



Ethnomathematics of Madurese Cultural Characteristics in the Emancipated Curriculum

Sri Indriati Hasanah¹, Moh Zayyadi^{1*}, Chairul Fajar Tafrilyanto¹, Yoga Dwi Windy Kusuma Ningtyas²

¹Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Madura, Indonesia

²Graduate School of Humanities and Social Sciences, International Educational Development Program, Hiroshima University, Japan

*Correspondence to: zayyadi@unira.ac.id

Abstract: The concept of mathematics is inextricably linked to the fabric of everyday life. Indeed, the cultural milieu of a given region can also profoundly influence how mathematical concepts are employed. Ethnomathematics represents a component of the mathematical learning process that integrates mathematical concepts within a given culture. This study aims to ascertain the characterization of ethnomathematics within the Madurese culture as reflected in the emancipated curriculum in Bangkalan Regency. This study employs an ethnographic approach, following a series of stages or cycles. The ethnographic research cycle comprises six stages: the selection of an ethnographic project, the formulation of ethnographic questions, the collection of ethnographic data, the production of ethnographic recordings, and the analysis of ethnographic data. Thematic ethnographic analysis was employed as the data analysis technique in this ethnographic study to provide a comprehensive description of the characteristics of Madurese culture in the emancipated curriculum. The research report's primary focus is a descriptive account of the cultural context. This study's findings indicate that mathematical concepts are embedded within the Madurese culture in Bangkalan Regency and can be leveraged as a learning medium in educational activities and as a representation of real-world mathematical geometry. Consequently, integrating these mathematical concepts within the Madurese culture in Bangkalan Regency can enhance students' comprehension of geometry.

Keywords: ethnomathematics, madurese culture, emancipated curriculum

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INTRODUCTION

Madura island is predominantly inhabited by the Madurese ethnic group, which is one of the largest ethnic groups in Indonesia. The island comprises four regencies: Bangkalan, Sampang, Pamekasan, and Sumenep. Each of the four regencies has its own distinctive art and culture, exhibiting notable differences (Febrianto & Sulaiman, 2014) despite their proximity to the archipelago. Madurese is one of the communities whose region is known as a village community. As a result, village communities have their own traditions, cultures, customs, and perspectives on various matters. Social values in the life of the Madurese community are reflected in its culture (Ambarwati et al., 2019). One persistent challenge for the East Java Education Service is the lack of engagement with the Madurese people regarding the value of education. The Madurese tend to view education as limited to basic religious knowledge, and those who pursue higher education are often seen as pursuing worldly interests.

Following the guidelines outlined in the Decree of the Minister of Education, Culture, Research, and Technology Number 56/M/2022 concerning the implementation of the curriculum in the context of learning recovery, it becomes evident that the focus of learning is on intracurricular learning and projects designed to reinforce the Pancasila profile. One such approach is culture-based learning. Incorporating culture-based learning in mathematics closely aligns with the principles of ethnomathematics. Ethnomathematics is a term derived from the combination of the words "ethno" (referring to ethnicity or culture) and "mathematics." It can be defined as a field of cultural anthropology that explores the relationship between mathematical concepts and diverse cultural traditions (Aini et al., 2019; Fajriyeh & Zayyadi, 2023; Prahmana & D'Ambrosio, 2020; Zayyadi et al., 2018). Ethnomathematics, defined as the intersection of mathematics and culture, must be contextualized within the lived experiences of individuals to ensure that mathematics is not merely a subject but rather a human activity deeply intertwined with local culture (Kusuma et al., 2017; Muhtadi et al., 2017; Zayyadi et al., 2023). Implementing the emancipated curriculum in schools is anticipated to be facilitated by incorporating mathematical concepts that are culturally specific to each region or regency. Mathematics is a subject that is often perceived as challenging by elementary school students, particularly in the context of Madura. This often

leads to a sense of apprehension and fear among students when confronted with mathematics lessons. One of the contributing factors to this phenomenon is the need for precise application of learning models in the teaching and learning process in the classroom. To enhance students' engagement and affinity for mathematics, it is essential to implement a contextual learning model that integrates local cultural values (Prahmana et al., 2021) pertinent to each regency in the Bangkalan regency, particularly those associated with mathematical subject matter. For this reason, this research will explore and characterize specific cultural values in each regency in Madura related to elementary school mathematics material to include them in a contextual learning approach or model by incorporating local cultural values in each region (Risdiyanti & Prahmana, 2020; Nur et al., 2020), thus fostering interest in mathematics among students by integrating cultural values that can influence their character development (Mauluah & Marsigit, 2018; Hunter, 2021; Walkington et al., 2024) in alignment with the objectives of the emancipated curriculum.

This research plan represents a significant advancement in the field, building upon previous research to develop a new and improved approach to the study of Pancasila. It will serve as a reference point and comparison for future research in this area, and its findings will inform the development of teaching materials for educators in each regency of Madura. These materials will be aligned with the Pancasila student profile. Previous research shows the characteristics of Madurese settlements that still have family ties and are in one complex (one yard) called taneyan lanjang, such as rectangular flat shapes, the concept of calculating area and circumference (Hafsi & Hasanah, 2018). This traditional Madurese children's game contains mathematical concepts such as flat shapes, length measurements, time measurements, and addition concepts (Zayyadi et al., 2018). Mathematical concepts are found in the Kerrabhan sape culture (bull racing in Madura). Mathematical concepts are closely related to everyday life, and even in the culture of a region, they also play a role in the use of mathematical concepts (Aini et al., 2019).

Previous research has identified several similarities, notably the application of mathematical concepts within the context of Madurese culture. However, the cultural characteristics of each regency in Madura have yet to be classified. Madura Island has four districts: Bangkalan, Sampang, Pamekasan, and Sumenep. Of the four regions, the Madurese are an ethnic group with distinctive cultural characteristics. This research plan will investigate the cultural characteristics of each regency in Madura. This research will initially examine the characteristics of the Bangkalan regency. Subsequently, the cultural characteristics of this regency can be employed by teachers in Bangkalan as a context for developing mathematics learning designs. The objective is to create an engaging mathematics learning design that reflects on students' daily lives and incorporates cultural values in alignment with the emancipated curriculum. Several studies have highlighted the importance of ethnomathematics in learning and teaching mathematics. These studies have also identified several mathematical concepts that exist within Madurese culture. For example, studying mathematical values in Madurese bull racing, batik, and tourist attractions effectively introduces innovations in mathematics learning, particularly in geometry, measurement, and algebra. However, there is currently a lack of research exploring the cultural characteristics of each regency in Madura. This research focuses on buildings in Bangkalan Regency, especially the Suramadu Bridge building and buildings at the Aermata Ibu religious tourism site. The objective is to ascertain the characteristics of Madurese cultural ethnomathematics in the emancipated curriculum in Bangkalan Regency.

METHODS

This study employed an ethnographic methodology, following the stages or cycles described by Spradley (1980) and Febrianti (2019). Ethnography is the study of the culture of a community. The objective of the ethnographic approach is to identify and delineate the patterns of thought that underpin social action and have the potential to enrich the educational experience. Ethnographic research is founded upon phenomenological thought. To understand culture, it is necessary to pass through three distinct stages: first, a breakdown; second, a resolution; and finally, coherence. (Bungin, 2015). This research was conducted in Bangkalan Regency with Madurese culture as the subject of investigation. This research focused on the cultural aspects of Madurese culture in Bangkalan Regency, specifically the Suramadu Bridge and the buildings in the Aermata Ibu religious tourism site. The primary data source for this study was community leaders who comprehensively understand the Suramadu Bridge and the buildings in the Aermata Ibu religious tourism. Secondary data, among other sources, was derived from residents. Furthermore, documentary sources were consulted. Data were collected using observation, in-depth interviewing techniques, and a combination. The ethnographic research cycle comprises six stages: (1) selecting an ethnographic project, (2) formulating ethnographic questions, (3) gathering ethnographic data, (4) creating an ethnographic record, (5) analyzing ethnographic data, and (6) composing an ethnography, which can be visualized in the diagram below. The data analysis technique employed in ethnographic research is thematic ethnographic analysis, which enables a comprehensive description of the characteristics of Madurese culture in the emancipated curriculum. The research report focuses on a descriptive

narrative of the cultural context.

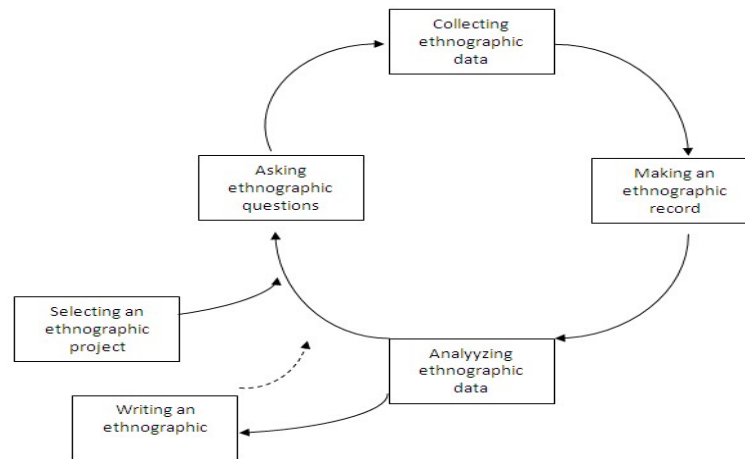


Figure 1. Ethnographic Research Cycle (Spradley, 1980)

RESULT AND DISCUSSION

The application of geometric concepts is utilized to ascertain the characteristics of shapes, to examine the structural forms of edifices, and to select and define images. A bridge is a structure that extends a pathway over an obstacle, such as a waterway or a roadway with regular traffic. One illustrative example of a bridge is the Suramadu Bridge. The Suramadu Bridge is a 5,438-meter-long structure that connects the city of Surabaya on Java with the island of Madura. The Suramadu Bridge serves as a cultural landmark, exemplifying the unique application of geometry in its construction. The bridge was constructed on three sides, namely Bangkalan and Surabaya. The Suramadu Bridge exhibits a multitude of geometric shapes. These shapes include flat, points, geometric shapes, congruence, and angles. This bridge was constructed to connect it to the existing dirt road on either side. The road comprises 36 sections on the Surabaya side and 45 on the Madura side. Furthermore, a 40-meter-long PCI buffer with a buffer diameter of 60 cm is utilized. The flat triangle with the red wire extending downward constitutes a triangular space. Additionally, a relationship exists between the lines, with the lines leaning to the right and left. This triangle connects three points and sides (Victory et al., 2023). Triangles themselves possess numerous varieties.

The number of supporting pillars for the main span reduces the adequate linear water depth within the cross-section of the strait. This will present a significant challenge to the safe navigation of maritime traffic beneath the bridge. Considering the construction of the Suramadu Bridge, regulations have been established about the maximum permissible dimensions for maritime vessels that may traverse the strait. Therefore, the passage of large ships beneath the Suramadu Bridge is not feasible, necessitating the planning of alternative traffic flows. The ample clearance at the base of the bridge allows for the safe navigation of large vessels through the Madura Strait, eliminating the risk of collisions with the supporting pillars. In addition to influencing adequate linear water, the presence of numerous pillars may also elevate the probability of scouring due to the action of seawater currents. It is postulated that this condition will also increase the risk of bridge collapse due to failure of the substructure. The connecting bridge, or approach bridge, is the structure that connects the main bridge with the flyover. The bridge comprises two sections, each measuring 672 meters in length. The main bridge comprises three distinct sections: two side spans, each measuring 192 meters in length, and a central main span, which extends to 434 meters. The main bridge employs a cable-stayed construction, interrupted by twin towers reaching 140 meters in height. The bridge floor is a composite structure with a thickness of 2.4 meters. To accommodate the passage of vessels through the Madura Strait, the bridge provides a clearance of 35 meters above sea level.



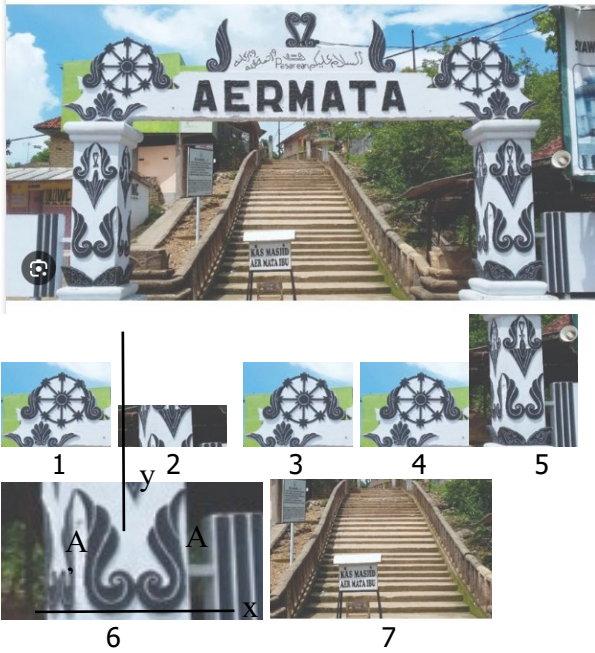
Figure 2. Suramadu Bridge

A right triangle is one in which all angles are right angles, and the longest side is called the hypotenuse. In an equilateral triangle, the three sides are of equal length; thus, the three angles are also equal. Additionally, the triangle possesses three axes of symmetry. An isosceles triangle is defined as a triangle with two sides of equal length, parallel to one another and to the remaining two sides of the triangle, which are of unequal length. This configuration has a single axis of symmetry and two equal angles at the legs. A triangle is a three-sided figure with three angles connected to the other three. The triangle, based on the Suramadu Bridge, is isosceles. Consequently, the angles between the legs are identical, whereas, at the apex, they are disparate.

The Suramadu Bridge also features a rectangular structure comprising two opposing parts. A rectangle is a four-sided shape, with each side of equal length and orientation. The rectangle is connected by four lines and four points, forming four equal angles of 90 degrees. The configuration below the square comprises flat trapezoid shapes positioned in opposition. A trapezoid is a four-sided figure with two pairs of opposite or parallel sides. One set of sides is of equal length, while the other set of sides is not. A trapezoid is defined as a quadrilateral with four angles, two of which are parallel. In addition to the flat shapes, the spatial shapes observed from various vantages on the Suramadu Bridge, upon closer examination, reveal a geometric configuration. The shape that appears to be a triangle on one side is, in fact, a rectangular pyramid. A rectangular pyramid has a single rectangular base and four triangular sides. Thus, the five flat shapes collectively form a rectangular pyramid with a top point. A rectangular pyramid has five corner points, as illustrated in the above image. Just like a flat shape, a pyramid or a three-dimensional geometric figure also has an area called surface area. Additionally, each spatial shape has a volume, which differentiates a spatial shape from a flat shape. Other spatial structures visible on the Suramadu Bridge include cylinders or tubes in pipes and connecting cables. A cylinder has three sides: two circular sides and one blanket side, derived from a rectangle.

Another spatial structure that is observed on various sides of the bridge is the cuboid. A block is a spatial shape comprising eight sides, each formed from a rectangle (Diniyati et al., 2022). The opposing sides are parallel and of equal length, as are the corners, which all form right angles. The mathematical geometry concepts embedded in the Suramadu Bridge can be leveraged to facilitate an understanding of mathematics through an iconic edifice. The geometric concept evident in the Suramadu Bridge encompasses flat shapes comprising multiple parts, which assume the forms of squares, triangles, and trapezoids. This concept also pertains to the relationships between lines, which can serve as pedagogical material for students by examining tangible examples of geometric applications in architectural design. Apart from that, an ethnomathematics study of Madurese culture in Bangkalan is shown in the following table.

Table 1. Ethnomathematical study of Madurese culture in Bangkalan

Aermata Ibu Religious Tourism	Ethnomathematics Concept
Entrance gate 	Circle Two circles in the upper sections of the right and left sides distinguish the gate. A circle is a flat shape comprising a collection of points equidistant from a central reference point. Triangle One of the carvings on the entrance gate features a triangular shape. A triangle is a flat figure with three sides and three vertices. Rectangle The steps are rectangular, formed by two pairs of equal sides. Cuboid The gate's two supporting pillars are block-shaped. A block is a three-dimensional shape formed by three pairs of rectangles of varying sizes. Fractions The concept of fractions is illustrated by a circular shape divided into eight equal parts. Line segments Line segments cut a circle into pieces. Mirroring (reflection) Many of the carvings on the entrance gate employ the concept of mirroring. It can be observed that the formation of carving A' is a result of the

Aermata Ibu Religious Tourism**Ethnomathematics Concept**

reflection of carving A along the y-axis. In other words, A' can be described as the image of A, reflected in the y-axis. The characteristics of the reflection in the carvings of the Aermata Ibu entrance gate can be described as follows: The object and image are always identical. The distance between the object and the mirror is identical to the distance between each point on the image and the mirror. This can be expressed as $s = s'$.

The concept of counting numbers. Counting is a fundamental mathematical operation determining the number of objects in each set. This concept can be applied to the steps of Aermata Ibu.

Interior around the tomb area



Cylinder

Tubular pillars characterize the tomb area. A cylinder is a three-dimensional shape formed by two parallel, identical circles and a rectangle surrounding the two circles.

Distance

The concept of distance is widely used, such as the closest distance between tomb 1 and tomb 2.

Quadrilateral

The rectangular shape is common in various contexts, including constructing guardrails and tomb barriers.

Pattern

The guardrail features a pattern, precisely a rectangular shape with repeated lines. Their shape or arrangement of shapes defines patterns.



1



2



3 & 4

Palate



The ceiling features a variety of flat shapes, including:

1. A square is a flat rectangular shape with four sides of equal length.
2. A circle is a two-dimensional figure with no width or depth, and all points on the circumference are equidistant from the center.
3. A triangle is a two-dimensional figure with three sides of equal length and one angle.
4. Ceiling decoration forms a pattern.

Aermata Ibu Religious Tourism

Ethnomathematics Concept



1



2



3



4

Calligraphy carving area



1

A circle is a two-dimensional figure with no width or depth, and all points on the circumference are equidistant from the center.
Line segments

Aermata Ibu Religious Tourism	Ethnomathematics Concept
Grave  1, 2, 3 5	Flat shapes are frequently observed in tomb carvings, including the following: 1. A circle is a two-dimensional figure with no width or depth, and all points on the circumference are equidistant from the center. 2. A triangle is a two-dimensional figure with three sides of equal length and one angle. 3. Rhombus is a two-dimensional figure with four sides of equal length. It is also known as an equilateral quadrilateral, as this designation signifies that all its sides are of equal length. 4. The concept of angles is evident in tomb carvings.

The table above illustrates mathematical concepts within the Aermata Ibu religious tourism site and building, starting from the entrance gate, interior around the tomb area, palate, calligraphy area, and grave. The most prominent of these is the existence of geometrical concepts: (1) line segments, (2) flat shapes – square, rectangle, triangle, circle, rhombus, quadrilateral –, (3) three-dimensional shapes such as cuboid and cylinder, and (4) reflection. Cultural elements that contain fundamental mathematical activities serve as a foundation for introducing mathematical principles in constructing cultural products (Nurrosadha et al., 2021), particularly in architectural design, as exemplified by the Aermata Ibu. The contextual problems derived from the geometry inherent in the architectural design of the Aermata Ibu site and building can be utilized as an emancipated exercise for students. Geometry is the field of mathematics with the greatest potential for incorporating abstract concepts. However, students often struggle to grasp these concepts (Herbst, 2006; Pirasa, 2016; Azmidar et al., 2017). It is, therefore, essential to establish links between mathematical concepts and the real world and to facilitate the transfer of knowledge from the classroom to the teachers' and prospective teachers' everyday lives. Integrating ethnomathematics into teaching mathematics can facilitate students' understanding of geometry (Verner et al., 2019; Prahmana & D'Ambrosio, 2020). Abstract mathematical concepts are generally perceived as more tangible when contextualized within the recipient culture's cultural milieu (Barton, 1996; François & Van Kerkhove, 2010; Rakhmawati, 2016). Ethnomathematics aims to provide an introduction and a link for students to understand abstract mathematical concepts (Mosimege, 2018; Machaba & Dhlamini, 2021). Students find it more straightforward to illustrate abstract concepts with the assistance of ethnomathematics implementation (Herawaty et al., 2020) in mathematics learning. Therefore, the recommended approach to mathematical concepts in Madurese culture in Bangkalan Regency can be employed as a learning medium in learning activities and real forms of mathematical geometry. Thus, ethnomathematics in this Suramadu bridge and Aermata Ibu site and buildings can be utilized by teachers in mathematics learning.

CONCLUSION

Considering the findings and deliberations undertaken, this research culminated in an ethnomathematics investigation of Madurese culture in Bangkalan Regency. The Suramadu Bridge features a variety of geometric shapes, including flat shapes, points, and other forms of congruence, angles, and other mathematical concepts. In Aermata Ibu, mathematical concepts are observed, including circles, triangles, rectangles, blocks, fractions,

line segments, reflections, and the concept of counting numbers. The Kyai Cholil Bangkalan Mosque features a variety of mathematical concepts, including tubes, distances, quadrilaterals, patterns, squares, circles, triangles, and line segments. Mathematical concepts are evident in several funerary practices in the context of Madurese culture in Bangkalan Regency. These include using circles, triangles, and rhombuses and representing angles and reflections in tomb carvings. Consequently, recommendations about integrating mathematical concepts in Madurese culture can serve as a valuable learning resource, facilitating understanding of real-world forms of mathematical geometry. This approach can enhance students' comprehension of fundamental geometric principles, particularly on the Suramadu Bridge.

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