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Exploration of Fort Marlborough Bengkulu and Its Implications for Mathematics Learning in School

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Abstract: This study aims to describe the facts, concepts, principles, and mathematical operations contained in the ethnomathematics of Fort Marlborough Bengkulu. This research is qualitative research with an ethnographic approach. The subjects in this study were seven: one Bengkulu history expert, two Marlborough Fort synthesizers, two mathematicians, and two Bengkulu City mathematics teachers. Data were collected through observation, interviews, and documentation. The data were analyzed through three stages, data reduction, data presentation, and conclusion. The results of the research found include, there are mathematical facts on the ethnomathematics of the Marlborough fort Bengkulu, Facts in the form of points, wake-up webs, lines, and line segments. Concepts: flat build, space build, trigonometry on the building and courtyard of Fort Marlborough. Principles: area and perimeter of plane figures, quadratic functions, volumes and surface areas of figures, trigonometric ratios:

Keywords: ethnomathematics, ethnographic research, Fort Marlborough

Abstrak: *Tujuan penelitian ini adalah untuk mendeskripsikan fakta, konsep, prinsip, dan operasi matematika yang terdapat pada etnomatematika Benteng Marlborough Bengkulu. Penelitian ini merupakan penelitian kualitatif dengan pendekatan etnografi. Subjek dalam penelitian ini sebanyak tujuh orang yang terdiri dari, satu pakar sejarah Bengkulu, dua orang pemadu Benteng Marlborough, dua orang pakar matematika, dan dua orang guru matematika Kota Bengkulu. Data dikumpulkan melalui observasi, wawancara, dan dokumentasi. Data dianalisis melalui tiga tahapan, reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian yang ditemukan diantaranya, terdapat fakta-fakta matematika pada etnomatematika benteng Marlborough Bengkulu,Fakta berupa titik, jaring-jaring bangun ruang, garis, ruas garis. Konsep: bangun datar, bangun ruang, trigonometri pada bangunan dan halaman Benteng Marlborough. Prinsip: berupa luas dan keliling bangun datar, funsi kuadrat, volume dan luas permukaan bangun ruang, perbandingan trigonometri:*

Kata kunci: *etnomatematika, penelitian etnografi, Fort Marlborough.*

▪ INTRODUCTION

Mathematics is one of the basic sciences that is introduced from an early age to university (Haji, et.al, 2019). This is because mathematics can be widely used in the fields of human life, such as in science and technology. However, various problems in achieving mathematics learning outcomes in class demand to be resolved. In achieving maximum mathematics learning results, it is necessary to emphasize learning facilities or resources in the classroom. Learning mathematics learning mathematics needs to provide a means between mathematics in everyday life and mathematics at school so that learning is more contextual (Agustina et al., 2016).

In learning mathematics, there are many theories and research results that support that culture is a context that can bridge mathematics. According to Wahyuni. et al (2013) one that can bridge the gap between culture and mathematics education is

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through exploration of mathematical concepts and principles based on ethnomathematics. In everyday people's lives, various activities are carried out without realizing it by using mathematical concepts such as measuring activities (length, area, volume, and weight), counting activities and so on. Ethnomathematic learning related to student culture and other cultures is important to do (Massarwe, Verner, & Bshouty, 2012). In the world of ethnomathematics education it can be said to be realistic mathematics learning because it uses concrete examples, namely everyday culture as material for learning mathematics (Irsyad et al., 2020).

Learning mathematics is more effective and meaningful if teaching begins with familiar learning situations found in the students' own socio-cultural environment. Local culture can be included in the mathematics syllabus, such as creating new mathematical terms in the local language, or as preparation of mathematics textbooks and class activities (Palhares & Shirley, 2015). Haji and Octizasari (2018) Learning that contains a realistic mathematical approach based on ethnomathematics will make it possible for the material being studied and their culture to generate motivation to learn and understand problem solving. Ethnomatematics learning can be done in solving math problems at school. According to Rosa & Orey, (2011) ethnomathematics studies the cultural aspects of mathematics; ethnomathematics is used to reveal the relationship between culture and mathematics (Balamurugan, 2015), ideas related to everyday mathematical practice (Francois, 2010). According to Massarwe, Verner, and Bshouty (2012) the importance of ethnomathematic learning activities related to student culture and other cultures has an important role. Achor, Imoko, and Uloko (2009), ethnomathematics is a science that studies mathematics considering the culture in which mathematics appears. According to Rowlands and Carson (2002) ethnomathematics should be a complement to the mathematics curriculum.

Some empirical evidence from previous research shows the role of ethnomathematics in learning mathematics. According to Cimen (2014) through etnomathematics mathematics can be relative between cultural perspectives and social groups, so that it can be developed as a result of various activities based on the practices and experiences of these cultural groups. Mathematical knowledge results from social interactions in which relevant ideas, facts, concepts, principles, and skills are acquired as a result of the cultural context of Rosa & Orey (2011). Research was conducted by Prahmana, et.al (2021) that ethnomathematics can be used as a starting point in learning, ethnomathematics in Yogyakarta batik can facilitate the concept of geometric transformation (Prahmana & D'Ambrosio, 2021); ethnomathematics research on Sasak architecture on Lombok Island (Supiyati & Hanum, 2019); Teaching cultural values is the basis for helping students understand, interpret, appreciate, and realize the importance of cultural values in life (Setiana, 2020).

One of the ethnomathematics contexts studied by researchers in this study is Fort Marlborough Bengkulu. This building is a historical relic from British colonialism in Indonesia. Researchers focused on mathematical objects in the ethnomathematics of Fort Marlborough Bengkulu so that they could be used as a source of learning mathematics in class. Ethnomathematics objects that can be used as concrete mathematics learning resources are found in artifacts in the form of historic buildings, namely Fort Marlborough, the general description of this fort is complete with ditches and underground passages. The fort had 72 cannons and the towers were intact but the

clock bells were gone, because they were taken to Batavia. Fort Marlborough has shapes and models that give it a mathematical feel. Starting from the spatial, numerical and mathematical logic. This makes it easy for students to explore mathematical objects. Therefore, the ethnomathematics contained in the fort building can be a starting point for learning mathematics. Based on this, the mathematical objects in Fort Marlborough can be used in teaching materials in class. This is in accordance with the opinion of Palhares & Shirley (2015) that local culture can be included in the mathematics syllabus, such as creating new mathematical terms in the local language, or as preparation for mathematics textbooks and class activities. Based on the study of the problems that have been described, the purpose of carrying out this research is as follows.

1. Describe the ma\thematical facts that exist in the ethnomathematics of Fort Marlborough Bengkulu.
2. Describe the mathematical concepts that exist in the ethnomathematics of Fort Marlborough Bengkulu.
3. Describe the mathematical principles that exist in the ethnomathematics of Fort Marlborough Bengkulu.

▪ METHOD

Research Design and Procedures

The research conducted was ethnographic research which aims to explore mathematical objects, namely: facts, concepts and mathematical principles of Fort Marlborough Bengkulu. The approach used in this study is a positivistic approach, the hypothesis is seen as something final and its support is sought through empirical research. The procedure for carrying out this research consists of six stages, namely: (1) introduction by doing observation of the object of research. This aims to ensure that the topics to be observed have data. (2) preparation. In the preparatory stage, what was done was to make research instruments in the form of observation guidelines and interview guidelines based on research planning. (3) Instrument preparation. In the preparatory stage, what was done was to make research instruments in the form of observation guidelines and interview guidelines based on research planning. Then an assessment was carried out by two mathematics education lecturers, one Bengkulu history expert and one cultural expert. (4) data collection. Data collection through the observation method is used to directly observe the mathematical objects contained in the fort Fort Marlborough. The interview method was carried out by interviewing research subjects to obtain mathematical object data. (5) Data Analysis. Processing the data obtained through observation and interviews by describing it into data that is easy to understand. After the data is collected, the next step is compiling the data according to the focus of the problem study and research objectives. (6) keconclusion. Conclusions are made based on the results of data analysis which refers to the formulation of the problem.

Participants

The subjects of this study were 7 people consisting of one Bengkulu history expert, two Fort Marlorough tour guides, two math experts and two Bengkulu City math teachers. The seven research subjects are sources of research data related to mathematical objects in the culture of Fort Marlborough in Bengkulu City.

Research Instruments

Interview Guidelines

Interviews were conducted using semi-structured interviews. In conducting interviews, researchers need to listen carefully and record what the informants say. This interview guide contains questions asked by the author to strengthen the results of data collection which was carried out using the documentation method and field notes.

Documentation Sheet

Documents about the cultural history of Fort Marlborough as a source of data information in this research. The documentation method is a data collection technique that is not directly aimed at research subjects, but through documents. The documents used can be in the form of diaries, personal letters, special notes on social activities and other documents.

Observation sheet

Direct observations were performed in Fort Marlborough. Observation is a way of collecting materials which is done by observing and systematically recording the phenomena being presented.

Data Analysis

The interview data were analyzed in three stages, namely: (1) Data Reduction. Data reduction can be interpreted as a process of selecting, sharpening, focusing and simplifying the data obtained, making unnecessary data from the interview results. From this data, it is then simplified so that it can be determined what ethnomathematics elements exist in Fort Marlborough that are related to mathematics. (2) Data Presentation. Presentation of data is done in the form of organizing and compiling data into meaningful information so that it is easy to draw conclusions. (3) Conclusion Drawing. Conclusions are drawn after all the data has been collected. This conclusion regarding Fort Marlborough is related to understanding mathematics.

▪ RESULT AND DISSCUSSION

The results of the Analysis of Observations and Documentation

The results of the observations and documentation show that Fort Marlborough contains facts, concepts and mathematical principles. This can be seen from the sides and back of the fort, the shape of the fort seen from above, the graves of the fort's figures, cannons, shrapel bullets and the main door of Fort Marlborough. The following are the parts of the fort and its mathematical elements. The nameplate is located on the side of the fort. Where the nameplate is in the form of a rectangular flat wake. The side wall of the fort adjacent to the beach. Where the wall is in the form of a rectangular flat wake, namely a trapezoid. The roof of the rear of the Marlborough fort, where the roof is in the form of a rectangular flat shape, namely a trapezoid. Miniature Design in the form of a fort seen from above. Where can we see the front or head of the fort forming a flat triangular shape and you can also see the congruent corners of the fort. Fort Marlborough Main Entrance. The main door is located in front of Fort Marlborough. Where you can see the shape of the door is in the form of a parabola opening downwards to form a quadratic function curve. Fort Marlborough Cemetery. At Fort Marlborough there are 3 graves, namely the tomb of Charles Murray, the tomb of

Thomas Parr and the tomb of Robert Hamilton. The three tombs are in the form of upright side structures, namely beams. The cannon is a weapon to face the enemy. In every corner of the fort there are cannons. Laying the cannons at the corners was made to make it easier for the soldiers to defend the British defense. Where to shoot and place the cannon by paying attention to the angle. Shrapnel bullets or cannonballs. This bullet is used to fire the cannon. Where the bullet is in the form of a curved side shape, namely a ball.

Results of Interview Analysis

Interviews conducted with 7 research subjects found that there were facts, concepts and mathematical principles in Fort Marlborough, namely quadrilaterals, triangles and geometric shapes. The facts that appear are geometric elements, namely flat structures and spaces, both with straight sides and curved sides, such as points, angles, sides and line segments. From the combination of these facts, a mathematical concept is formed, namely the concept of a rectangle, the concept of a triangle, the concept of a trapezium, the concept of geometric shapes, namely the concept of beams, the concept of congruence, the concept of quadratic functions and the concept of trigonometry. From the gun you can use the principle of measuring the angle of inclination. The door of the fort which forms a parabolic curve that opens downwards and there are rooms that look the same contains the concept of congruence, there is also a trapezoidal cross-section of the fort. The mathematical principles are area, circumference, volume, surface area, angle sizes, trigonometry ratios and so on.

Results of Mathematical Exploration

The analysis of mathematical exploration is explained based on the results of observations, documentation, and interviews conducted by researchers obtained various forms and symbols contained in the Marlborough fort which contain facts, concepts and mathematical principles. This can be seen from the sides and back of the fort, the shape of the fort seen from above, the graves of the fort's figures, cannons, shrapel bullets and the main door of Fort Marlborough. The results of the analysis are described as follows.

Figure 1. Fort marlborough nameplate

Mathematical exploration that can be studied from the context of the Fort Marlborough nameplate is viewed from a mathematical object. Judging from the concept of mathematics, on the nameplate of the Marlborough fort can be found the

concept of geometry. The mathematical concept found on the signboard of Fort Marlborough is the geometric concept of a rectangular shape. A rectangle is a two-dimensional flat shape formed by two pairs of sides, each of which is the same length and parallel to its partner, and has four angles, all of which are right angles. Judging from the mathematical facts, it was found that on the nameplate of the Marlborough there were mathematical facts in the form of corner points and lines. Mathematical facts can be points, for example point A, point B, point C and point D, angles: for example: , and line segments: for example . Meanwhile, the mathematical principles contained in the components of the fort's nameplate are the area and circumference of the flat shape. The flat shape that is formed is a rectangle, so that it can apply the principle: area of a rectangle = length x width, Perimeter of a rectangle = 2 length + 2 width or 2 (length + width)

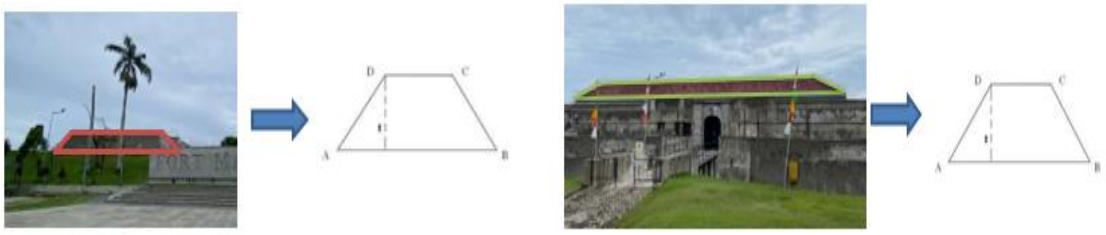

Figure 2. Wall the flanks and rear roof of fort Marlborough

Based on the analysis carried out on the form of the appearance of the fort walls from the side, a mathematical concept was found, namely the concept of a flat trapezoid shape. This relates to concepts that can be applied in learning mathematics at school regarding the flat shape of a trapezoid. Judging from the mathematical facts, the results of the analysis show that the mathematical facts contained in the side walls of Fort Marlborough are points, angles and line segments. We can relate this concept from a mathematical point of view which is clearly illustrated by the geometric shapes of the side walls of the fort. Angles and lines. In learning in the classroom, the teacher can use point separators A, B, C, D on each side of the side of the fort. Analysis of mathematical principles the mathematical principles contained in the shape of the walls from the side are a flat trapezoidal shape, so that it can apply the principle of trapezoidal area = number of parallel edges x height: 2, Trapezoidal perimeter = AB + BC + CD + DA.

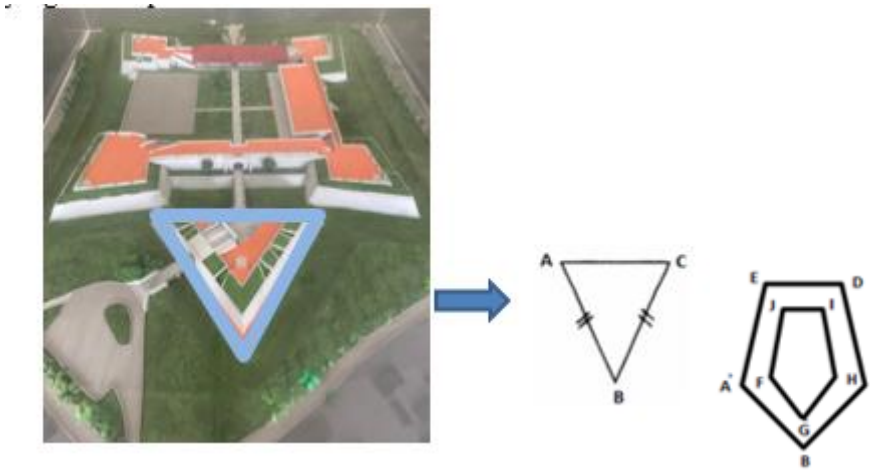

Figure 3. Replica of the design Fort Marlborough

The results of ethnomathematics analysis on the design replica of the Marlborough fort found a mathematical concept, namely the concept of geometry. In the corner of the Marlborough fort, the concept of congruence is found. Congruence is the condition when two plane figures have the same angles. In addition to the angles, the lengths of the sides of the angles also correspond to the same ratio. The concept of geometry is the shape of an isosceles triangle. The results of the analysis in terms of mathematical facts, there are mathematical facts in the replica bastions *Marlborough* namely points, angles and line segments. We can relate this fact from a mathematical point of view which is clearly illustrated by the geometry of the fort replica. Points of angles and lines in learning in the classroom the teacher can use the separation of points A, B, C, D on each side of the replica of the fort.

The results of the analysis in terms of the mathematical principles contained in the design replica of the Marlborough fort are the principles of the area and circumference of a flat shape, namely an isosceles triangle. The area that can be calculated is: the area of the Isosceles Triangle = 1/2 x base x height and the circumference: The perimeter of the Isosceles Triangle = side + side + side. Another principle is the congruence with the formula: $\frac{AB}{DE} = \frac{BC}{EF} = \frac{AC}{DF}$, $\frac{<A}{<D} = \frac{<B}{<E} = \frac{<C}{<F}$

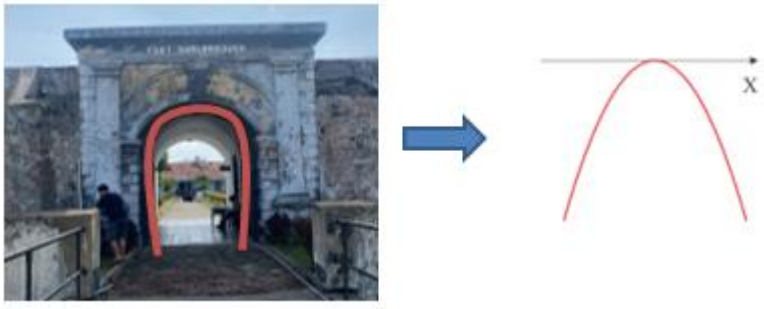

Figure 4. Fort Marlborough gate

The results of the analysis of mathematical concepts on the gate of Fort Marlborough found that the concept that can be related to the shape of the main door of Fort Marlborough is the concept of a quadratic function graph. The mathematical principle can be a general form of the quadratic function f(x)=⟦ax⟧^2+bx+c. Meanwhile, the mathematical facts contained in the design replica of the Marlborough fort are general forms of quadratic functions. Results The value of a in the function y = ax2 will affect the shape of the graph: If a > 0 then the graph will open upwards ifa < 0 then the graph will open downwards Mathematical Facts

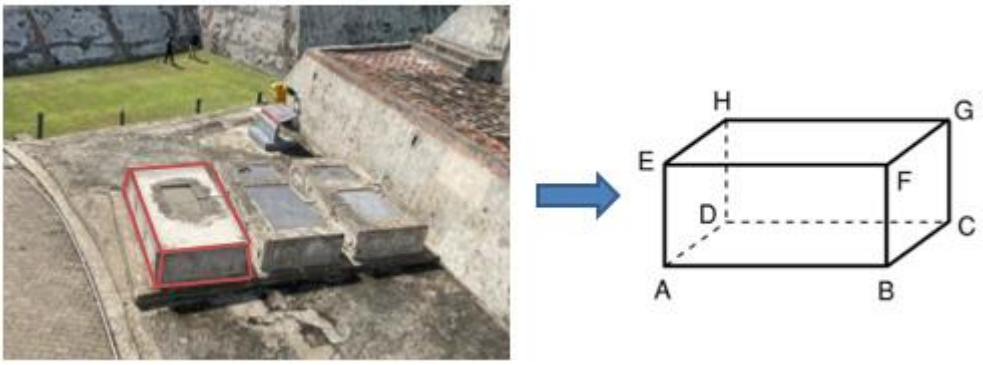

Figure 5. Tombs of Fort Marlborough figures

The results of the analysis of mathematical concepts in the ethnomathematics of the tomb is a quadrilateral, namely a cube. While the mathematical facts found are points, line segments, planes, angles. Points for example C, point D, point E, point F, point G and point H. Angle $< ABC < BCD < CDA < DAB < EFG < FGH < GHE < HEF$. Segment $\overline{AB}, \overline{BC}, \overline{CD}, \overline{AD}, \overline{EF}, \overline{FG}, \overline{GH}, \overline{EH}$. Side ABCD, side EFGH, side ADEH, side BCFG, side ABEF, side CDGH. Exploration of the mathematical principles contained in the principles of volume and area of geometric shapes. Block Volume = $p\ x\ l\ x\ t$. block surface area = 2 × (pl + pt + lt)

The results of this study indicate that there are facts, concepts, principles and mathematical operations at Fort Marlborough. The mathematical objects found can be used as a source of learning mathematics in class. Several studies have proven the use of ethnomathematics can improve students' ability to understand concepts.This research is supported by several studies, namely research conducted by Haji and Yumiati (2018) with the title "Study of the concepts of geometric transformation on Bengkulu besurek batik cloth".This study aims to identify the concepts- the concept of geometric transformation in Besurek Bengkulu fabrics.Sarwoedi, et.al (2018) found that ethnomathematics is effective in understanding students' concepts, Ethnomathematics in Pranatamangsa birth calculations in Yogyakarta has the potential to be used as a starting point in learning mathematics (Prahmana, et.al, 2021) ; Ethnomatematics Studies: cultural values and geometric concepts i in the “tanean-lanjang” traditional house in Madura-Indonesia (Sari, Budiarto, & Ekawati, 2022).

▪ CONCLUSION

Based on the results of the research that has been described, the conclusion of this study is that there are mathematical objects for learning in schools in Fort Malrborough ethnomathematics. The mathematical concepts found were: the concept of a rectangle on the fort's nameplate, the trapezoidal concept on the side walls of the fort and the roof of the fort's office, the concept of triangle on the head of the fort, the concept of congruence on the corners of the fort, the concept of quadratic function on the main door of the fort, the concept of beams on the tomb of the fort. Facts found in the ethnomathematics of Fort Marlborough Bengkulu, namely: points, angles, line segments, quadratic equations. While the principles found include the area and perimeter of the plane shape, the ratio of the sides of the plane shape, the maximum value of the quadratic function, the area and volume of the beam.

The results of this study have implications for the implementation of learning in schools. The use of ethnomathematics, especially fort Marlborough, can be used as a context in emphasizing mathematical concepts to students. Through a real context and close to students, it is hoped that learning objectives can be achieved. Suggestions that can be conveyed based on the results of the research are that teachers can use ethnomathematics in other contexts that are close to students in delivering material in class.

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