Ethnomathematics in Cultural Transformation at the Banten Museum: Uncovering Geometric Patterns and Symmetry in Historical Heritage

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Abstract: Ethnomathematics is the study of mathematics among identifiable cultural groups including national societies, tribes, labor groups, children, members of specific age groups, and the professional class. This research was conducted at the Museum of Archaeological Sites in which there are interesting historical objects to discuss. Researchers found interesting things in the objects in the Banten Archaeological Site Museum, these objects include memolo, pottery, pottery fragments, umpak and bullets, which are interesting to discuss in this study because they contain ethnomathematical elements. The research method used in this study is qualitative with a cultural approach (ethnography). The results and discussion in this study of historical objects in the Banten Archaeological Site Museum in addition to containing philosophical (historical) values also contain mathematical values, especially in geometric transformation materials, namely translation (shift), reflection (reflection), rotation (rotation) and dilation (enlargement or diminution).

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A. INTRODUCTION

Mathematics is a science that uses numbers, patterns, and logical relationships to study quantity, structure, place, and change. This science uses symbols, formulas, problem-solving, and analysis to understand life events. It is possible to define mathematics as knowledge or knowledge derived from reasoning, which can be achieved by trying to motivate the mind to perform ratios or thinking exercises. Therefore, basic ideas, techniques, processes, and reason work together to form mathematics in one's mind. In line with what the (Sinaga et al., 2021). Mathematics is a science whose truth is absolute, it cannot be revised because it is based on pure deduction which is the unity of systems in proving mathematics. In learning mathematics in schools, students still consider mathematics to be complicated, too abstract, many formulas and so on, this is because mathematics learning in school is too formal and not by what students experience in daily life. Therefore, further research is needed to explore the cultures around us to find concrete mathematical concepts to be applied in school mathematics learning(Turmuzi et al., 2022). For this reason, innovative new things are needed to make students be able to learn mathematics in a fun way, one of which is associated with culture.

According to Brown (1963:46;Zamhari et al., 2025), "People are bound together by their culture. Human behavior that is patterned and considered acceptable is referred to as culture.

The knowledge, ideas, values, art, laws, conventions, and other skills and behaviors people learn as members of society are all considered part of the culture." This is in line with what the Central Statistics Agency said, according to him, one of the media that must be protected is culture as a reflection of the noble values of the nation. In strengthening the bonds of solidarity and solidarity to advance the nation's principles. Art, cultural artifacts, historical artifacts, tribal races, traditional games, customs, languages, traditional ceremonies, traditional sports, traditional products, and local knowledge are just a few of the many cultures that abound throughout Indonesia. In line with (Widyastuti, 2021) The cultural foundation in the educational process for students actively aims to develop their potential, internalize the process, and appreciate the values that become their personalities in associating in society, developing a more prosperous community life, and developing the life of the community and the nation in the future.

Meanwhile, according to (Syakhrani & Kamil, 2022) Culture or culture comes from the Sanskrit language, namely buddhayah, which is the plural form of buddhi (budi or intellect) interpreted as things related to the human mind and intellect, in English culture is called culture which comes from the Latin word colere which is cultivating or working can also be interpreted as cultivating the land or farming, the word culture is also sometimes translated as "Culture" in Indonesian. According to (Alifia dkk,2021;Kuswantara, 2023)) The cultural diversity in the community contains values that can be used to improve character education. Education based on cultural diversity or multiculturalism aims to foster and guide students to be more sensitive to the surrounding environment. In Indonesia itself, various types and types of cultures in society can be implemented in learning as one of the efforts in shaping students' character. So connecting mathematics learning can improve the character of students who love culture and do not think mathematics is not boring but fun. With this, the culture associated with mathematics can be used as an innovation called ethnomathematics.

In 1977, D'Ambrosio, a Brazilian mathematician, was the first to promote ethnomathematics. Ethnomathematics, according to D'Ambrosio, is etymologically made up of two words: ethno, which denotes something broad that leads to social and cultural life, including language, superstitions (myths), ethics (behavior), signs (symbols), and slogans (jargon). The second word is mathematics, which means explaining, knowing, understanding, and performing tasks such as categorization, measurement, coding, concluding, and modeling. Techne, which means technique, is the root of the last word, tics. According to nomenclature, ethnomathematics is the study of mathematics among identifiable cultural groups, including national societies, tribes, labor groups, children, members of specific age groups, and the professional class(D`Ambrosio,1985;Shiffa Firdaussa et al., 2021). In line with (Fitriyah & Dasari, 2023), ethnomathematics is an approach that involves local culture with mathematical concepts that can be included in the learning process in schools. Thus, it can be said that ethnomathematics is a collection of sciences that comes from the mathematical thinking of an environment of a community group (Kristial et al., 2021).

Banten is one of the provinces in Indonesia with the capital city of Serang. Banten was established based on Law Number 23 of 2000. Administratively, Banten is divided into 4

districts and 4 cities, namely Serang Regency, Pandeglang Regency, Lebak Regency, Tangerang Regency, Serang City, South Tangerang City, Tangerang City and Cilegon City (Ngulwiyah et al., 2022). Banten is the southernmost province on the island of Java which has a wealth of customs and cultural history that is still preserved to this day. The rich culture that forms Banten's identity is shown in everything from the significant Debus artwork to the historic architecture of the Banten Sultanate to what we often hear about one of the tribes that still exists today, the Baduy, and many more. Banten also has a variety of ancient manuscripts, ceramics, traditional weapons, and architectural remains of the Sultanate of Banten. These are just a few examples of objects that show the region's significance in the trade route and the spread of archipelago culture.

Inside the Banten Archaeological Site Museum, you can see various historical artifacts at the Banten Museum, including cannons of colonial descent, inscriptions documenting important events, and artifacts from the daily lives of the Banten people. These artifacts serve as a silent record of history and teaching tools to help the next generation better understand and appreciate the rich cultural heritage that has been left behind. Preserving these heritage items further strengthens Banten's historically and culturally rich status. Based on the research conducted by Irma Ainni and Iin Hindayati at the Banten Archaeological Site Museum about historical objects relics of the Banten kingdom if associated with mathematics using ethnographic or cultural approaches, a title was obtained "Ethnomathematics in Cultural Transformation at the Banten Museum: Uncovering Geometric Patterns and Symmetry in Historical Heritage".

B. METHOD

The method used in the research uses a qualitative method with a cultural approach (ethnography). In this case, ethnography is derived from the Greek, ethnos which means person and graphein which means writing. Another meaning is meaningful, where ethnography is interpreted as a writing or report about an ethnic group written by an anthropologist based on the results of field work. Classificationally, ethnography is included in qualitative research. (Kamarusdiana, 2019;(Mahendra et al., 2024). The ethnographic approach to qualitative methods is a research methodology that emphasizes a thorough understanding of a particular group or society's social, cultural, and customary relationships. Originating in anthropology, ethnography is often used to study people's values, opinions, and ways of life in their social environment. The purpose of this research is to provide an overview or description of mathematics in a culture contained in historical objects in the Banten Museum, as well as to be a reference for further research, this study tries to document customs, cultures, or social practices that have not received much attention. The location of this research was conducted at the Banten Antiquities Museum which is located at the Old Banten Archaeological Site Museum, Jalan Masjid Agung Banten, Kasemen District, Serang City, Banten Province.

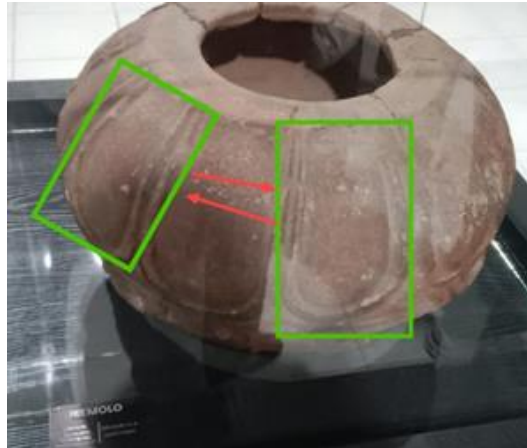## C. RESULT AND DISCUSSIONS

1. **Memolo**

Figure 1. Memolo

The Momolo motif is a pattern consistently repeated across the entire pottery surface using translation. In figure 1, the momolo motif shifts in position around the momolo. Motif elements, for example, can be moved at a certain distance either vertically or horizontally to produce symmetrical and repetitive patterns. A sense of aesthetic regularity is generated by this technique, which guarantees that the motif remains constant without deforming or positioning. The translation of Momolo motifs has symbolic significance in addition to aesthetically pleasing. In addition to reflecting its creators' natural order and culture, repetitive patterns represent continuity and harmony in life. The harmonious and attractive designs reinforce the artistic value of traditional pottery artisans can create using shifting techniques or in geometric terms referred to as translation. According to (Sutopo & Ratu, 2021) Translation is a material that studies the movement of all points on a building with the same direction and distance.

2. **Gerabah**

A reflection, a transformation with mirror shadow characteristics, drives every point in the plane. A geometric transition known as reflection produces a mirror shadow of an object against a specific line known as the axis of reflection. One can observe that the left motif is reflected in Figure 2, creating the exact motif.
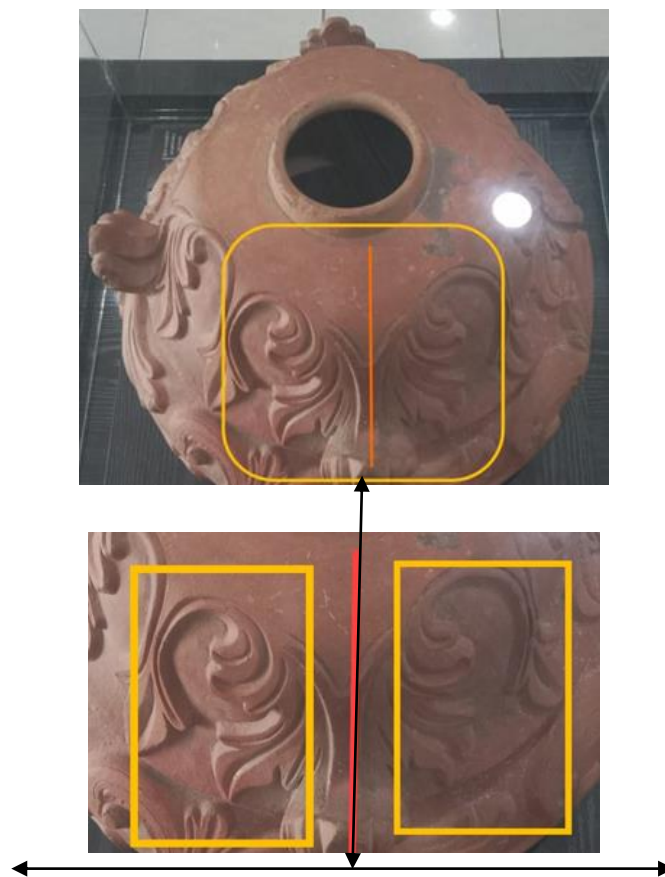
Figure 2. Gerabah

In Figure 3, the pottery motif is the same shape, only it has changed because the motif is like an object facing a mirror. Reflection follows the rule that each point on the original object has the same distance from the axis of reflection as its shadow point. If a point (x,y) is reflected against a particular axis in Cartesian coordinates. This is by the ancient artisans's principle that mirroring is often used in pottery to produce symmetrical patterns that decorate the surface of objects. For example, traditional designs such as batik or pottery carvings can be repeated in inverted patterns to create visual harmony. This technique is often used in geometric designs to create a harmonious appearance, where one side of the pattern is reflected to the other. In many civilizations, reflections in pottery have symbolic significance in addition to their aesthetic value. Some motifs depicted include spiritual ideas, the interaction between humans and nature, or balance in life. Artisans can create aesthetically pleasing and highly philosophical products by utilizing the idea of reflection.

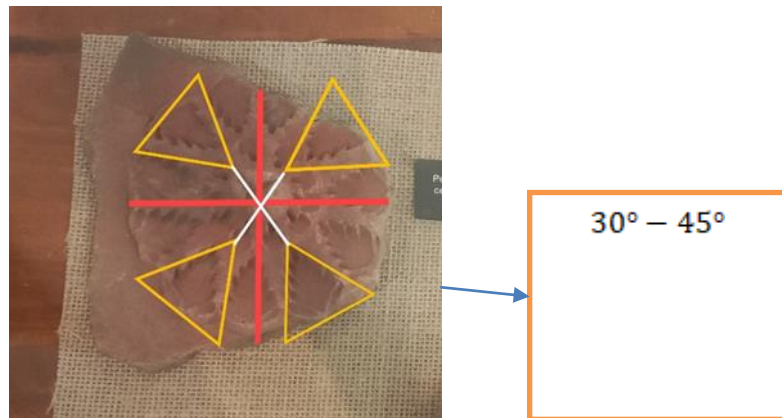### 3.   Fractional Gerabah and Umpak

Figure 3. Pecahan Gerabah

In the pottery motif above the shape or object surrounds the Cartesian coordinates using the same degree without changing the shape of the motif itself. In the principle of rotation without changing the size or shape of an object, rotation is a geometric change that rotates it around a central point. In ceramic motifs, this focal point is usually located in the center of the pottery surface, giving the impression that the motif surrounds it regularly. In the above motif, the researcher estimated the degree used in the rotation process to make the motif so that it is symmetrical from 30°-45°, because it is still half and half of the angle of the elbow or 90°.
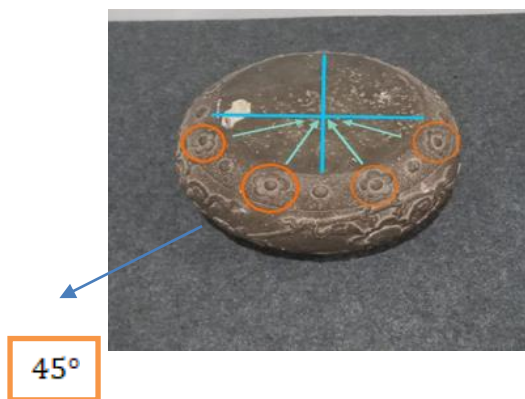

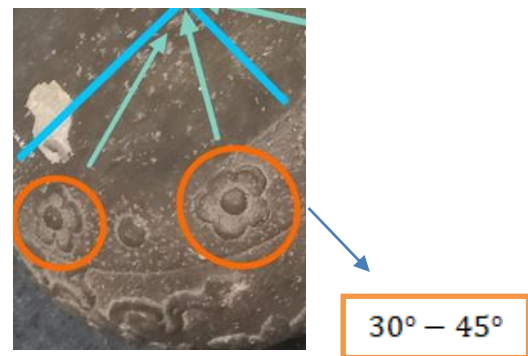
Figure 5. Umpak   **Figure 4.** Motif Umpak

A geometric transformation known as rotation rotates an object around a fixed point known as the center of rotation. Umpak is one of the examples of ancient history of Banten that shows the mathematical value in the idea of rotation. In traditional structures, such as historical artifacts in Banten, umpak is the foundation stone for the main pillars. The polygonal shapes of Banten's historical heritage, such as octagons and rectangles, show rotational symmetry. It is evident from the photo above that the umpak motif is arranged in a circle. This pattern shows rotational invariance, meaning it can be rotated at a certain angle

without affecting its overall shape. The umpak motif above moves around the umpak to the same degree without changing its shape.

A circular repeating pattern can be created by using this calculation to return each motif element to its original position after being rotated at a specific angle, such as 30°, 45° & 60°. When applied to pottery motifs, rotation results in aesthetically pleasing and harmonious designs such as ordinary geometric shapes, tendrils, or floral patterns. These motifs are often seen in traditional craft art, where the repetition of a rotating shape produces a unique visual balance. By applying the principle of rotation, pottery can produce a symmetrical and dynamic design that enhances the aesthetic appeal of the pottery.

4. **Bullet**

Figure 6. Bullet

In the picture above, there is a dilation of the bullet where there is a magnification and shrinkage of an object. Dilation is a modification that changes the size of the building (change in size) without changing the shape of an object. It is evident from the above image that the size of the bullet varies from large to small without affecting its proportions. A "size change" phenomenon occurs when an object becomes larger or smaller for various reasons. Dilation is a mathematical term for a change in size, a geometric transformation that modifies a shape's size without changing its proportions. This procedure uses a scale factor, where a value between zero and one results in a decrease and a value of more than one in expansion.

D. **CONCLUSION AND SUGGESTIONS**

Based on the results of the discussion on historical objects in the Banten Antiquities Museum, it can be concluded that these historical objects not only have historical (philosophical) values but also have mathematical values if connected using an ethnographic approach. The historical objects in the Banten Antiquities Museum must be preserved and conveyed to the next generation. Historical objects in the Museum of Banten Antiquities above there are mathematical values in geometric transformations, namely translation (shift), reflection (mirroring), rotation (rotation) and dilation (change in size).

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