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Ethnomathematical Values in Sitiwinangun Traditional Pottery and Its Potential for Contextual Mathematics Learning

Zalfaanisa Maryani[1], Sansan Nurhasanah[2], Miqdad Dhiya Ulhaq[3], Arif Muchyidin[4]
[1,2,3,4]Universitas Islam Negeri Siber Syekh Nurjati Cirebon, Indonesia

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ABSTRACT

This study examines ethnomathematical values embedded in traditional pottery crafts in Sitiwinangun Village, Cirebon Regency, Indonesia, and discusses their potential for contextual mathematics learning. Using an exploratory qualitative case-study design, data were collected through non-participant observation, semi-structured interviews with craftsmen, and visual documentation. The analysis reveals mathematical ideas in both the pottery forms and production process, including spatial geometry (circles, cylinders, cones, and spheres), radial symmetry, proportional reasoning, rotation, and volume estimation. Traditional tools such as the spinning wheel (petra) illustrate rotational principles that can support learning in geometry and related mathematical concepts. Beyond mathematical aspects, pottery artefacts (e.g., jugs) also convey cultural-symbolic values associated with balance in local traditions. Digital visualisation of pottery shapes using Maple software further supports geometric understanding. To our knowledge, the ethnomathematical exploration of Sitiwinangun pottery as a contextual learning resource has received limited attention. These findings indicate that pottery-based ethnomathematics can enrich geometry instruction by connecting cultural practices with formal mathematical concepts and informing the development of local culture-based learning modules.

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Corresponding Author:

Zalfaanisa Maryani
Faculty of Tarbiyah and Teacher Training, Cyber State Islamic University Syekh Nurjati Cirebon
Email: akunresmi2.zalfaa@gmail.com

1. INTRODUCTION

Ethnomathematics is an interdisciplinary field that examines the relationship between local cultural practices and mathematical concepts. In this study, mathematics is not only seen as an abstract science that stands alone, but also as an inseparable part of people's lives, reflected through cultural artefacts, traditions, and knowledge systems that develop from generation to generation. This approach was introduced as one of the contextualization efforts in mathematics education, with the main goal of bridging students' cultural heritage with their understanding of formal mathematics concepts in the classroom. Through ethnomathematics, mathematics learning becomes more relevant and meaningful, and it respects students' cultural backgrounds, making it not only a tool for cultural preservation but also an educational medium that integrates local values into modern mathematics learning [1]. In line with this perspective, “ethnomathematical values” in this study refer to both mathematical ideas embedded in cultural practices and the cultural meanings that accompany the artefacts produced. Therefore, ethnomathematics becomes a strategic entry point to connect everyday community activities with school mathematics, especially when learning is designed contextually.

In recent years, various studies have shown that integrating elements of local culture into mathematics learning, such as the application of mosque architectural patterns [2] and traditional arts, has a positive impact on increasing students' interest and understanding, especially in geometry and other mathematical concepts. This kind of contextual approach provides a space for learners to see mathematics not only as a collection of abstract formulas and symbols, but as an integral part of their lives and socio-cultural environment. Thus, students can interpret and internalise mathematical concepts more easily and in a more meaningful and relevant way [3]. However, many implementations still primarily present cultural objects as illustrations, while the systematic identification of mathematical values and their translation into learning activities remains limited. This situation indicates the need for studies that not only document cultural practices but also clearly articulate how the embedded concepts can function as contextual resources for mathematics learning.

In Indonesia, pottery crafts are among the objects of ethnomathematical study with great potential for exploration in the context of education. Pottery does not only serve as a tool for household needs but also stores representations of mathematical concepts, such as spatial reasoning, symmetry, and geometric transformations, including rotn [4], [5]. One real example is Sitiwinangun Village in Cirebon Regency, known as a centre of traditional pottery production. The daily activities of the artisans in this village present an authentic learning space, where geometric shapes such as cylinders and cones on jugs, or parabolic curves seen in decorative plate designs, are naturally reflected in the process of making crafts [6]. This shows that local cultural practices can be a contextual and meaningful learning resource in understanding mathematical concepts. In addition, the use of traditional tools such as the spinning wheel (petra) highlights rotational processes that can be linked to geometric reasoning and measurement activities in the classroom. Thus, Sitiwinangun pottery offers tangible forms and observable processes relevant to contextual mathematics learning, particularly in geometry.

Despite its significant potential, the use of pottery as a learning resource in mathematics learning has not received adequate attention in the formal curriculum. This reflects the gap between the richness of local culture and its application in the context of mathematics education. In response to these conditions, this research is directed at examining more deeply the mathematical elements of the pottery production process and exploring how these values can be incorporated into the development of contextual learning modules. The main objective of this study is to strengthen students' mathematical literacy through a local culture-based approach that is not only applicable but also able to arouse students' interest and involvement in the learning process [7], [8]. This gap is also evident in the limited availability of learning designs that map pottery-making activities to specific topics such as spatial geometry, symmetry, rotation, proportion, and volume estimation. Accordingly, the present study positions pottery not merely as cultural content, but as a contextual learning resource whose ethnomathematical values can be systematically identified and pedagogically utilised.

Using a qualitative approach supported by field observations, this study aims to comprehensively describe the relationship between pottery production practices and mathematical concepts, including rotation, radial symmetry, volume, and proportion. By directly observing the work process of the craftsmen, it is hoped that the forms of mathematical representations that arise naturally in their daily activities will be identified. The findings of this study are expected to provide a foundation for designing a contextual mathematics learning model aligned with the principles of the Independent Curriculum. Apart from being a pedagogical innovation, this approach is also intended to contribute to the preservation of local culture and to strengthen students' cultural identity in the educational process [1], [9]. To strengthen the analysis, this study also considers how the shapes of pottery products can be digitally represented and visualised to support geometric understanding. Ultimately, the study contributes to ethnomathematics-based learning by offering an evidence-based description of Sitiwinangun pottery as a contextual resource that connects cultural practices with formal mathematical concepts.

2. METHOD

This study applies an exploratory qualitative approach using a case study method to reveal, in depth, the ethnomathematical values integrated into the practice of pottery making in Sitiwinangun Village, Cirebon Regency. The selection of a qualitative approach is based on the consideration that this method allows researchers to explore the meanings, patterns, and structures of local culture in a naturalistic manner, particularly as they relate to the representation of mathematical concepts in everyday life. With this approach, researchers can understand the relationship between cultural activities and mathematical understanding more holistically, in accordance with an ethnomathematical framework that places culture as an integral part of the learning process [2], [4]. In line with the article title, “ethnomathematical values” in this study include (a) mathematical ideas embedded in forms and processes of pottery production and (b) cultural-symbolic meanings attached to the artefacts. The research location was chosen purposively for its uniqueness and representativeness of traditional pottery culture as an ethnomathematical context. The research subjects consisted of local pottery artisans who had more than five years of experience, as well as pottery factory managers who acted as key informants. The technique for selecting informants is purposive sampling, commonly used in qualitative studies grounded in local traditions [5]. These criteria were used to ensure that the informants had sufficient experience to explain both procedural steps and the meanings behind the craft practices.

Data collection in this study used various techniques to provide a comprehensive picture of the ethnomathematical values in the practice of pottery making. The first technique is non-participatory observation, in which the researcher is present during the production process without being actively involved, observing artisans' activities and their work environment [8]. The second technique is a semi-structured interview designed with open guidance, aiming to delve deeper into perceptions, mathematical intuition, and traditional values from the perspective of local cultural actors [3]. In addition, visual documentation through photographs and videos is also used as supporting materials for data interpretation, with an ethnographic visual approach that allows researchers to capture the symbolic and procedural dimensions of these cultural practices. To strengthen the "contextual learning potential," the observation and interview protocols also noted moments when activities, tools, or product forms could be mapped to school mathematics topics (e.g., geometry, symmetry, rotation, proportion, and volume). The visual documentation was further used to support the reconstruction and geometric representation of pottery forms.

The main instrument in this study is the researcher himself, who plays an active role as an observer and interpreter of data, equipped with observation guidelines designed based on ethnomathematical indicators. These indicators include representations of spatial shapes (such as circles, cylinders, and cones), symmetry, proportions, and the use of traditional measuring instruments [1]. Additional indicators were included to capture transformation and process-based aspects, such as rotational motion in the use of the spinning wheel (petra) and estimation strategies used by artisans during shaping. The observation was carried out in one intensive session in April 2025, with a duration of about two hours, covering the entire production stage or starting from the process of formation, combustion, to the final stage of dyeing. Field notes were compiled during and immediately after the observation to preserve contextual details, including tool use, the sequence of actions, and the verbal explanations provided by artisans during work.

The data obtained was analysed using thematic analysis techniques, which consisted of three main stages: (1) data reduction, namely filtering relevant information; (2) categorisation based on ethnomathematical indicators; and (3) interpretation of the cultural and mathematical meaning implied in the practice of pottery production. This analytical procedure refers to the framework developed by Spradley in educational ethnographic studies, which has proven relevant in similar studies [2]. Field notes were compiled during and immediately after the observation to preserve contextual details, including tool use, the sequence of actions, and the verbal explanations provided by artisans during work.

To ensure the validity and credibility of the data, this study applied triangulation of sources and methods, as well as peer discussion, to verify the findings. Through this approach, the research aims to delve deeper into the non-formal mathematical understanding held by craftsmen and explore the possibility of adapting this knowledge into contextual mathematics learning modules based on local culture [9].

Source triangulation was conducted by comparing information from artisans and managers, while method triangulation compared observation records, interview responses, and visual evidence of the production process and products. Peer discussion focused on assessing the clarity of the ethnomathematical categorisation and ensuring that interpretations of learning potential remained consistent with the qualitative scope of the study (i.e., identifying potential rather than testing learning effectiveness).

3. RESULTS AND DISCUSSION

3.1. Result

During a field visit to one of the pottery factories in Sitiwinangun Village, Jamblang District, Cirebon Regency, the research team observed various traditional handicraft products, such as plates, bowls, glasses, and jugs, as well as the use of a turning tool known as a petra, or pottery wheel. The production process begins with selecting and extracting high-quality clay as the base material. The clay is then processed manually through the *pinching technique,* which involves massaging and forming by hand before being rotated on a petra. The tool is circular in shape and operates on a rotational principle, allowinghe formation of radial symmetry and natural hollows on the pottery's surface [6]. These observations indicate that ethnomathematical values emerge not only from the finished products but also from the sequence of actions and tools used during production. From a learning perspective, the production stages provide authentic contexts to introduce mathematical ideas through real cultural practices.

The following process involves forming the main structure of the pottery, including the body, neck (especially for jugs), and base. Products such as plates and bowls are designed with a basin adapted to their function, while jugs are shaped with more complex techniques: hands and tools are skillfully used to produce a narrow neck, a rounded body, and a stable base to stand upright. Each stage of this formation involves mastering the concepts of proportions and basic geometric shapes. Circles are used to form the base and lip sections, while cylindrical volume is evident on the body of the plate and glass. In addition, the concave shapes of the plates and bowls resemble parabolic slices or half-balls, reflecting the intuitive application of mathematical concepts in the crafting process. These product forms represent spatial geometry that can be connected to classroom topics such as circles, cylinders, cones, spheres, and curved surfaces. Thus, the geometry is not presented as an abstract object but as a visible, tangible structure embedded in everyday artefacts.

The use of Petra in the pottery-making process is a direct application of physics and mathematical concepts, especially the principle of rotation. When this turner is operated, the symmetrical mass distribution and radial symmetry play an important role in maintaining the shape stability of the pottery during the forming process. Findings in ethnomathematical learning show that although they did not rely on formal formulas, artisans were able to estimate the volume and shape of the pottery structure with a high degree of precision. They use simple calculation techniques based on intuition and experience to model various geometric shapes, such as the volumes of short tubes, ball holes, and jug necks, based on the object's radius and height. This indicates a form of informal mathematical reasoning, in which estimation, proportional reasoning, and measurement are performed through experience-based strategies. As a contextual learning resource, the petra can be used to introduce rotation, symmetry, and volume estimation through observable changes in shape during spinning.

The final stage in the production process is pottery firing, which is still traditionally done by the open-firing method. This technique uses local silica sand as a coating that improves the pottery's resistance to high temperatures and physical stress. Although it still maintains traditional methods and strong cultural values, the sustainability of pottery production in Sitiwinangun Village faces serious challenges, including the lack of succession among young artisans and limited land for harvesting r materials [10]. In ethnomathematical terms, this stage reflects cultural-technological knowledge involving materials, temperature, timing, and procedural control, which can be discussed in the context of measurement and applied reasoning. At the same time, these challenges highlight the importance of documenting and integrating local cultural practices into learning to sustain cultural knowledge through education.

In addition to producing functional pottery such as plates, bowls, glasses, and jugs, artisans in this village also create artistic and decorative pottery. Some works have abstract forms that do not follow conventional geometric patterns but rather express the craftsman's aesthetic freedom. This type of pottery is often used as a decorative element or artwork with high aesthetic value. In addition, products with more systematic geometric patterns or traditional carving motifs that represent typical symbols of local culture are also found. This diversity of forms and functions shows that pottery crafts in Sitiwinangun Village are not only of practical value but also have an artistic dimension and deep cultural significance. These findings demonstrate that ethnomathematical values include both mathematical structures (shape, symmetry, proportion) and cultural-symbolic meanings represented in motifs and artefact functions. Therefore, pottery products can support contextual learning not only in geometry but also in discussions linking mathematics to culture and meaning.

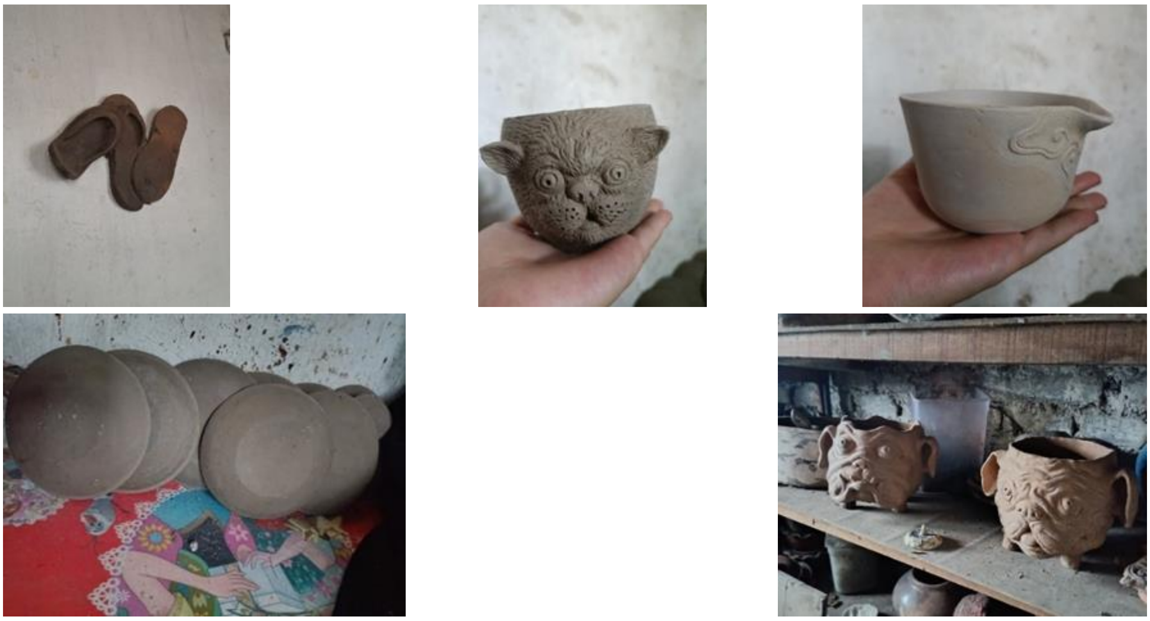


Figure 1. Kind of like pottery

In addition to making observations, the research team had the opportunity to be directly involved in the pottery-making process, especially plates, as part of the field experience. This activity begins by forming clay that has been processed to the appropriate level of flexibility, then placing it on a rotating tool (petra). When the petra starts to rotate, we try to shape the plate by adjusting the basin's thickness and width with finger pressure and a simple tool. Although the primary observation was non-participatory, this guided, hands-on experience served as a complementary step to better procedural details that are difficult to capture through observation alone. The activity also provided concrete evidence of how rotation and symmetry control are enacted in real time during shaping.

This experience provides a hands-on understanding of the importance of fine motor coordination, hand skills, and sensitivity to symmetrical shapes, which must be maintained consistently throughout the formation process. Maintaining the proportions of diameter and depth with precision is crucial to ensure the final result meets both function and aesthetics. Through this practice, we realised that the process of making pottery, which seems simple on the surface, actually involves a high level of complexity and demands precision, aesthetic sensitivity, and mathematical intuition that craftsmen naturally possess. These experiential findings reinforce the potential of pottery-making as a contextual mathematics learning resource, particularly for developing students' geometric reasoning, proportional thinking, and measurement awareness. In this sense, the craft practice offers a learning context where mathematical concepts are embedded in culturally meaningful activities rather than presented as isolated procedures.

Figure 2. Manufacture of Decorative Plates directly

3.2. Discussion

3.2.1 Petra

The use of the Petra tool in the context of mathematics learning not only represents physical principles (such as angular velocity, centripetal force, and mass distribution) but can also be contextualised within an ethnomathematical framework. According to D'Ambrosio (1985), ethnomathematics refers to how certain societies formulate and use mathematical ideas in daily life. In this case, the use of petra—as a traditional turning tool—illustrates the integration of culture and science through a real production practice. In line with this study's focus, the petra is discussed as an ethnomathematical value because it embodies mathematical ideas (rotation and symmetry) while remaining rooted in local craft traditions.

Richardo's Research [11] and Yudhi [12] show that local tools serve as a bridge to strengthen contextual learning grounded in local wisdom. The rotational symmetry of Petra teaches mathematical concepts such as rotational groups while also conveying cultural values of order and precision, as seen in woven patterns andculptures of the archipelago [13]. Thus, the Petra becomes relevant not only as a “tool” but also as a cultural context that supports meaningful learning connections between mathematics and students’ lived environments.

In the context of science and mathematics learning, the Petra tool is often referred to as *a turntable or rotary wheel, a round device mounted on a shaft that* can be rotated manually or mechanically. The tool is designed to visualise rotational phenomena, including angular acceleration, the centre of mass, andhe effect of centripetal force on objects on their surface [14]. In the pottery context, these concepts appear naturally because the craftsman’s success depends on maintaining stable rotation and balanced shaping during the spinning process.

From a physical and mathematical perspective, the working principle of this tool involves the rotation of rigid objects around a vertical axis. When rotated, each point on the wheel follows a circular trajectory around the centre, illustrating the relationships among angular velocity (ω), radius (r), and linear velocity ($v = \omega \cdot r$), as well as the centripetal force $F = m \cdot r \cdot \omega^2$. The centre of mass of the tool is usually placed at its centre to distribute the mass and maintain balance during rotation evenly [15]. Although artisans may not express these relations in formal formulas, their practice reflects experiential control over stability, speed, and symmetry—an important form of informal mathematical knowledge.

Figure 3. Manual turntable

The circular motion of the Petra tool also reflects the real-world application of the concepts of rotation and symmetry in geometry. Each element of the wheel, such as an evenly divided line or segment, has the property of symmetrical rotation, meaning that the shape of the wheel will appear identical when rotated by a certain angle, such as 60° for a wheel divided into six segments. This principle provides a concrete illustration of the theory of rotational groups and radial symmetry, which is an important part of the study of geometry. For contextual mathematics learning, this visibility helps students connect abstract symmetry ideas to a tangible artefact they can observe directly.

Furthermore, the rotation of the petra naturally produces radially symmetric patterns, such as concentric traces or sector-like divisions, visible during spinning. This phenomenon is relevant to the study of plane figures and spatial structures, including circles, circular sectors, and rotational patterns. By associating rotary motion with geometric concepts, students can more concretely understand topics such as central angles, arc length, and rotational transformations. This aligns with the “potential for contextual mathematics learning” emphasised in the study, as concepts emerge from an authentic cultural practice rather than decontextualised exercises.

In practice, the Petra tool can also be used in cross-disciplinary learning activities. For example, measuring angular and linear velocity with digital sensors (such as an Arduino), and analysing centripetal forces in the context of simple physics experiments. Facilitate understanding of rotational geometry through visual experiments, such as dividing a wheel into n segments and observing rotational symmetry patterns and the relationships between the centre angle and arc length [7]. If implemented in school settings, these activities can be adapted into guided tasks that remain culturally grounded while still meeting formal curriculum objectives.

By linking the physical phenomena involved in the use of petra to local cultural values and mathematical concepts, learning becomes more contextual and applicable, and students' appreciation of local wisdom as a source of knowledge is strengthened. This approach is considered important to increase the relevance and meaningfulness of mathematics learning among Indonesian students [16]. In other words, the petra represents an ethnomathematical value that simultaneously supports conceptual learning (rotation and symmetry) and cultural appreciation (craft knowledge and local identity).

3.2.2. Plates and Bowls

Pottery, as a handicraft of clay formed and then burned, presents a clear visual representation of geometric concepts, both in flat and spatial forms. Products such as plates and bowls, for example, explicitly show the use of a circular pattern as a basic shape on both the base and the edges, which are geometrically closely related to a concave plane resembling a short tube or a half-spherical slice [17]. These visible structures make plates and bowls particularly suitable as contextual objects for geometry learning.

More than geometric shapes, these handicraft plates and bowls also reflect the local community's mathematical knowledge, developed from generation to generation. The craftsman's hand movements in the shape of a concave parabolic curve on a bowl, or the curved "S" shaped profile on a plate, represent geometric shapes that are not made calculatively, but are formed with a high degree of precision based on mathematical intuition that has been passed down through generations [18]. This illustrates an ethnomathematical value: informal geometric reasoning embedded in skilled cultural practice.

In the manufacturing process, pottery craftsmen in Sitiwinangun Village generally go through four main stages, namely: (1) making tombong as part of the base or base; (2) the formation of bebentet, which is the curved side that forms the body of the pottery; (3) the arrangement of belong, namely the neck or the connection between structures; and (4) lip finishing, which refers to the mouth or lid of the pottery. Each of these stages of formation indirectly reflects mastery of concave shapes and basic geometric principles, which are precisely applied in practice [19]. Linking each stage to school topics (e.g., circles, curvature, symmetry, and measurement) can help transform the production sequence into a structured contextual learning activity.

Figure 4. Pottery bowl

As a follow-up to studying the mathematical elements in pottery crafts, the use of Maple software as a visualisation tool is an important means of systematically and accurately representing geometric shapes. The visualisation of pottery models in Maple not only strengthens understanding of the structural features of the craft's products, but also enables explicit representations of geometric shapes using mathematical functions. The integration of this software with local cultural objects is a concrete example of the application of digital ethnomathematics, which is the use of technology to bridge cultural heritage and formal mathematical concepts [20]. This step supports the study’s emphasis on learning potential by showing how cultural artefacts can be connected to formal representations used in classrooms.

Using the three-dimensional graphic modelling feature in Maple, the typical curved shapes of Sitiwinangun pottery can be visualised as mathematical equations that represent curved side spaces, such as paraboloids, semispheres, or cylinders. This visualisation not only reinforces the connection between culture and mathematics in tangible terms but also expands the possibilities for contextualised mathematics learning. Thus, this approach makes an important contribution in making it easier for students to understand mathematical concepts through media that are close to their lives and rooted in local wisdom. In educational terms, the pottery-to-model transition helps students move from concrete observation to semi-formal representation and then to formal concepts.

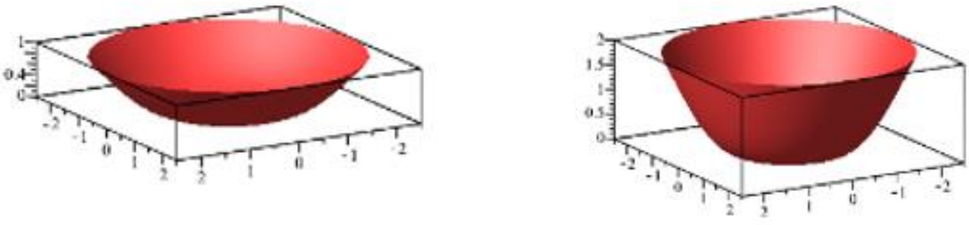


Figure 5. Maple plates and bowls

Here are the steps of the model on the Maple application. The explanation below clarifies how the cultural object is translated into parameters and functions that represent its geometry.

```
with(plots); dia := 8; tinggi := 1; lebar := 6;
```

First, the code begins by loading a package *of plots* that provides a 3D visualisation function. Next, three main parameters are defined: *dia* (total diameter of the plate) is worth 8 units, *height* (height of the curved side) is worth 1 unit, and *width* (diameter of the flat base) is worth 6 units. This parameter determines the plate's overall geometric proportions. The selection of these values is arbitrary but is designed to create a balanced shape of the plate between the flat part and the curved side. In learning contexts, these parameters can be linked to measurement activities and proportional reasoning (e.g., how changing diameter affects curvature and capacity).

$$f := r \to tinggi \cdot \left(1 - \cos\left(\frac{\mathrm{Pi}}{2} \cdot \max\left(0, \frac{\left(r - \frac{lebar}{2}\right)}{\left(\frac{dia}{2} - \frac{lebar}{2}\right)}\right)\right)\right);$$

Second, the *f(r)* function is at the heart of this modelling, which controls the curved shape of the side of the plate. This function uses a modified cosine operation with *the max* function to ensure a non-negative value. The section *(r-width/2)/(dia/2-width/2)* normalises the radial distance from the edge of the flat section to the edge of the plate, while *cos(π/2·...)* creates a smooth transition from a flat base to a curved side. The use of this cosine results in a smooth S-shaped curve (sigmoid), ideal for cutlery designs because it has no abrupt changes in surface slope. This modelling step can also introduce the idea that curves in real objects can be approximated by functions, without requiring students to start from advanced calculus.

```
plate := plot3d(
   [r * cos(theta), r * sin(theta), f(r) ],
    r = 0 ..dia/2,
   theta = 0 ..2 * Pi,
   style = patchnogrid,
    color = "orange",
   glossiness = 0.7
 );
```

```
plate := PLOT3D(...)
```

Figure 6. Results of the Maple *plate code*

Third, the *plot3d command* converts a mathematical function into a 3D object with a polar coordinate system. The *variables r* and *theta* represent radial and angular coordinates, respectively. The components *[r*cos(theta), r*sin(theta), f(r)]* convert polar coordinates to Cartesian, with *f(r)* determining the elevation (z-axis) of each point. Styling options can be applied to enhance the surface's visual appearance. Pedagogically, this step provides a clear example of how circular symmetry in pottery relates to polar representations in mathematics.

The *style=patchnogrid* option removes grid lines, giving the ceramic a solid appearance, while the orange colour and glossiness=0.7 properties give it a shiny look. The default grid parameter is used because it is not explicitly defined.

```
display( [ plate ],
    title = "Piring Modern dengan Sisi Melengkung",
    orientation = [ 60, 75 ],
    scaling = constrained,
    lightmodel = light4 );
```

Figure 7. Results from the Maple *display code*

Fourth, the rendering process is run with *the display*, where the camera orientation is set to *[60.75]* degrees to display the perspective of the scaling=constrained setting, maintaining the original proportions without distortion, while *lightmodel=light4* applies multidirectional lighting that improves depth perception. The title "Modern Plates with Curved Sides" was added for visual context. The result is a plate model with a flat centre and sides that curve gradually upwards, resembling a contemporary plate design. In classroom use, the rendered model can support discussions about cross-sections, surface shape, and how a rotationally symmetric object is constructed from a profile curve.

The most dominant geometric shape in the structure of pottery plates and bowls is the circle, which is generally used as a basic design on the base, with a specific diameter (d) and radius (r). The choice of a circular shape not only provides an aesthetic impression and visual balance but also plays an important role in ensuring the object's functional stability, especially in distributing load evenly on a flat surface. This provides a direct context for learning circle properties (radius, diameter, circumference) through an artefact that students can observe and measure.

In pottery bowls, the basin is characterised by its geometric form. If the basin has a cylindrical contour with near-vertical sides, it can be modelled as a short cylinder. If the interior forms a deeper, smoothly curved hemispherical space, it resembles half of a sphere. Meanwhile, the basin on a plate tends to be shallower and can be modelled as a parabolic-like surface, which is useful for estimating depth (h) and shape variation. These distinctions help clarify why different pottery types can be used to introduce different modelling assumptions in contextual problems.

These geometric relationships show that basic geometric principles, such as circles, parabolas, and various spatial structures, have been used practically and intuitively in the design of traditional tableware by craftsmen. This reinforces the understanding that local cultural practices are inseparable from the application of scientifically explainable mathematical concepts [5]. Within the ethnomathematical lens, the key point is not that artisans "use formulas," but that they enact mathematical reasoning through design choices, estimation, and control of symmetry.

Pottery plates and bowls are concrete examples of the application of spatial geometry in daily life, realised through traditional craft activities. The shape of a bowl that resembles a short tube can be estimated in volume by using $V \approx \pi r^2 h$the formula. where is the radius of the base, and is the depth of the basin. On the other hand, for a round bowl or container with a half-ball shape, the volume can be approximated using the formula. These two forms indirectly require craftsmen to have a practical understanding of the relationships among diameter, depth, and the capacity or volume of space. Although it does not use a formal formula, the skill that is passed down through generations reflects a high level of mathematical intuition in designing shapes that are not only functionally efficient, but also aesthetically efficient $rhV \approx \frac{2}{3}\pi r^3$ [1]. For contextual learning, these approximations can be presented as "modelling choices" rather than exact measurements, emphasising reasoning and interpretation.

In the context of learning mathematics, modelling the shapes of bowls and plates as parabolas or half-spheres can introduce various mathematical concepts, such as the relationships among volume, surface area, and the geometric properties of curves. The study conducted by Silalahi et al. [21] shows that this contextual approach significantly improves students' spatial abilities and understanding of integral concepts, as learning becomes more concrete and meaningful. In this study, the emphasis remains on the potential and design relevance of pottery contexts, since the research does not directly test learning outcomes in classrooms.

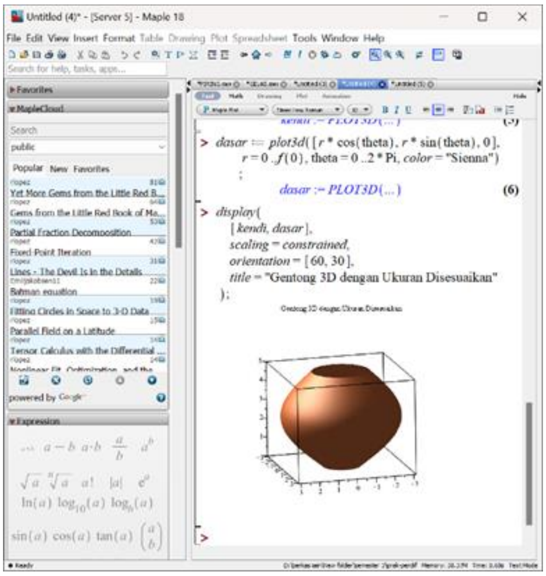
However, this article has not discussed the forms of local pottery comparatively with traditional containers from other cultures. In fact, a cross-cultural study by Wulandari et al. [22] suggests that traditional containers across Southeast Asia share similar geometric patterns and structures, including the dominance of circular shapes and radial symmetry. These findings open opportunities to expand the scope of ethnomathematical studies globally while enriching perspectives on the relationships among culture, form, and mathematical concepts across various societies. This limitation also suggests a future research direction: comparing how similar geometric ideas emerge from different cultural practices and how those differences can enrich contextual learning design.

3.2.3 Jug

Jug is a form of traditional pottery that clearly represents the combination of three types of spatial construction: tubes at the neck, balls at the body, and cones at the base or at the transition between the neck and body. In the process of making it, craftsmen intuitively apply the ratio between the fingers and the height to produce a shape that is not only aesthetically pleasing but also stable and functional in its daily use. Ethnomathematical studies conducted by Jelita [23] show that this j-shaped structure has great potential for learning the concept of rotary volume and integral calculus, especially in contextual approaches grounded in local culture. In this article, the jug is discussed as an ethnomathematical object because its geometry is inseparable from the cultural craft knowledge that shapes it.

The characteristic of the traditional jug with a narrow neck, rounded body, and conical base is the result of a geometric understanding passed down from generation to generation. A field study on pottery crafts from Kampung Abar, Sentani, for example, revealed that the shape of the jug consistently involves elements of circles, tubes, and cones that reflect a rich local knowledge of basic geometric concepts. Meanwhile, similar research conducted in the Banyumulek area also showed a corresponding geometric pattern: the neck and base of the jug tend to resemble tube-and-cone structures, while the rounded body resembles a ball or a half sphere [15]. This consistency strengthens the argument that everyday artefacts can serve as stable contexts for teaching core geometry concepts across different regions.

Furthermore, the use of software such as Maple in modelling the jug's shape provides a more systematic visual representation of its geometric structure. This digital visualisation makes it clear that the principles of mathematics are not separate from everyday life but are naturally present in various cultural practices. Therefore, this approach opens new space for the development of local culture-based mathematics learning, which not only deepens understanding of abstract concepts but also enriches students' perspectives on cultural wisdom as an authentic source of knowledge. This aligns with the “contextual mathematics learning” focus by connecting cultural artefacts, geometric modelling, and digital representation within a single learning pathway.



```
> dasar := plot3d([r * cos(theta), r * sin(theta), 0],
      r = 0 ..f(0), theta = 0 ..2 * Pi, color = "Sienna")
   ;
                dasar := PLOT3D(...)                          (6)
> display(
    [kendi, dasar],
    scaling = constrained,
    orientation = [60, 30],
    title = "Gentong 3D dengan Ukuran Disesuaikan"
  );
```

Figure 8. Maple jug

The proportions of the jug's shape are not based solely on aesthetic considerations; they also take into account complex practical functions. The narrow neck of the jug slows heat transfer, so the water inside can remain at a more stable temperature for a longer period. The rounded body allows for the storage of larger volumes of water without sacrificing position stability, while its curved shape also makes it easy to grip. This ergonomic design is inseparable from the craftsman's intuitive understanding of the neck radius (r_1), body radius (r_2), and neck height (h), which, in turn, leads to volume optimisation and structural stability. Such functional reasoning can be used as contextual problem prompts, for example, asking students to compare capacity or stability under different radius–height designs.

In practice, jug making involves the direct application of practical mathematical concepts. The craftsmen used the principle of circular measurement to determine the neck and body diameters and radii, and the concepts of tubes and cones to estimate the volumes of each part of the jug. One study even linked the creation of these jugs to the learning of integral calculus, specifically in terms of modelling the shape of rotating objects such as tubes and cones to calculate volume mathematically. This shows that even without formal formulation, artisans have actually applied modern mathematical principles in their creative process—from measurement to achieving optimal functions that include volume efficiency, shape stability, and natural thermal insulation.

However, this article examines the mathematical form and function of jugs solely from the perspectives of geometry and calculus, without considering their symbolic meaning and social function within local culture. In fact, this aspect is very important in the ethnomathematical framework. A study by Jelita [23] revealed that jugs in some traditional societies also have strong symbolic value, often used in rituals to symbolise harmony, balance, and wholeness. Its harmonious form was chosen not only for its function but also as a reflection of the philosophical values that shape local culture.

By adding this dimension of symbolic meaning, the understanding of mathematics becomes more complete, not only by focusing on formulas and forms, but also by relating these concepts to the cultural narratives, social values, and worldviews contained in the objects being studied. This aligns with the goal of ethnomathematics to expand students' learning horizons, from mathematics as an abstract science to an integral part of life and culture. Consequently, contextual learning can foster both conceptual understanding and cultural literacy, which supports meaningful learning in diverse classrooms.

4. CONCLUSION

This research reveals that pottery crafts in Sitiwinangun Village not only function as living cultural heritage but also as a cultural practice laden with ethnomathematical values. The pottery production process clearly reflects the application of various mathematical concepts, such as geometric shapes (circles, cylinders, cones, and spheres), radial symmetry, proportion, rotation, and volume estimation. The use of traditional tools, such as the petra (spinning wheel), also shows the link between the principles of physics and mathematics, especially in the context of rotation and mass distribution, a topic rarely addressed in conventional learning. In accordance with the article's focus, these findings indicate that ethnomathematical values emerge from both the forms of the artefacts and the production processes observed in the field.

This ethnomathematical approach, grounded in local cultural practice, is highly relevant to mathematics education, especially in bridging formal concepts with everyday contexts. By integrating local values and cultural artefacts into learning materials, mathematics learning can become more meaningful and contextual while supporting cultural preservation. Furthermore, the findings indicate that pottery-based ethnomathematics has the potential to support geometry learning by connecting cultural practice with formal mathematical representation, including through digital visualisation. However, the contribution of this study is to identify and describe learning potential and contextual relevance, not to measure learning effectiveness in classroom interventions. Therefore, the main educational implication is to provide culturally grounded contexts that teachers can adapt into tasks, discussions, and modules aligned with curriculum needs.

However, the limitation of this research lies in its scope, which is limited to one location, namely the Sitiwinangun pottery centre, so the findings cannot be generalised to other regions with different cultural backgrounds and craft techniques. For this reason, further research is recommended, particularly by involving pottery-producing regions in other parts of Indonesia and comparing variations in forms, tools, and cultural meanings. Collaboration with teachers is also suggested in developing ethnomathematics-based modules or teaching tools and examining their feasibility in real classroom settings. Future studies may also expand the analysis to include more systematic mapping between identified ethnomathematical values and specific learning objectives, grade levels, and assessment indicators.

In practical terms, these findings have important implications for developing a mathematical learning model grounded in local culture, which not only strengthens cognitive conceptual understanding but also fosters concern for cultural values. Thus, mathematics learning is not only a place to master formulas but also a medium for fostering cultural sensitivity, creativity, and reflective thinking in students as part of a community rooted in local wisdom. By positioning pottery crafts as a context for learning, this study supports the integration of cultural heritage into mathematics education in ways that are academically meaningful and socially relevant.

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