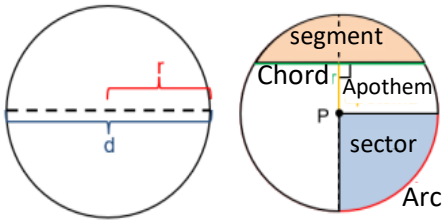


Figure 3. Circle

Explanation:

- Center point (P): the point that serves as the center of the circle located exactly in the middle of the circle.
- Radius (r): the distance between the center of the circle and a point on the circle
- Diameter (d): a line that connects two points on the circle through the center point
- Arc: a curved line on the edge of the circle
- Chord: a line that connects two points on the circle
- Segment: the area bounded by an arc and a chord
- Apothem: a line that connects the center point with the chord (perpendicular to the bowstring)

A circle is the set of points that are equidistant from a certain point. The certain point referred to is the center of the circle, while the equidistant distance is the radius of the circle. The properties of a circle are as follows:

- ✓ Has a total angle of 360°
- ✓ Has a total angle of 180°

- ✓ Has one center point.
- ✓ Has a diameter that divides the circle into 2 equal sides.
- ✓ Has a radius that connects the center point to the arc point of the circle.
- ✓ Its diameter is constant.
- ✓ Formula to find the area of a circle: $L = \pi r^2$
- ✓ Formula to find the circumference of a circle: $K = 2\pi r$

Based on the analysis in Table 2, it can be concluded that there are geometric concepts of cylindrical and semicircular shapes in the *Kue Putu Ayu*.

Figure 4. Semi-circle

A semicircle is half of a circle. A semicircle is formed when a line passes through the midpoint and touches both ends of the circle. The properties of a semicircle are as follows:

- ✓ A semicircle only has one diameter
- ✓ It has a center point, radius, and diameter.
- ✓ Formula for finding the area of a semicircle: $L = \frac{1}{2}\pi r^2$
- ✓ Formula for finding the circumference of a semicircle: $K = \pi \times r$

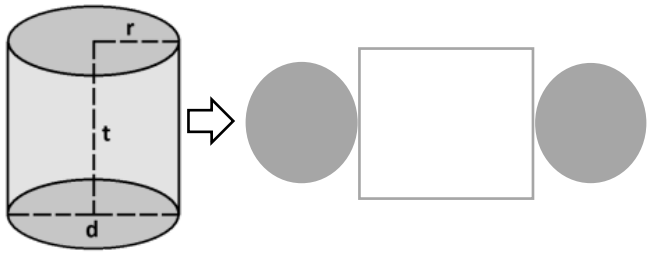


Figure 5. Cylinder

A cylinder is a three-dimensional shape that consists of a top and a base in the form of circles of the same size, with vertical side surfaces covering its body in the form of rectangles. The properties possessed by a cylinder are as follows.

- ✓ Has 3 faces, namely the base, the top, and the lateral surface
- ✓ Has 2 edges
- ✓ Does not have vertices
- ✓ The base and top have the same circular shape
- ✓ The distance between the base and the top is called the height of the cylinder.
- ✓ Formula for the volume of a cylinder: $V = \pi \times r^2 \times t$
  Description:
  V: Volume of tube (cylinder)
  π: Pi, a mathematical constant that is approximately 3.14159
  r: The radius of the base of the tube (radius)
  t: Tube height (cylinder)
- ✓ Formula for the surface area of a cylinder: $Lp = 2 \times \pi \times r \times (r + t)$
  Description:
  Lp: Surface Area

Based on the analysis in Table 3, it can be concluded that there is a geometric concept of a cube shape in the *Kue Jadah*.

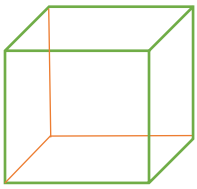
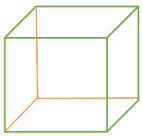


Figure 6. Cube

Table 3. *Kue Jadah* and *Kue Lapis*

Types of cakes	Geometric analysis	Geometric concepts
		Cube
		Cuboid

A cube is a three-dimensional space bounded by 6 congruent square-shaped faces. A cube is also referred to as a regular hexagonal prism. The properties of a cube are as follows:

- ✓ Has 6 congruent faces
- ✓ Has 12 edges of equal length
- ✓ Has 8 vertices of equal size
- ✓ Has 12 face diagonals, 4 space diagonals
- ✓ Has 6 face diagonals
- ✓ Formula for finding the volume of a cube: $V = side \times side \times side$
- ✓ Formula for finding the surface area: $L = 6\ (side \times side)$

Based on the analysis in Table 3, it can be concluded that there is a geometric concept of a rectangular prism in the *Kue Lapis*.

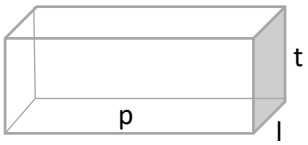


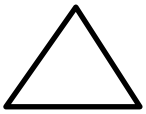
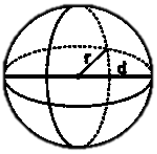
Figure 7. Cuboid

A Cuboid is a three-dimensional shape formed by three pairs of rectangles, with at least one pair being of different sizes. The properties of a Cuboid are as follows:

- ✓ Has rectangular-shaped faces
- ✓ Parallel edges have the same length
- ✓ Each diagonal plane on opposite faces has the same length
- ✓ Has 12 face diagonals or plane diagonals
- ✓ Has 4 space diagonals
- ✓ Has 6 diagonal planes
- ✓ Has 3 pairs of parallel planes

- ✓ Has 12 edges, Has 6 faces, Has 8 vertices
- ✓ Formula for finding the volume of a Cuboid: $V = p \times l \times t$
  Description:
  V : Volume of the beam
  p : Length of the beam
  l : Width of the beam
  t : Beam height
- ✓ Formula for finding the surface area of a Cuboid: $Lp = 2 \times \big((p \times l) + (p \times t) + (l \times t)\big)$
  Description:
  Lp: Surface Area

Table 4. *Kue Lupis* and *Klepon*

Types of cakes	Geometric analysis	Geometric concepts
		Triangle
		Sphere

Based on the analysis in Table 4, it can be concluded that there is a geometric concept of triangular shape in *Kue Lupis.*

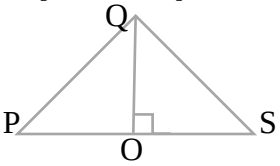


Figure 8. Triangle

A triangular plane figure is a flat shape bounded by three sides that meet and has three vertices. A triangle is a polygon with three edges and three vertices. This is one of the basic shapes in geometry. This triangle has angles equal to 180°. The properties of a triangle are as follows:

- ✓ Having three angles
- ✓ Having three sides
- ✓ Formula for finding the area of a triangle: $L = \frac{1}{2} \times base \times height$
- ✓ Formula for finding the perimeter of a triangle: $K = PQ + QS + SP$

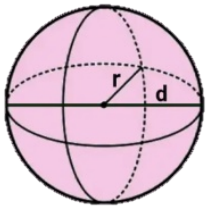


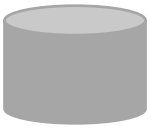
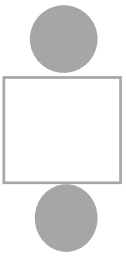
Figure 9. Sphere

Based on the analysis in Table 4, it can be concluded that there is a geometric concept of a spherical shape in *klepon*.

A sphere is a three-dimensional shape formed by an infinite number of circles with equal radius and centered at the same point. A sphere consists of only one curved surface. The properties of a Sphere are as follows:

- ✓ Having one side, a closed curved side
- ✓ No vertices
- ✓ Having one center point
- ✓ Having infinite radii and all the same length
- ✓ Formula for finding the volume of a sphere: $V = \frac{4}{3} \times \pi r^3$
- ✓ Formula for finding the surface area of a sphere: $Lp = 4 \times \pi r^2$

Table 5. *Lemper* and *Kue Lumpur*

Types of cakes	Geometric analysis	Geometric concepts
		Cylinder
		Cylinder

Based on the analysis in Table 5, it can be concluded that there is a geometric concept of the Cylinder shape in *Kue Lemper* and *Kue Lumpur*.

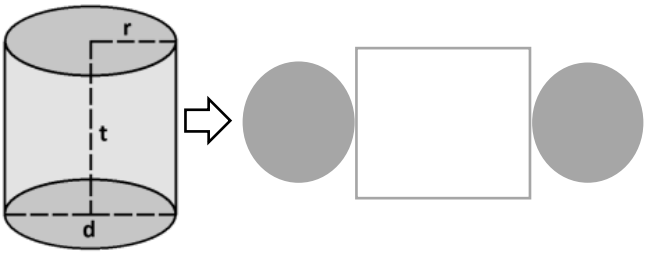


Figure 10. Cylinder

A cylinder is a three-dimensional geometric shape that consists of a top and a base in the form of circles of the same size, with vertical side surfaces that cover its body in the form of rectangles. The properties possessed by a cylinder are as follows:

- ✓ Has 3 faces, namely the base, the top, and the lateral surface
- ✓ Has 2 edges (base and lid)
- ✓ Does not have vertices
- ✓ The base and top have the same circular shape
- ✓ The distance between the base and the top is called the height of the cylinder.
- ✓ Formula for the volume of a cylinder: $V = \pi \times r^2 \times t$

Description:

V: Volume of tube (cylinder)
π: Pi, a mathematical constant that is approximately 3.14159
r: The radius of the base of the tube (radius)
t: Tube height (cylinder)

✓ Formula for the surface area of a cylinder: $Lp = 2 \times \pi \times r \times (r + t)$
Description:
Lp: Surface Area

3.2. Discussion

Traditional Javanese food is not merely a means of communication or a creation of the Javanese community from ancient times to the present. Traditional Javanese cakes have also undergone changes over time. This change occurred due to the passage of time, where traditional Javanese cakes became a daily necessity for the Javanese community and a marker of identity for the Javanese people.

At the Senior High School (SMA) level, learning about building spaces is very important because it provides a strong foundation for understanding more complex and applicable geometry concepts. Spaces studied include various shapes such as cubes, blocks, rectangular prisms, tubes, cones, and spheres. This material not only focuses on calculating volume and surface area, but also involves analyzing geometric properties and application in real situations. For example, students will learn how to calculate the volume and surface area of tubes to determine storage capacity and efficiency, or apply the concept of rectangular prisms in building planning. A deep understanding of geometry allows students to develop critical thinking and problem-solving skills that are needed in various fields, such as architecture, engineering, and science. Therefore, mastery of spatial concepts at the high school level is essential for higher education and professional life.

Ethnomathematics is a field of study implemented to understand mathematics adapted based on the culture of certain communities. In the culture of society itself, there are various kinds such as games, buildings, food/cakes, and so on. Here, the researchers chose traditional cakes as the object in the ethnomathematics study, as we know that traditional cakes have become an identity for the community, especially the Javanese community. The traditional Javanese cakes studied are *Getuk, Wajik, Serabi, Kue Jadah, Putu Ayu, Lupis, Lemper, Kue Lumpur, klepon, and Kue Lapis*.

From the results of geometric concepts, the following geometric shapes were obtained: Rhombus, Parallelogram, Circle, Semicircle, Cube, Cylinder, Triangle, Sphere, and Rectangular Prism. Based on the results of this research, it can be proven that the concepts identified from traditional Javanese cakes can serve as a source of mathematical learning by linking mathematics and culture through traditional cakes in mathematics education, thereby enabling a better understanding of concepts, especially in Geometry learning.

Traditional Javanese cakes, as part of a culture that contains mathematical concepts, deserve to be preserved. Mathematical concepts should be reintroduced, as they are currently fading and being influenced by modernization and the sophistication of information technology. There are many types and shapes of traditional Javanese cakes that have different flavors and forms. Etnomathematics learning can actually make it easier for a teacher in teaching mathematics in the classroom. Classroom learning activities become enjoyable because the teacher uses something that students see every day, like the traditional cake. Ethnomathematics can be one of the solutions for teaching mathematics or other subjects in the classroom, as learning that was initially boring can become enjoyable.

4. Conclusion

Based on the analysis and discussion conducted on traditional Javanese cakes, the researchers concluded that ethnomathematics in traditional Javanese cakes contains many geometric concepts such as Rhombus, Parallelogram, Circle, Semi-circle, Cube, Cylinder, Triangle, Sphere, and Rectangular Prism. Therefore, the mathematical concepts found in traditional Javanese cakes can be used to introduce mathematical concepts through local culture and serve as teaching materials for mathematics lessons in class on Geometry.

Based on the research conclusions, the researchers recommend the following suggestions: 1) Teachers, when teaching contextual learning related to the geometry of traditional Javanese cakes, are advised to use it as a teaching tool in mathematics education. 2)Researchers, a very valuable experience in terms of exploration and as a starting point for researchers for future studies. 3)Readers, as reference material related to ethnomathematics.

The limitation in this study lies in the shape of the traditional cake. In general, what the researchers found in the field is that the shapes of traditional Javanese cakes are relatively the same. However, if subsequent researchers find differences in the shapes of these traditional cakes, those shapes can be used as alternatives for study, especially in the field of geometry.

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