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ALGEBRAIC REPRESENTATION ON SLICE OF MANDAR'S TYPICAL PASO CAKE SHAPE USING THE GEOGEBRA APPLICATION

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ABSTRAK

Penelitian ini bertujuan untuk menganalisis representasi aljabar berupa irisan kue paso khas Mandar dengan memanfaatkan aplikasi GeoGebra. Metode penelitian yang digunakan adalah pendekatan kualitatif dengan analisis deskriptif dengan desain etnografi yang melibatkan observasi dan wawancara dengan masyarakat suku Mandar tertentu. Hasil penelitian ini memberikan informasi lebih lanjut kepada masyarakat Mandar bahwa terdapat hubungan antara matematika dengan budaya mereka. Selain itu, objek kue paso memperkaya pengalaman belajar siswa melalui integrasi budaya lokal dalam pembelajaran matematika dan menunjukkan bahwa penggunaan GeoGebra tidak hanya meningkatkan pemahaman siswa terhadap konsep irisan kerucut tetapi juga dapat meningkatkan kemampuan representasi aljabar geometri dengan lebih mudah. Penelitian ini diharapkan dapat memberikan kontribusi untuk meningkatkan pemahaman siswa terhadap konsep matematika melalui visualisasi yang interaktif dan efektif dalam meningkatkan keterampilan representasi matematika siswa serta pengembangan metode pembelajaran matematika yang lebih kontekstual dan relevan.

Kata Kunci : Etnomatematika, Geogebra, Irisan Kerucut, Metode Pengajaran

ABSTRACT

This study aims to analyze algebra representations in the form of Mandar's typical paso cake slices by utilizing the GeoGebra application. The research method used is a qualitative approach with descriptive analysis with ethnographic design that involves observation and interviews with certain Mandar tribal communities. The results of this study provide further information to the Mandar people that there is a relationship between mathematics and their culture. In addition, the paso cake object enriches students' learning experience through the integration of local culture in mathematics learning and shows that the use of GeoGebra not only improves students' understanding of the concept of cone slices but can also improve the algebraic representation ability of geometry more easily. This research is expected to contribute to improving students' understanding of mathematical concepts through interactive and effective *visualization in improving students' mathematical representation skills as well as the development of more contextual and relevant mathematics learning methods*

Keywords : Ethnomathematics, Cone Slice, Teaching Methods, Geogebra

INTRODUCTION

Mathematics is one of the teaching materials taught at every level of education, which starts from students stepping on the world of education to the lecture period (Putri, 2023; Ulkhaq, 2023). This is of course because learning mathematics has a very important role in overcoming a problem in daily life (Firdaus, 2019). By learning mathematics, students can apply their understanding by applying it to find the best solutions to their problems in real life. That is the reason why students are always guided to be able to understand mathematics. So it will be easy for students to be able to face the development of the times that are increasing continuously, especially in terms of technology.

However, it is very rare for students to be able to understand the concept of mathematics learning, and there are even some students who hate the lesson. Many of the learners feel that math is a very difficult, boring, and scary subject because they think that learning math is only focused on formula games, calculations, and struggling with numbers that sometimes make them find it difficult to understand and end up dizzy. As far as we know, mathematics is one of the learning that requires critical thinking and of course will be needed to sharpen the brain (Fidencia et al., 2024). However, with these competencies, it will be easier to train and grow students' mindset skills so that they are able to solve the problems they face, both in the field of mathematics and problems in daily life (Bela et al., 2019).

Geometry is one of the branches of mathematics which is certainly no less important when compared to various other disciplines. This is because geometric materials have a concept that is very closely related to the context of life (Nur'aini et al., 2017; Trisanti et al., 2024). Thus, the concept of geometry not only plays a role in making it easier for humans to understand and explain the surrounding environment, but also becomes the basic foundation in mastering various other mathematical concepts such as algebra, numbers, and arithmetic. That is why it is important to improve the ability to think geometry which of course can support advanced thinking skills, and this needs to be developed through manipulation and spatial interaction in daily life. In addition, the concept of geometry is closely related to other mathematical concepts and is widely applied in real life (Zuhdi & Reflina, 2024). That is why learning and mastering geometry is an important part of mathematics education.

Recently, mathematical proof in the concept of geometry has become a challenge that results in the development of geometric understanding is felt to be less than optimal (Sundawan et al., 2018). Understanding of the concept of geometry is still very lacking in both students and students, especially in solving problem-solving problems (Unaenah, 2017). The above statement is evident from the results of Andina and Selvia Erita's research *"Analysis of Students' Difficulties in Solving Mathematics Problems in Geometry Materials in Class XII Mas Modern Arafah"* concludes that students tend to focus on memorizing formulas without knowing how to apply these formulas to problems because of the lack of critical thinking of students by not applying visual objects in making it easier to answer these problems (Andina & Erita, 2024). Lack of understanding of geometry concepts is one of the reasons why students are often unable to answer questions correctly, even though these questions have been studied since elementary, junior high, and high school levels.

One of the reasons for the lack of understanding of students, especially in geometry material, is because their learning is not contextual or not directly related to students' daily activities (Hanafi, 2020). So it is necessary to make efforts to get mathematics learning, especially in geometry learning. Where in this context, we integrate or bring mathematics closer to students' daily activities in order to foster a sense of criticality in students. In this case, one of the efforts that can be made is an ethnomathematical approach. Through the integration of mathematics in daily activities, students will more easily develop critical thinking skills, because they can directly feel the relevance of the problems they face. The use of geometry concepts will also make it easier for them to find solutions to the challenges they face in real life.

One of the efforts to overcome this problem is to use an ethnomathematical approach in mathematics learning. D'Ambrosio defines ethnomathematics as "mathematics practiced among identifiable cultural groups" such as tribal societies and professional groups (D'Ambrosio, 1985). Rosa & Orey (2011) assert that ethnomathematics has a strong relevance in everyday life. The crucial challenge is how we can implement the mathematical concepts that exist in ethnomathematics into learning, so that we can create a close relationship between these concepts and the cultural context and life experiences of students (Rosa and Orey 2011).

The existence of ethnomathematics learning will bring students' understanding of the material more deeply because the objects associated with the material being taught can be seen directly (Irawan & Kencanawaty, 2023; Wahyuni et al., 2013). By recognizing the contributions of local communities to the development of mathematics and understanding the cultural richness contained in their mathematical practices, ethnomathematics plays an important role in building a deeper understanding of the universal nature of mathematics, while appreciating the diversity of human beings around the world.

West Sulawesi's culinary specialties are increasingly developing and diverse both in terms of variety, richness and attractiveness which are certainly no less interesting than the various kinds of culinary in Indonesia, of course (Qibtiya, 2019). This traditional cake is not only alluring with its sweet deliciousness, but also a testament to the culinary richness of the archipelago that has been passed down from generation to generation. One of them is the Paso Cake which is famous for its unique shape. The characteristics of the cone in the cake open up opportunities to be used as a source of learning in understanding field analytical geometry material.

Paso cake has a deep meaning in the culture of the Mandar Tribe. Its name comes from the word "Paso" which means nail in the Mandar language, referring to its shape that resembles a nail or cone. Because of its distinctive shape, this cake managed to attract the attention of researchers to conduct further research. Paso cakes symbolize strength and durability, similar to the role of nails in a building. In addition, these cakes are often served at traditional events, reflecting the value of togetherness and culinary heritage that needs to be preserved amid the current of modernization.

Several previous research studies on ethnomathematics based on traditional cakes have revealed the existence of ethnomathematical elements in traditional Bugis cakes. These elements include the concept of geometry in the form of flat and space. The researchers also found that there is a concept of comparison and similarity that applies in the typical Bugis cake (Pathuddin & Raehana, 2019; Rusli & Azmidar, 2023). In line with these two studies, another research focuses on the application of ethnomathematics in the process of making barongko traditional food. The research highlights the relationship between cultural practices, mathematical concepts, and learning approaches to integrate local values in mathematics education (Aras et al., 2022). Outside the ethnomathematical context of Bugis culture, research conducted by Prahmana and D'Ambrosio explores mathematical concepts, especially geometric transformations, contained in Yogyakarta's typical batik motifs. The study also examines the moral, historical, and philosophical values that exist in batik motifs, as well as how ethnomathematics can be an approach to bring mathematics learning closer to local culture (Prahmana & D'Ambrosio, 2020).

The selection of pastime cake as an object in this study is based on two main factors. First, this traditional cake has a unique geometric shape and is interesting to study. Second, based on the literature review that has been conducted, no research has been found that specifically makes paste cake an object of research in the context of learning geometry based on local culture.

This research is also motivated by the gap in the local culture-based geometry learning approach in several previous studies. Previous studies have often used a top-down approach that tends to impose formal geometric concepts into cultural contexts, rather than developing an understanding of geometry from the cultural practices themselves. This kind of approach results in the loss of the authenticity and richness of indigenous mathematical knowledge that is actually contained in the local culture.

In addition, most of the existing research is still descriptive and has not developed an applicative learning model. The integration between cultural content and geometric materials in these studies often seems forced and does not take place naturally, so that it has not achieved optimal learning goals, both in terms of mastery of mathematical concepts and appreciation of cultural values.

Based on this description, this research is important to be carried out to fill the gaps that exist in ethnomathematical studies, especially those based on traditional cakes as a medium for learning geometry. This research focuses on the representation of geometry formed from the results of paso cake slices and their relationship with the concept of cone slices. An analysis will be carried out on the algebraic aspect of the formed geometric shape, where the geometry is composed of a collection of points whose position can be determined in Cartesian coordinates. To help this analysis process, the GeoGebra application is used as a research tool. In the cultural context, this study aims to show that Indonesian tradition and culture are closely related to mathematical concepts. This is evidenced through the observation of paso cakes that have regular geometry, where after slicing will produce a new geometric shape. Furthermore, this research also aims to provide insight to teachers that mathematics learning can be more effective when using a contextual approach. The use of regional specialties as a learning medium is one way to concretize the concept of mathematics, because traditional food has become part of the daily life of students.

RESEARCH METHOD

The method used in this study is a qualitative descriptive approach with ethnographic design, this study collects data through literature studies by researching various related research journals. Qualitative descriptive aims to analyze related literature in order to gain a deeper under of ethnomathematics contained in Mandar's typical cake, namely paso cake. What is meant by literature study is an investigation process that focuses on the study and analysis of various relevant literature sources for a particular research topic or study (Baringbing, Abi, and Silaban 2022; Soebagyo et al. 2021).

In this approach, researchers try to identify, collect, understand, and synthesize information or data from various sources such as books, journals and articles, as well as documentation in the form of images, or electronic documents that can certainly support the research of the object being studied. By taking a literature study approach, it will certainly be very helpful for researchers in understanding the status of existing knowledge about the topic and identifying research gaps that still need to be explored. Ethnographic research is a method used to understand and explore the culture and behavior of people in a certain area (Dosinaeng et al., 2020; Gay et al., 2012; Kamarusdiana, 2019; Mufidatunnisa & Hidayati, 2022; Wijaya et al., 2018).

The purpose of the ethnographic method is to explain a culture as a whole, both abstract such as experiences, beliefs, and norms, as well as material ones such as cultural artifacts (ancestral relics), tools, buildings, and clothing (Ghony & Almanshur, 2012; Rezhi et al., 2023). The researcher uses ethnographic methods with the aim of understanding in depth the meaning and philosophy of the shape of the pastime cake according to the local people who have a comprehensive understanding of this traditional cake as an ancestral heritage. In addition, this method allows researchers to observe and analyze directly the geometric characteristics of the pastime cake when sliced from various angles and positions. In line with this goal, the researcher tried to represent the mathematical elements contained in the traditional cake studied in this study.

In conducting this research, of course, there are several steps that need to be taken in analyzing the data. At the stage of collecting data and then analyzing it, researchers follow an interactive model that has been developed by Miles and Huberman (Baba, 2017; Saleh, 2017; Umrati & Wijaya, 2020). The interactive capital needs to do three important things, namely *data reduction*, data *display*, and verification (Putri, Wanabuliandari, and Fardani 2022). The following is a brief explanation of the three things that are.

a. Data reduction is The initial process of data processing in which researchers convert raw data such as recordings or images into text form and data selection is carried out or selecting appropriate data and inappropriate data to separate relevant information (Rijali, 2018). In this stage, the researcher looks for a picture of the shape of the typical paso cake and then describes it into a text that can describe the characteristics of the cake. The purpose of data reduction is to make it easier to draw conclusions and produce meaningful information. In addition, data reduction aims to organize the data in such a way that the final conclusion can be obtained or successfully verified (Nurdewi 2022; Zulfirman 2022).
b. Data display is the process of organizing and visualizing data to make it easier to understand and interpret (Baba, 2017; Saleh, 2017). At this stage, the researcher uses *the GeoGebra* application to help in analyzing the new geometry that is formed with an explanation of the geometric elaboration concept using the Cartesian coordinate approach. With good data presentation, complex information can be conveyed clearly and can be easily understood.

Data verification is the process of taking the results of data analysis and making assumptions or decisions based on findings (Umrati & Wijaya, 2020). This stage can also be said to be the stage of drawing conclusions where in this stage we can find out the existence of new geometries that are formed after the slicing of the paso cake and its elaboration in the field of Cartesian coordinates.

RESULT AND DISCUSSION

In this research, ethnomathematics is focused on geometric shapes formed after the slicing of traditional Mandar cakes which are specialized in Paso cakes. After researching deeper, it turns out that this traditional cake, namely paso cake, when sliced will form various geometries which when viewed from the original shape of this cake is conical. The cone slice on the traditional cake will occur when the cake is cut. These pieces can produce different geometric shapes, such as circles, ellipses, paraboles and hyperbolas. The findings were corroborated by the findings Rizal (2018) which shows geometric shapes in cone slices. These geometries are formed when a flat plane cuts a cone from various positions and various angles of a piece from a flat plane. In this study, with the help of traditional cakes in the shape of a cone, it can be a visual tool that greatly helps students in understanding the concept of cone slices in a more concrete way.

A. Paso Cake Typical of Mandar Culture

Paso cake is a traditional snack that comes from the culture of the Mandar Tribe, an ethnic group that inhabits West Sulawesi Province. Paso cake is made from rice flour, starch flour, liquid palm sugar, and coconut milk. The manufacturing process involves mixing ingredients, filling molds from banana leaves, and steaming until ripe. Paso cakes are known for their sweet and savory flavors, and they are usually served warm. Paso cake has a deep meaning in the culture of the Mandar Tribe. Its name comes from the word "Paso," which means nail in the Mandar language, referring to its shape that resembles a nail or cone. Because of its distinctive shape, this cake managed to attract the attention of researchers to conduct further research. Paso cakes symbolize strength and durability, similar to the function of nails in construction.

In addition, this cake is often served on traditional occasions, reflecting the value of togetherness and culinary heritage that needs to be preserved in the midst of modernization. One of the reasons researchers chose this cake is because until now there has been no research that discusses the typical shape of paso cake, so this research is considered important to do.

Figure 1. Paso Cake Typical of Mandar Culture

One of the interesting things about this typical cake is that it uses banana leaves as a wrapper, giving it a distinctive aroma that adds a unique taste. Its traditional manufacturing process and natural ingredients add historical value as well as health. The historical value in question includes important aspects of cultural heritage, symbolism in traditional ceremonies, traditional economic empowerment, role in the history of the Mandar people's journey, and contribution to the spread and introduction of Mandar culture to other regions.

This makes paso not just a cake, but also a symbol of rich and high-value cultural heritage in the history of the Mandar tribe. Paso also shows flexibility in serving, suitable for daily snacks as well as special dishes.

B. Ethnomathematics in Paso Cake

If you look at the shape of the typical Paso cake in the shape of a cone. Mathematically, the geometry of this Lapek cake can create a new geometry if we slice the cake depending on the angle and position of the cut.

For more details, here is the display of Paso cake in Cartesian coordinates in 2D and 3D planes:

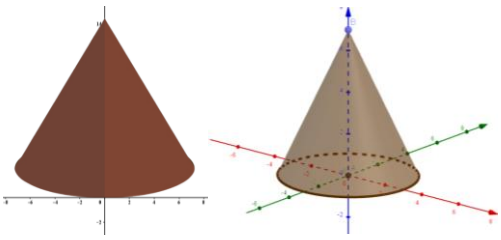
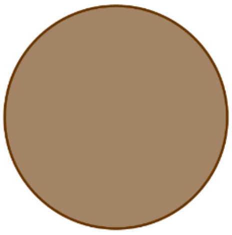
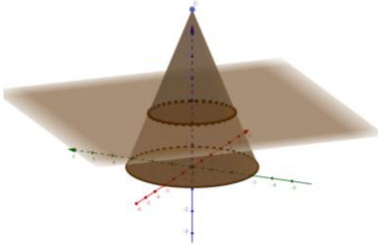
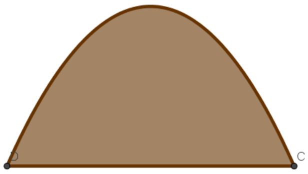
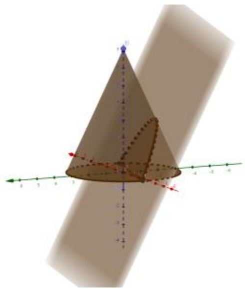
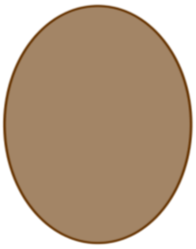
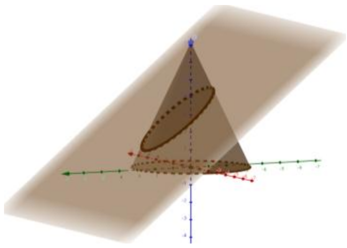
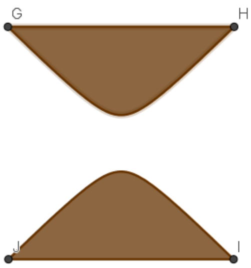
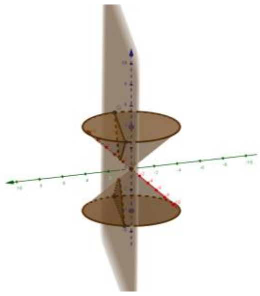


Figure 2. Illustration of Paso Cake in *GeoGebra*

In the concept of analytic geometry it is said that there are several geometries that can be formed from slices of cones. In this study, the researcher tried to prove that the concept of cone slices can produce new geometries where the original shape of this cake is a cone, so that if slicing is carried out, it will produce new geometry if it is based on the concept of cone slices.

The following geometry formed after slicing on the Paso cake, can be seen in the table:

Table 1. Illustration of the Geometric Shape of a Cone Slice Using *Geogebra*

Geometry (2D)	Conic Section
 Figure 3. Circle	 Figure 4. Illustration of Circles
 Figure 5. Parable	 Figure 6. Parabolic Illustration
 Figure 7. Elips	 Figure 8. Illustration of the Ellipse
 Figure 9. Hyperbola	 Figure 10. Hyperbolic Illustration

The table above explains that there are four geometries that are formed due to the slicing of cones, namely circles, parabolas, ellipticals, and hyperbolas. Furthermore, these four geometries will be analyzed using GeoGebra software to study the elaboration of geometry and the reduction of the formula, where it should be noted that the geometric equation can be reviewed from the position of the center point.

With the help of *the GeoGebra* application, it will be more effective for students' understanding in learning cone slices. As a study that has been conducted by Ekayanti (2017) states that GeoGebra-based *cone slice learning* is very effective to be used in cone slice learning with the results of its findings that meet the criteria of valid, practical and effective.

Based on the position of the center point, the geometry of the cone slice is divided into two types, namely standard and non-standard. A cone slice is said to be standard if the center point position is at $(0,0)$, while if the center point position is at (α, β), then the cone slice is non-standard.

C. Circle Equation

Analytical geometry combines the concepts of algebra and geometry by providing a systematic and analytical way of studying the properties of a geometry. This research is in line with the discovery of Rusli & Azmidar (2023) which connects algebra and geometry, finding the existence of algebraic concepts in the geometry of traditional Bugis cakes. Based on these findings, this research focuses on how the algebraic representation of geometry formed from paso cake slices with the help of *the GeoGebra* application in order to be able to review the geometry in the Cartesian coordinate area.

It has been previously visualized that it is true that a circle is formed after a cone slice or it can be said that an upright cone space structure cut by an n-sided flat plane will produce a circular flat shape. Then the algebraic representation of the circle will be carried out, namely how the algebra is subtracted from the circle so that it forms a circle equation.

One of the interesting aspects of the concept of analytic geometry is the formation of geometry which is composed of a collection of points into a plane and then into space. This is reinforced by the research of Sudihartinih & Purniati (2017) which states that the cone slice is the locus of all the points that form a two-dimensional curve. Based on this statement, it can be concluded that a circle is formed from a collection of dots that make up it. In this discussion, the circle equation will be reduced, where the center point will affect the result of the equation.

The equation of a circle can be determined by knowing the coordinates of the center point and using one additional point, with the distance between the two points defining the length of the radius.

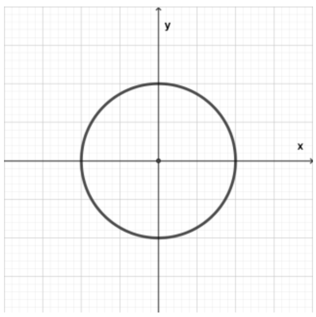


Figure 11. Standard Circle with a Center Point in (0,0)

Suppose we have a circle with a center point in the coordinates $(0,0)$ with the fingers r. This circle is a collection of all the dots (x, y) which is far away r from the center, namely (0,0). So to use the formula for the Euclidean distance, which is:

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Next, let's assume that the central point is $(x_1 - y_1)$ and arbitrary points as $(x_2 - y_2)$ and obtained:

$$\sqrt{x^2 + y^2} = r$$

And it was found that the equation of the circle centered on the point $(0,0)$ is:

$$x^2 + y^2 = r^2$$

The same is true if the center point of

the circle is not in the coordinates (0,0)

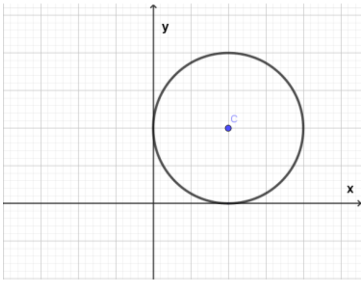


Figure 12. Non-standar Circle with a Center Point in (α, β)

Let's assume that the coordinates of the center point are positioned at (α, β) with aradius of r. Just like the previous steps, that is, by using the Euclidean distance formula

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} = r$$

$$r^2 = (x - \alpha)^2 + (y - \beta)^2$$

It was found that the equation of the circle centered on the coordinates (α, β) is:

$$(x - \alpha)^2 + (y - \beta)^2 = r^2$$

D. Parabolic Equations

To derive the parabolic equation in analytic geometry, we start with the definition of a parabolic as the set of all points that are equidistant from a fixed point called the focal point and a fixed line called a directorial line. The decrease in the parabolic equation is again seen from the peak point, which if the peak point is at (0,0), then it is included in the standard parabola, while if the peak point is shifted to (α, β), then it is included in the non-standard parabola. From the standard and non-standard equations, it is again divided into several parts, including horizontal *concave to right, horizon concave to left*, *vertical concave up*, and *vertical concave down*. Because the satellite dish has many parts, the researcher only tried one part, which is *horizontal concave to the right*.

Table 2. Standard Parabola

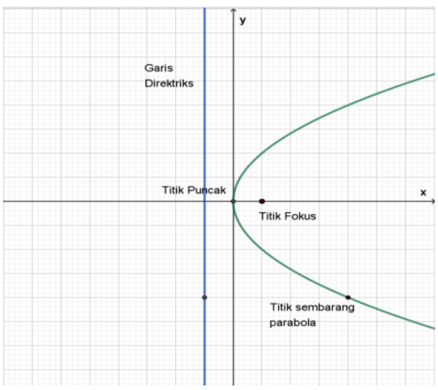


Figure 13. Standar Horizontal Right Parabola

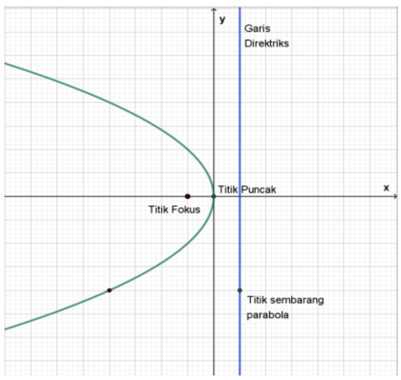


Figure 14. Standar Left Horizontal Parabola

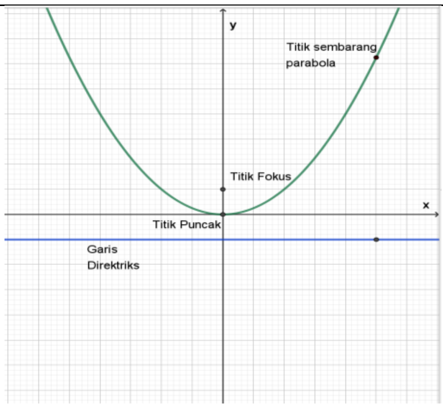


Figure 15. Standard Vertical Parabola Concave Top

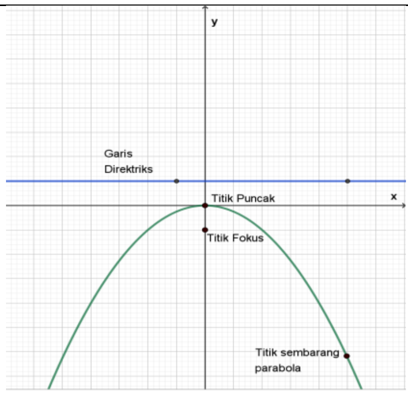


Figure 16. Standard Vertical Parabola Concave Bottom

On the satellite dish that opens to the right, the focus is on the point $(p, 0)$ and the directories are vertical lines so that $x = -p$.

For each point on the satellite dish(x, y), the distance to the focal point is $(p, 0)$ must be equal to the distance of the points (x, y) to the directorial line $x = -p$

Know the distance between points (x, y) to the focal point $(p, 0)$ with the formula to find the distance from point to point, namely:

$$\sqrt{(x-0)^2 + (y-0)^2}$$

And the distance from point to day to find the distance from point (x, y) to the directorial line $x = -p$, i.e.:

$$|x + p|$$

And because of the point (x, y) are equally distant from the focal point and the directorial line, then the formula becomes:

$$\sqrt{(x-p)^2 + y^2} = |x + p|$$

$$(x-p)^2 + y^2 = (x+p)^2$$

$$x^2 - 2px + p^2 + y^2 = x^2 + 2px + p^2$$

$$-2px + y^2 = 2px$$

$$y^2 = 4px$$

It was found that the parabolic equation that opens to the right with the vertex point at (0.0) is:

$$y^2 = 4px$$

For other standard parabolic equations, it can be derived as above, if the parabolic is horizontal to the left, then the equation is the opposite of the horizontal parabolic equation to the right, namely $y^2 = -4px$. The same goes for vertical satellite dishes that are concave upwards $x^2 = 4py$ and lower concave vertical parabola $x^2 = -4py$.

The formula for the parabola is not standard if there is a shift in the peak point from (0,0) become (α, β) then the shape of the equation will remain only a change occurs in the center which if shifted horizontally to the right as far as α then the variable x becomes $(x - \alpha)$ and the center point shifts vertically upwards, then the variable y becomes $(y - \beta)$. Thus, the change in the apex point will affect the parabolic equation, including the focal point, the directorial line, and the axis of symmetry, because these elements are interrelated.

Table 3. Non-standard Parabola

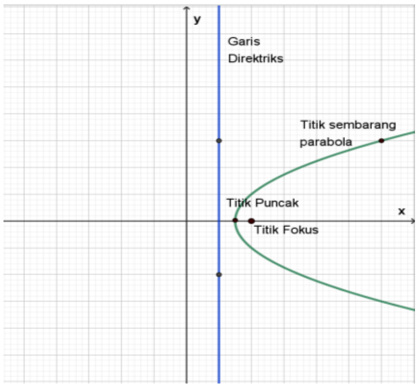


Figure 17. Right Horizontal Non-standard Parabola

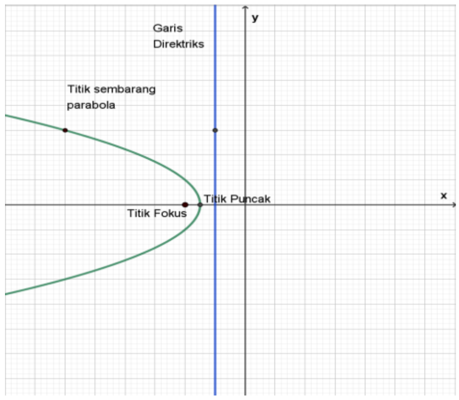


Figure 18. Left Horizontal Non-standard Parabola

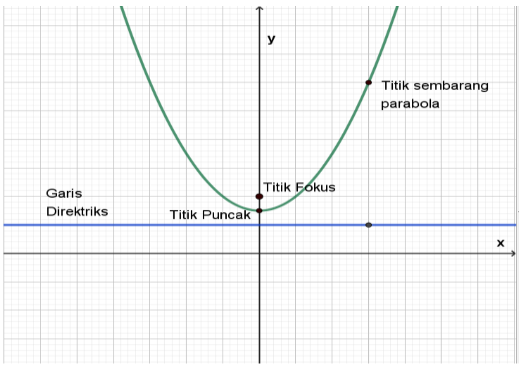


Figure 19. Non-standard Parabola Vertical Concave Top

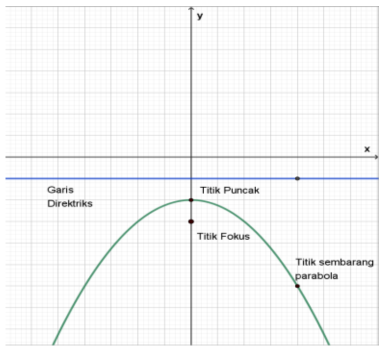


Figure 20. Bottom Concave Vertical Non-standard Parabola

Suppose the focal point is in $(\alpha + p, \beta)$ and the directorial line is a vertical line $x = a - p$ where p is the distance from the peak to the focal point or from the peak to the director. So take the equation of finding the distance from point to point:

$$\sqrt{\left(x - (\alpha + p)\right)^2 + (y - \beta)^2} = |x - (\alpha - p)|$$

$$(x - (\alpha + p))^2 + (y - \beta)^2 = \left(x - (a - p)\right)^2$$

$$(x - \alpha - p)^2 + (y - \beta)^2 = (x - \alpha + p)^2$$

$$(x - \alpha)^2 - 2p(x - \alpha) + p^2 + (y - \beta)^2 = (x - \alpha)^2 + 2p(x - \alpha) + p^2$$

$$-2p(x - \alpha) + (y - \beta)^2 = 2p(x - \alpha)$$

$$(y - \beta)^2 = 4p(x - \alpha)$$

and it is found that the parabolic equation is horizontally concave to the right with the vertex point at (α, β), is

$$(y - \beta)^2 = 4p(x - \alpha)$$

For other non-standard parabolic equations, it can be derived by following the steps above.

Non-standard parabolics can occur not only due to a shift in the apex, but also due to a change in its main axis. The shift of the main axis occurs when the symmetrical axis of the parabola is no longer aligned with the axes at the Cartesian coordinates. As a result, the new satellite dish has two axes perpendicular to each other but the two axes form an Cinclination to the axis-x and the axis-y.

E. Elliptical Equations

The next geometry that is formed is elliptical. An ellipse can be seen as a merger of two satellite dishes facing each other with vertices that are far apart and spaced apart. An ellipse is also a geometry formed from a set of dots. If we take any point in the set of elliptical points and connect it with a certain point which of course is not a member of the set of elliptical points and we call it the focal point, then it can be ensured that the sum of the distances of each elliptic point with these two focal points will remain (constant). From the description above, we can use it as an approach in decreasing the elliptical equation. But before decreasing the ellipse equation, we need to know what is important to be in the same way as the previous geometry, the ellipse is also divided into 2 which are standard and non-standard which are determined by the position of the ellipse's center point. In the ellipse there are elements called the major axis and the minor axis, where in the Cartesian coordinates these two axes are perpendicular to each other with the major axis longer than the minor axis. The position of the major axis determines the position of the ellipse, where if the major axis is squeezed or parallel to the axis-x*(horizontal),* then the ellipse is called a horizontal ellipse, as well as if the major axis is squeezed or parallel to the axis- y*(vertical),* then the ellipse is called *a vertical ellipse.* Here is the decrease in the horizontal elliptical equation.

Table 4. Standard Ellipse

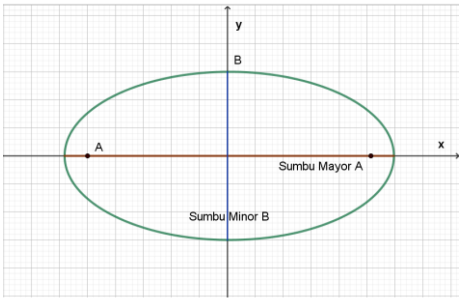


Figure 21. Horizontal Standard Elliptical

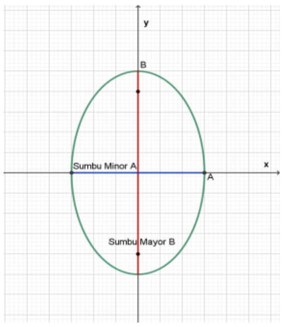


Figure 22. Vertical Standard Elliptical

By thinking of ellipses as a collection of points (x, y) which has a constant number of distances to two focal points in the coordinates $(c, 0)$ and $(-c, 0)$ as the coordinates of points F1 and F2 and consider $p = (x, y)$ to be any point on the ellipse, It can be stated that $\sqrt{(x-c)^2 + y^2} + \sqrt{(x-c)^2 + y^2} = 2a$. Where 2a is a measure of the length of the major axis as a whole

$$\sqrt{(x-c)^2 + y^2} = 2a - \sqrt{(x-c)^2 + y^2}$$

$$(x-c)^2 + y^2 = 4a^2 - 4a\sqrt{(x+c)^2 + y^2 + x^2 + 2cx + c^2}$$

$$-4cx - 4a^2 = -4a\sqrt{(x+c)^2 + y^2}$$

$$4cx + 4a^2 = 4a\sqrt{(x+c)^2 + y^2}$$

$$\sqrt{(x+c)^2 + y^2} = \frac{4cx + 4a^2}{4a}$$

$$\sqrt{(x+c)^2 + y^2} = \frac{cx}{a} + a$$

$$x^2 + 2cx + c^2 + y^2 = a^2 + 2cx + \frac{c^2}{a^2}x^2$$

$$x^2 + c^2 + y^2 = a^2 + \frac{c^{2x^2}}{a^2}$$

$$\left(1-\frac{c^2}{a^2}\right)x^2+y^2=a^2-c^2$$

This relationship is based on the definition of elliptical geometry and can be derived from *the Pythagorean theorem* in the context of ellipses:

$$a^2-c^2=b^2$$

$$\left(1-\frac{a^2-b^2}{a^2}\right)x^2+y^2=b^2$$

$$\left(\frac{a^2-a^2+b^2}{a^2}\right)x^2+y^2=b^2$$

$$\left(\frac{b^2}{a^2}\right)x^2+y^2=b^2$$

The two segments are multiplied $\frac{1}{b^2}$, then the final result is obtained:

$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is a general equation of horizontal ellipticals.

Table 5. Non-standard Ellipse

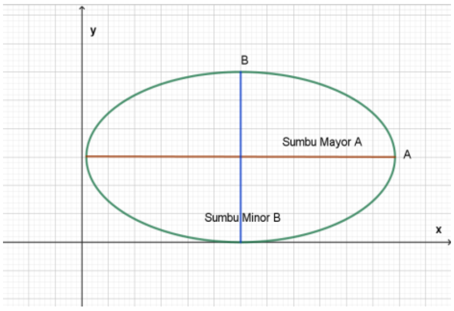


Figure 23. Horizontal Non-standard Elliptical

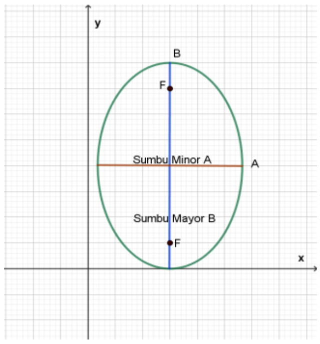


Figure 24. Vertical Non-Standard Elliptical

To derive the equation of a horizontal ellipse centered in (α,β), We will do from the standard elliptical equation and then shift the center from (0,0) shifting to (α,β). So the initial equation we use is $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ where a is half the length of the major axis and b is half the length of the minor axis. Then shift the center of the ellipse to (α,β) so that the value of x become $(x-\alpha)$ and y become $(y-\beta)$. Next, substitution x and y into the general equation of the standard elliptical:

$$\frac{(x-\alpha)^2}{a^2}+\frac{(y-\beta)^2}{b^2}=1$$

To verify this equation, we check that the substitution shifts the center of the ellipse without changing its base shape. By replacing x with $(x-\alpha)$ and y with $(y-\beta)$, We make sure that the elliptical center is now shifted and is at the point (α,β) with the major and minor axes remaining the same. Thus, the end result of the decrease in the non-standard horizontal elliptical equation is found:

$$\frac{(x-\alpha)^2}{a^2}+\frac{(y-\beta)^2}{b^2}=1$$

F. Hyperbolic Equations

Based on the illustration, the hyperbola is formed from the slicing of two conical space shapes that open in opposite directions by a flat plane perpendicular to the two cones.

Table 6. Standard Hyperbole

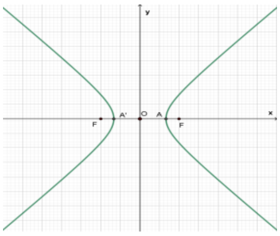


Figure 25. Horizontal Standard Hyperbole

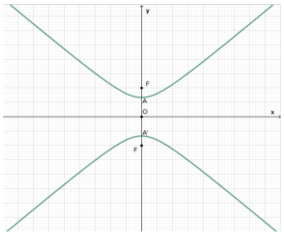


Figure 26. Vertical Standard Hyperbole

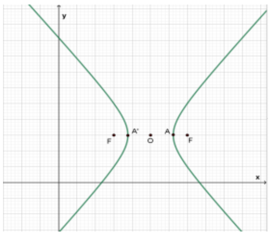


Figure 27. Vertical Non-standard Hyperbole

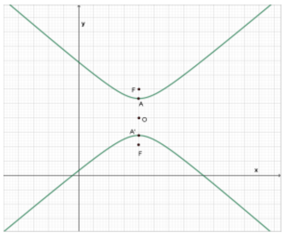


Figure 28. Horizontal Non-standard Hyperbole

Hyperbole is a collection of points whose absolute distance is fixed relative to two focal points. There are different types of hyperbolic equations that rely on the location of the transverse axis and the conjugate axis to the axis of Cartesian coordinates, as well as their center point. As we know that if the center point is located at (0,0), then it is a standard hyperbole and if the center point is located at (h, k), then it is included in a non-standard hyperbol. In addition, in non-standard hyperboles that need to be considered are the transverse axis and the deceptive axis which are perpendicular to each other but not parallel to the axis of Cartesian coordinates. In decreasing the standard elliptical equation, of course, we are based on the definition of a particular object. As has been explained, the hyperbola has an absolute difference from the distance of the focal point to its directory line is constant, i.e., $2a = |AA'|$, so

Table 7. Standard Hyperbole

$$\left|\sqrt{(x-c)^2+y^2}-\sqrt{(x+c)^2+y^2}\right| = 2a$$

$$\left(\sqrt{(x-c)^2+y^2}-\sqrt{(x+c)^2+y^2}\right)^2 = (2a)^2$$

$$(x-c)^2+y^2+(x+c)^2+y^2-2\sqrt{((x-c)^2+y^2)((x+c)^2+y^2)} = 4a^2$$

$$(x^2-2xc+c^2+y^2)+(x^2+2xc+c^2+y^2)-2\sqrt{((x-c)^2+y^2)((x+c)^2+y^2)} = 4a^2$$

$$2x^2+2y^2+2c^2-2\sqrt{((x-c)^2+y^2)((x+c)^2+y^2)} = 4a^2$$

Move $2\sqrt{((x-c)^2+y^2)((x+c)^2+y^2)}$ to the right segment and each segment is divided by 2

$$x^2 + y^2 + c^2 = a^2 + \sqrt{((x-c)^2 + y^2)((x+c)^2 + y^2)}$$

$$(x^2 + y^2 + c^2 - a^2)^2 = ((x-c)^2 + y^2)((x+c)^2 + y^2)$$

$$(x^2 + y^2 + c^2 - a^2)^2 = (x^2 - 2xc + c^2 + y^2)(x^2 + 2xc + c^2 + y^2)$$

$$(x^2 + y^2 + c^2 - a^2)^2 = (x^2 + y^2)^2 - (2xc)^2 + (c^2)^2$$

$$(x^2 + y^2 + c^2 - a^2)^2 = (x^2 + y^2)^2 - 4x^2c^2 + c^4$$

Taking into account that a and b which are constant and relate to the dimensions of the major and minor axes, a standard hyperbolic equation can be formulated:

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1 \text{ (horizontal hyperbola)}$$

$$\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1 \text{ (vertical hyperbola)}$$

Non-standard hyperbolic equations consist of two types with the following decreasing formula:

Type 1 non-standard hyperbole occurs when the two axes are parallel to the axis of Cartesian coordinates. Based on the definition of hyperbole, in a horizontal hyperbola, both focal points are at $(h+c,k)$ and $(h-c,k)$ and the central point is at (α,β)

Table 8. Non-standard Hyperbole Type 1

$$\left|\sqrt{(x-(h+c)^2 + (y-k)^2} - \sqrt{\left(x-(h-c)\right)^2 + (y-k)^2}\right| = 2a$$

$$\left(\sqrt{\left(x-(h+c)\right)^2 + (y-k)^2} - \sqrt{\left(x-(h-c)\right)^2 + (y-k)^2}\right)^2 = (2a)^2$$

$$\left(x-(h+c)\right)^2 + (y-k)^2 + \left(x-(h-c)\right)^2 + (y-k)^2 - 2\sqrt{\left(\left(x-(h+c)\right)^2 + (y-k)^2\right)\left(\left(x-(h-c)\right)^2 + (y-k)^2\right)} = 4a^2$$

$$(x-h-c)^2 + (y-k)^2 + (x-h+c)^2 + (y-k)^2 - 2\sqrt{((x-h-c)^2 + (y-k)^2)\left(\left(x-(h-c)\right)^2 + (y-k)^2\right)} = 4a^2$$

$$2(x-h)^2 + 2(y-k)^2 + 2c^2 - 2\sqrt{((x-h)^2 - 2c(x-h) + c^2 + (y-k)^2)((x-h)^2 + 2c(x-h) + c^2 + (y-k)^2)} = 4a^2$$

Move it is

$$2\sqrt{((x-h)^2 - 2c(x-h) + c^2 + (y-k)^2)((x-h)^2 + 2c(x-h) + c^2 + (y-k)^2)}$$

the right and each segment is divided by 2, then the next step is completed according to the decreasing step of the standard hyperbolic equation. The equation produced in this type 1 non-standard hyperbola is

$$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1 \text{ (horizontal)}$$

$$\frac{(x-h)^2}{b^2} - \frac{(y-k)^2}{a^2} = 1 \text{ (vertical)}$$

Furthermore, a type 2 non-standard hyperbola is a hyperbola whose two axes are perpendicular but not parallel to the axis of Cartesian coordinates. This type of hyperbole has a transverse axis and a cordial axis that are perpendicular to each other but not parallel to the Cartesian coordinate axis

.

Table 9. Non-standard Hyperbole Type 2

Suppose the traversal axis has a length $|AA'| = 2a$ with the equation $(l_1x + m_1y + n_1 = 0)$ and its companion axis by length $|BB''| = 2b$ with the equation $(m_1x - l_1y + n_2 = 0)$ where the two lines are perpendicular to each other. Thus, the hyperbolic equation given is

$$\frac{|PL|^2}{a^2} - \frac{|PL|^2}{b^2} = 1$$

$$\frac{\left(\frac{m_1x + l_1y + n_2}{\sqrt{m_1^2 + l_1^2}}\right)^2}{a^2} - \frac{\left(\frac{l_1x + m_1y + n_1}{\sqrt{l_1^2 + m_1^2}}\right)^2}{b^2} = 1$$

$$\frac{(m_1x - l_1y + n_2)^2}{a^2\left(\sqrt{m_1^2 + l_1^2}\right)^2} - \frac{(l_1x - m_1y + n_2)^2}{b^2\left(\sqrt{l_1^2 + m_1^2}\right)^2} = 1$$

So that the non-standard hyperbolic equation type 2 is obtained, i.e.

$$\frac{(m_1x - l_1y + n_2)^2}{a^2\left(\sqrt{m_1^2 + l_1^2}\right)^2} - \frac{(l_1x - m_1y + n_2)^2}{b^2\left(\sqrt{l_1^2 + m_1^2}\right)^2} = 1$$

G. Case Studies

Case study 1:

A mathematics teacher will teach analytical geometry material in the field of cone slices using concrete media in the form of paso cakes, a traditional Mandar cake. The pastry is conical with a height of 24 cm and a base radius of 20 cm. To demonstrate the concept of ellipticals, the teacher plans to cut the cake at a 30° incline to the base of the cake. Based on the learning context, students are asked to prove the truth of the elliptical equation formed from the slices of paso cake.

Discussion: There are several data

obtained:

1. Cake height $(h) = 24\ cm$
2. Diameter dasar $= 20\ cm$
3. b: small wick = 10 cm (the base of the paso cake)
4. Tilt angle wedges $(\beta) = 30°$

Based on the data obtained, the eccentricity value of the paso cake slices is at $e = 0.5$ with the description:

- Step one: determine the elliptical axes
  a. Minor axis (r): 10 cm
  b. Mayor axis $(2a)$:
  $a = \frac{r}{\cos\beta}$
  $a = \frac{10}{\cos 30°}$
  $a = \frac{\frac{10}{\sqrt{3}}}{2}$
  $a = \frac{20}{\sqrt{3}} \approx 11.547cm$
- Proof of eccentricity
  $c^2 = a^2 - b^2$
  $c^2 = \left(\frac{20}{\sqrt{3}}\right)^2 - 10^2$
  $c^2 = \frac{400}{3} - 100$
  $c = \sqrt{\left(\frac{400}{3} - 100\right)}$
  $e = \frac{c}{a}$
  $e = \frac{\sqrt{\left(\frac{400}{3} - 100\right)}}{\frac{20}{\sqrt{3}}}$
  $e = 0.5$

It is evident that the slices are elliptical with their eccentricity $e < 1$

The result of the elliptical derivative obtained the final equation, namely

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

Because it is known that $a =$ 11,547cm and $b = 10$ cm. Furthermore, the substitution of values from a and b to the equation is found.

$$\frac{x^2}{11{,}547^2} + \frac{y^2}{10^2} = 1$$

Case study 2:

Mira is a traditional cake entrepreneur who is famous for her paso cakes. For a cake making demonstration event at a school, he wanted to show a slice of the parabolic on the paso cake. The pastry cake made has a height of 25 cm and a base diameter of 30 cm. If the cake is cut parallel to the cone painter's line, i.e. . Determine the standard parabolic equation formed after slicing$\alpha = 31°$

Discussion:

- Identification information:
  - Height = 25 cm(h)
  - Diameter = 30 cm → Circle radius (r) = 15 cm
  - Sudut irisan $\alpha = 31°$
- Parameter parabola:
  - $p = \frac{r^2}{2h}$
  - $p = \frac{225}{50}$
  - $p = 4.5\ cm$
  - Because then the type of parabolic is concave upwards$p > 0$,
- Parabolic equations:
  - $y = \frac{x^2}{4p}$
  - $y = \frac{x^2}{18}$ (upward-concave vertical parabolic)

CONCLUSION

This study shows that Mandar's typical pastime cake can be represented as a geometric object that has great potential to be used in contextual mathematics learning. The results of direct observation and visual documentation show that the physical shape of the pastry cake resembles the shape of a space such as a blunt cone or cylinder, while the slices of the pastry cake produce flat shapes such as circles, parabolas, ellipticals and hyperboles. So that when the analysis is carried out using *the GeoGebra application*, it strengthens the ethnomathematical approach by presenting evidence that local cultural artifacts, such as pastime cakes, have mathematical structures and meanings that can be explained using algebra and geometric representation theory. This finding adds to the local culinary-based ethnomathematical literature that has been limited, especially from the context of Mandar culture.

This finding enriches the ethnomathematical literature, especially in the context of local culinary that has been understudied, especially from the Mandar culture. Practically, this study presents an alternative learning media based on technology and contextual culture. The Paso cake representation model through *GeoGebra* can be used by teachers as teaching materials that are close to students' daily lives, so that it not only facilitates the understanding of mathematical concepts, but also instills cultural values in the learning process. Thus, this research not only provides a new understanding academically, but also has a direct impact on the development of contextual, meaningful, and local wisdom-based learning

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