ETHNOMATHEMATICAL STUDY ON THE TRADITION OF

GREBEG MAULUD YOGYAKARTA

IN STEM PERSPECTIVE

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01 Introduction

Education is an important means in shaping superior human resources and able to compete in the era of globalization. In the context of learning, the approach used needs to adapt to the times and the needs of students. One of the approaches that is increasingly used in modern education is the STEM (Science, Technology, Engineering, and Mathematics) approach. This approach aims to integrate various disciplines holistically so that students are able to think critically, creatively, and innovatively in solving real-world problems (Beers, 2011).

However, in its implementation in Indonesia, the STEM approach still faces a number of challenges. One of them is the lack of integration between local cultural values and the modern learning approach. In fact, local culture has great potential in supporting contextual and meaningful learning. Therefore, a study is needed that links local culture and STEM learning, one of which is through ethnomathematics.

Ethnomathematics is an approach that links mathematics to the culture, traditions, and activities of the local community. D'Ambrosio (2001) states that ethnomathematics is a way in which certain societies understand, articulate, and practice mathematical concepts that originate from their own environment and culture. This approach views mathematics not only as an abstract science, but also as part of human life and culture.

The Grebeg Maulud tradition in Yogyakarta is a form of local wisdom that contains mathematical values. This tradition is a celebration of the Birthday of the Prophet Muhammad SAW which is carried out for generations by the Yogyakarta Palace. In it there are various cultural activities such as mountain carnivals, food distribution, and various symbols that contain mathematical elements such as symmetry, patterns, geometry, and number concepts. When studied from a STEM perspective, this tradition not only has aesthetic and religious value, but also contains aspects of science, technology, engineering, and mathematics that can be developed into contextual teaching materials.
By examining the Grebeg Maulud tradition from the perspective of STEM-based ethnomathematics, it is hoped that it can contribute to the development of learning that is more contextual, meaningful, and rooted in the nation's culture. This study is also expected to be able to foster a love for local culture while increasing the STEM literacy of students in Indonesia.

02

The Tradition Of Grebeg Maulud

A. History and Meaning of Grebeg Maulud

The Grebeg Maulud tradition is a typical celebration of the Yogyakarta Palace to commemorate the birth of the Prophet Muhammad SAW. Grebeg comes from the word "garebeg" which means crowd or crowd, while Maulud refers to the Prophet's Birthday. This tradition has been going on since the time of the Mataram Sultanate and is still preserved by the Yogyakarta Palace as a form of respect for Islamic values and Javanese culture.

Grebeg Maulud not only has a religious meaning, but also contains social and spiritual messages. The palace as a cultural center provides an example in caring for traditional values while sharing them with the community. With the carnival and the distribution of mountains, the Palace expresses generosity, welfare, and gratitude to God.

B. Series of Grebeg Maulud Activities

The series of Grebeg Maulud processions began with a ceremony inside the Palace called "Sekaten". During Sekaten, two of the Palace's heirloom gamelan, namely Kyai Nogowilogo and Kyai Gunturmadu gamelan, were played alternately in the Sri Manganti Ward. Then, the peak event was a mountain carnival that was brought from the Palace to the Gedhe Kauman Mosque.

Gunungan is a symbol of produce and food that is arranged symmetrically to resemble mountains. There are several types of mountains, such as Gunungan Lanang, Gunungan Wadon, and Gunungan Pawuhan. After prayer, the mountains are distributed to the general public who believe that the contents of the mountains bring blessings.

C. Cultural Symbols and Mathematical Elements

In each element of the Grebeg Maulud procession, there are many symbols and structures that reflect cultural values and mathematical concepts. For example:

- Mountains have a symmetrical shape and contain geometric elements such as triangles and cones.
- The preparation of food is carried out in a repetitive and patterned manner.
- The number of certain elements in a carnival or procession is arranged based on symbolic numbers, such as odd numbers that are considered sacred.
- The direction and path of the carnival follow the traditional Javanese spatial pattern which is geometric and philosophical.

These symbols can be identified as part of ethnomathematics, which is the use of mathematical concepts that are integrated into local culture. Further studies may uncover the relationship between these patterns and STEM concepts.

03 Ethnomathematical Perspective

A. Definition and Origins of Ethnomathematics

The term "ethnomathematics" was first introduced by Ubiratan D'Ambrosio in the early 1980s as a form of criticism of the hegemony of Western views in mathematics education. According to D'Ambrosio (2001), ethnomathematics is a method used by certain cultural groups in understanding, articulating, and practicing mathematical concepts that grow from their own environment. He stated that mathematics is not universal in a single form, but has a diversity of forms that arise from different cultural and social activities.

This concept was born from the realization that each community group has its own way of solving daily life problems using a logical approach, although it is not always written or formalized like academic mathematics. Therefore, ethnomathematics elevates various forms of local knowledge as legitimate parts of mathematical understanding.

B. Scope and Concepts of Ethnomathematics

Ethnomathematics is not limited to one specific branch of mathematics, but it encompasses various aspects such as:

1. Numbers and OperationsTraditional number systems, counting methods in market transactions, or inheritance distribution rules in customs.
2. Geometry and SymmetryThe design of batik motifs, the architecture of traditional houses, and the arrangement of visual elements in cultural rituals.
3. Measurement and ScaleA way for local people to measure length, weight, or time, for example by inches, cubits, or the number of days of the Javanese market.
4. Patterns and RelationshipsRepeated patterns in woven bamboo, traditional dances, and gamelan music.
5. Spatial Organization and NavigationThe spatial layout of traditional villages, ritual directions, and building orientations that are often full of philosophy.

C. Ethnomathematics in the Context of Education

In the world of education, ethnomathematics can be used as a contextual approach that is able to bridge local and academic knowledge. Some of the reasons why ethnomathematics is relevant for learning are:

- Contextualization: Relate learning to real-life experiences that are close to students' lives.
- Affirmation of local culture: Valuing and acknowledging the contribution of local culture in science.
- Strengthening STEM literacy: Providing an alternative to project-based learning and culturally relevant problem-solving.
- Inclusivity: Providing space for students from diverse cultural backgrounds to actively contribute.

The implementation of ethnomathematics is in line with the philosophy of the Independent Curriculum, which emphasizes the importance of context-based learning and local wisdom.

D. Relevance of Ethnomathematics in the Grebeg Maulud Tradition

The Grebeg Maulud tradition in Yogyakarta is a clear example of cultural practices that are loaded with mathematical concepts. When viewed through an ethnomathematical lens, this tradition reflects:

- The geometric structure of the Gunungan shape, which is symmetrical and orderly.
- Patterns and repetitions in the preparation of food and the symbolization of sacred numbers (odd numbers).
- The organization of space and time in the layout of the carnival and the Javanese-Islamic calendar cycle.
- Local rationality in conveying religious and social values through mathematical visualization.

The ethnomathematical analysis of Grebeg Maulud is the gateway to make this tradition a contextual and meaningful learning resource in STEM education.

04

STEM Approaches In Tradition

A. STEM Concepts in Education

STEM, which is an acronym for Science, Technology, Engineering, and Mathematics, is a learning approach that integrates the four disciplines holistically and interdisciplinaryly. The main goal of the STEM approach is to prepare students for real-world challenges by blending knowledge from different fields of science to produce innovative solutions to the problems at hand. In Indonesia, this approach is increasingly popular in order to develop 21st century skills such as critical, creative, and technology-based thinking.

The implementation of STEM in education is not only limited to teaching scientific concepts, but also includes the development of practical skills necessary to design and implement technical solutions. Therefore, the STEM approach prioritizes project-based learning that allows students to apply the knowledge and skills gained in a real-world context.

B. Integration of STEM in the Grebeg Maulud Tradition

The Grebeg Maulud tradition in Yogyakarta, which has a very high cultural value, can be analyzed and developed in a STEM context to improve students' understanding of mathematics, science, technology, and engineering. Some aspects of this tradition that are relevant to the STEM approach include:

1. Mathematics in Grebeg Maulud

Grebeg Maulud has many elements that contain mathematical concepts, such as symmetry, patterns, geometry, and numbers. These concepts can be analyzed in depth to show how mathematics is used in the daily lives of the people of Yogyakarta. For example:

- Mountains formed in the form of pyramids or cones, show an understanding of geometry and symmetry.
- The pattern of food arrangement that is repetitive, contains elements of numbers and patterns, as well as its relationship with the rhythm of traditional life.
- The arrangement of elements of the kirab such as odd numbers that are considered sacred, as well as the counting of numbers that have a certain meaning.

In the context of STEM, the mathematics contained in this tradition can be integrated into learning to demonstrate the application of mathematical concepts in local cultures.

2. Science and Technology in Grebeg Maulud

Science and technology aspects are also present in the Grebeg Maulud tradition, especially in terms of making mountains, preparing food, and implementing kirab. For example:

- Technology in the manufacture of mountains: In the preparation of mountains, there is high technical skill in terms of balance, weight distribution, and stability. It contains simple technological elements, such as an understanding of physics in the calculation of weights and the distribution of objects.
- Science in food processing: The process of making food distributed in the mountains also involves science concepts in terms of the cooking process, food preservation, and equitable distribution of food to the community.

With a STEM approach, students can be invited to understand how aspects of science and technology are applied in these traditions, as well as how they relate to broader scientific principles.

3. Engineering and Engineering in the Grebeg Maulud Tradition

Engineering and techniques in the Grebeg Maulud tradition can be found in the aspects of planning and implementing the carnival and making mountains. Some engineering questions that can be asked include:

- How to make a mountain that is stable and can be carried by several people without collapsing easily?
- What techniques are used to ensure the balance of the mountains so that they do not tip over during the carnival trip?
- How is the preparation of food patterns in the mountains to ensure that the food is easily distributed fairly to the community?

This is a real example of how engineering concepts and techniques can be applied in everyday life through cultural traditions that have existed for hundreds of years.

C. STEM Learning Based on the Grebeg Maulud Tradition

Integrating the Grebeg Maulud tradition in STEM learning can provide a deep and meaningful learning experience for students. Some ways to implement the STEM approach in the context of Grebeg Maulud include:

1. Local Culture-Based Learning Projects

One way to apply STEM in learning is to use the Grebeg Maulud tradition as a project based on local culture. For example, students may be asked to model mountains using mathematical and physical principles, as well as understand the technologies involved in the formation and transportation of those mountains.

2. Scientific Experiments and Testing of Science Concepts

Students can conduct experiments to test the various scientific concepts contained in this tradition. For example, they could test the stability of mountain structures using physical principles (e.g., the concept of balance and weight distribution) or experiments related to the preservation of traditional foods used in celebrations.

3. Pattern and Geometry Analysis

In the mathematics learning section, students can be invited to analyze the patterns and geometry found in the shape of mountains and the arrangement of food. They can learn about symmetry, repetitive patterns, and symbolic numbers used in the tradition.

4. Technology and Engineering Learning

Students can also be invited to design and build tools or models that can be used to help the implementation of the Grebeg Maulud tradition, such as designing tools to transport mountains with good stability or designing an efficient food distribution system.

D. Advantages of STEM Integration in the Grebeg Maulud Tradition

The integration of STEM in the Grebeg Maulud tradition has several advantages, including:

1. Contextual Learning
Linking learning to local traditions will make the material more relevant and engaging for students, as they can see firsthand the application of the knowledge they are learning.

2. Improving STEM Literacy
Local culture-based learning can help improve students' STEM literacy in a fun and applicative way.

3. Appreciation of Local Culture
Integrating local culture in STEM education can foster a sense of love and pride for Indonesian culture, while introducing the diversity of mathematical and technological knowledge that exists in the world.

4. Project-Based Learning
This approach supports project-based learning methods, where students can collaborate, solve problems, and produce useful real work.

The STEM approach in the Grebeg Maulud tradition can be a very relevant example to connect education with local wisdom. Through the application of the STEM concepts contained in this tradition, students can gain a deeper understanding of the application of science in everyday life. In addition, it also provides an opportunity to preserve local culture through a more contextual and project-based approach to education.

05

Analysis And Findings

A. Gunungan

1) Gunungan Mass Center as a Cone

The mountains (Gunungan) in Grebeg Maulud are shaped like cones, which can be mathematically modeled as homogeneous solid cones. The center of mass of the cone is located on the axis of vertical symmetry, right at:

$$timecenter\,(CM) = \frac{1}{4}h$$

h = cone height

Philosophical meaning:
The location of the center of the mass closer to the base indicates a strong earthly foundation, but still pointing upwards (spiritual).
This point can also be interpreted as a point of balance between the material and spiritual dimensions, reflecting the values in Javanese philosophy.

2) Radius and Height Ratio: Ideal Proportions

If r is the radius of the base and is the height of the cone, then the ratio h/r expresses the visual shape of the mountain. In Javanese architecture and classical art, these proportional values are not made arbitrarily.

Examples of proportional mathematics:
Many traditional buildings or ornaments use the golden ratio.
If the mountain has

$$\frac{h}{r} \approx \varphi$$

then its shape is considered ideal and visually harmonious.

Symbolic implications:
This ratio is not only aesthetic but also spiritually meaningful harmony between heaven and earth.

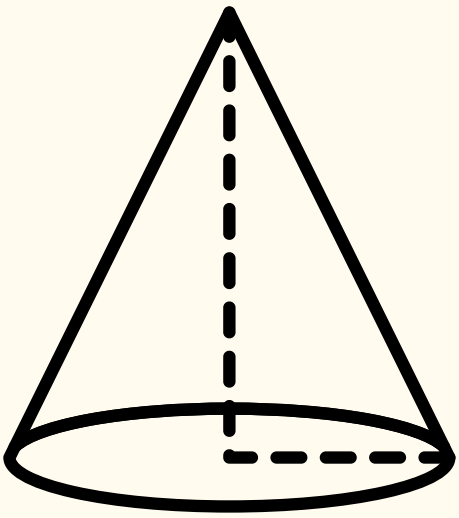
3) Vertical Symmetry: Spiritual and Worldly Balance

Mountains have vertical symmetry, meaning that the shape of the left and right sides is the same against the central perpendicular axis. In mathematics, this is called axial symmetry:

$$f(x) = f(-x)$$

Philosophical meaning:
Symmetry symbolizes the balance of life,
Left = worldly
Right = spiritual

It also implies the structure of the cosmic order, what is on earth is a reflection of the heavens.



4) Volume and Surface Area of the Mountains

If you want to involve further math, you can calculate:

Cone

$$volume = \frac{1}{3}\pi r^2 h$$

$$surfacearea = \pi r(r + s)$$

s=painter's line

It can be used to show how much produce can be piled up to form mountains, or a symbol of the abundance of sustenance given to the people.

B. Mathematical Concepts Used in Other Designs

1). Symmetry in Soldier Costumes

a. Folding Symmetry (Reflection)
The left and right sides of the costume are identical to the central vertical axis.
In geometry:

$$(x, y) \rightarrow (-x, y)$$

b. Rotational Symmetries
Spherical elements such as shields have rotational symmetry. If the shield has 4 identical patterns:
Rotational symmetry of order 4 (every 90°)

$$R(\theta) : (x, y) \rightarrow (x', y')$$

with theta = 90°, 180°, 270°

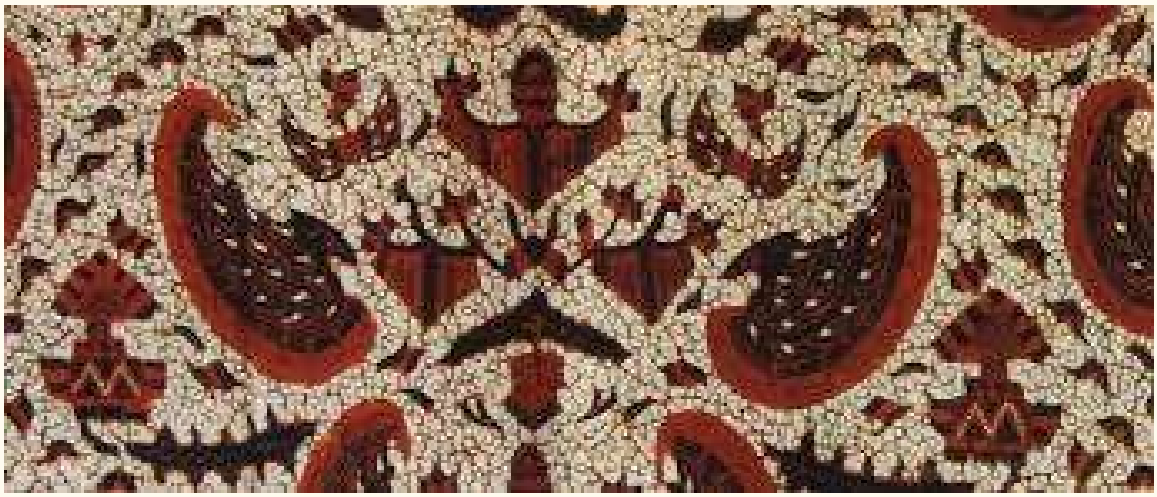
2. Repetitive Patterns (Tesselation) of Gamelan and Kencana Train Ornaments

a. Tesselation (Enfining)
The carving of ornaments on gamelan and carriages forms a repetitive pattern.
Regular tessellation: using only one type of shape such as a square or hexagon.
Semiregular tessellation: a combination of two or more regular shapes.

b. The Transformations Involved
Translation: the repetition of a pattern in a certain direction

$$(x, y) \rightarrow (x + a, y + b)$$

3. Batik Motifs: Translation, Rotation, Reflection



a. Translasi
The main motif is shifted and repeated on a two-dimensional plane. It creates a sense of continuity.

$$(x, y) \rightarrow (x + a, y + b)$$

b. Rotation
Some motifs such as kawung or ceplok have rotations:
Rotation around the central point of the motif.

c. Reflection
Mirror symmetry is often used in slope or machete motifs:

$$(x, y) \rightarrow (-x, y)$$

or

$$(x, y) \rightarrow (x, -y)$$

d. Geser Symmetry (Glide Reflection)
A combination of translation and reflection, typical of machete batik, with Translation+Reflection on the parallel lines of the translation direction

C. Locating

1. Representation of the Procession Path as a Directional Graph

   The procession from



Bangsal Kencana → Alun-Alun Utara → Masjid Gedhe Kauman

   can be modeled in a directional graph:
   Nodes: important locations such as Bangsal Kencana (B), the middle of the Square (A), and the Gedhe Kauman Mosque (M).
   Edges: the paths that connect the nodes, in a fixed direction from B to A to M.

   Graphically:

$$B \rightarrow M \rightarrow A$$

   In graph theory, this path is linear and optimal in a ritual context: without branching, thus ensuring solemnity and clarity of symbolic meaning.

2. Coordinate Geometry: Procession Space Modeling

   Each important point and participant formation can be modeled in the Cartesian coordinate system.

   Example:
   Kencana Ward: (0.0)
   Middle Square: (0,d1)
   Masjid Gedhe: (0,d2)

   Here, the path moves straight towards the positive Y axis (north).
   The distance between the nodes can be calculated:

$$d_{BA} = d_1,\ d_{AM} = d_2 - d_1$$

3. Position Vector and Directional Orientation

The motion of the procession can be described as a position vector:
From Ward to Square:
vector rBA=(0,d1)
vector rAM=(0,d2−d1)
Consistent vector direction north: \vec{u} = (0, 1)
This directional orientation also follows the direction of the qibla cosmology, although it is not entirely identical in geographical orientation, but rather in spiritual symbolic value.

4. Principles of Localization and Spatial Efficiency

Positioning:
Mountains: in the center, as the main focus.
Soldiers: march forming a line of protection.
Abdi Dalem: flanking, forming layers of social and spiritual protection

In mathematics, this approaches the principle of space efficiency:
Minimizing the area used while maintaining distance between formations.
Lane optimization to ensure smooth procession.
This form of arrangement pattern is close to the minimum configuration of energy in mathematical physics: each element seeks a stable position with respect to the center (mountain) and direction of motion.

5. Path Optimization, A Mathematical Perspective

In the context of optimization:
Goal: minimize travel time, maximize order, minimize distractions.
The cost function can be arranged:
C=w1×Distance+w2×Directional deviation+w3×Formation neatness
This traditional practice has actually applied a cultural experience-based optimization heuristic, showing the natural form of the application of mathematics in culture.

D. Counting

The activity of counting in Grebeg Maulud is not just a matter of numbers, but implies social structure, spiritual symbolism, and patterns of cultural order. Behind every number that appears in the procession, there is a meaning that is closely related to the Javanese Islamic belief system and Javanese philosophy.

Symbolism of Numbers in Grebeg Maulud:

1. 7 Gunungan

There are seven types of mountains prepared: Gunungan Lanang, Gunungan Wadon, Gunungan Pawuhan, Gunungan Darat, Gunungan Bromo, Gunungan Gepak, and Gunungan Pakualaman.

The number 7 in the Javanese-Islamic tradition has the meaning of spiritual perfection and the unity of the cosmos (7 layers of the sky, 7 days a week).

2. 7 Days of Gamelan Sounded

Two sacred gamelans, Kyai Gunturmadu and Kyai Nogowilogo, are sounded for 7 consecutive days in the Sekaten series, signifying the continuity of harmony in the universe.

3. 12 Rabiul Awal

The celebration of Grebeg Maulud coincides with the 12th of Rabiul Awal in the Hijri calendar, the date of the birth of the Prophet Muhammad SAW.

In ethnomathematics, the number 12 reflects the structure of multiples that are common in the calculation of time and calendar (12 months of the year).

4. Number of Soldiers

The soldier formations are arranged in specific numbers, usually multiples of 4 or 8, forming a pattern of regularity that reinforces the visual impression of symmetry and order.

Mathematical Activities in Calculating
Counting in the context of Grebeg Maulud includes:

1. Enumeration (enumeration)
Determine the number of mountains, the number of warriors, the number of gamelan groups, and the number of mountain contents (such as vegetables, fruits, and traditional foods).
2. Grouping and Organizing
Groups soldiers into small formation units for line efficiency. This is related to the concept of grouping and number factors.
3. Number and Sequence Patterns
For example, the distribution of the ranks of soldiers follows a certain numerical pattern that can be analyzed using the concept of arithmetic series or number symmetry.
4. Distribution System
In the distribution of mountain products, the concepts of ratio and proportion are used: how to distribute limited resources (produce) to the population of the people present.

- Philosophy and Reasoning in Counting Activities
- Counting in Grebeg Maulud also contains the philosophy:
- Order as a form of cosmic harmony.
- Balance between the justice of the king and the people, established in the amount of distribution.
- Acceptance of the results of distribution as part of destiny and gratitude.

Thus, the concept of counting here is not as rigid as ordinary mathematical operations, but becomes part of the way society:

1. Reading the world (through patterns and numbers),
2. Organize their lives (through structure and formation),
3. Understand social relationships (through the distribution of sustenance).

E. Playing

Playing activities in Grebeg Maulud reach their peak when people participate in the tradition of "mountain fighting". At this stage, the atmosphere changes from a sacred procession to a dynamic interaction between people, with various expressions of joy, hope, and strategy. Although it appears to be a spontaneous act, it is actually loaded with social structures, spiritual values, and hidden mathematical principles.

Mountain Struggle (Tradition, Hope, and Strategy)
After the mountains were prayed at the Gedhe Kauman Mosque, the part of the produce began to be "removed" to be contested. Every individual, regardless of age, social status, or background, is entitled to a share of the mountains.

From a cultural perspective:
1) The scramble for mountains symbolizes the search for blessings and the hope of sustenance.
2) The community believes that getting a part of the mountains will bring prosperity, safety, and good luck throughout the year.
3) This tradition shows egalitarianism: everyone has an equal right to the blessings given by the king.

From a mathematical perspective:
1) Each individual actually performs an analysis of opportunities intuitively.
2) They choose strategic positions, calculate the time to approach, and optimize the chances of obtaining results.

Mathematical Elements in Play Activities

1. Probability (Chance)

Suppose if there are 300 parts of the mountain content and 1000 people are up for grabs, then the basic chances of a person getting one share are approximately:

P = 300/1000 = 0.3 or 30%

2. Optimal Strategy (Optimization)

Individuals may take into account:

How close should I stand from the mountain?

Which side of the chance is greater (e.g. the side without a lot of crowds)?

When is the right time to start moving?

This concept is related to mathematical optimization under limited conditions.

3. Distribution and Distribution

When the contents of the mountains are scattered, the distribution of goods can be described as a statistical phenomenon.

There are areas with "high density" of crops and areas with "low density", similar to the spatial opportunity distribution model.

4. Dynamic Simulation

On a STEM education scale, mountain fights can be modeled by simulations:

Each agent (person) has an opportunity based on speed, starting position, and mass density.

This simulation teaches the concepts of queues, dynamic movements, and stock distribution

Playing Philosophy

More than just a physical game, mountain scrambles also contain moral values:

1) Teach Resilience: Those who are earnest and put in the effort, usually succeed. This is in line with the concept of business and results in Islam.

2) Teaching Togetherness: Even though they compete, the atmosphere is still colored by laughter, jokes, and a sense of brotherhood, the concept of healthy competition.

3) Teaching Tawakal: Not everyone succeeds, but all accept the results with open arms, realizing that sustenance has been arranged by the Almighty.

4) In the logic of Javanese culture, the success of obtaining a part of the mountains is not only a matter of speed or strength, but also a matter of predetermined blessings. This teaches a balance between human effort (ikhtiar) and acceptance of destiny (qadar).

06 Conclusions

Based on the ethnomathematical study in the tradition of Grebeg Maulud Yogyakarta, it can be concluded that the activity is loaded with mathematical concepts that contain cultural, aesthetic, and spiritual meanings. A cone-shaped mountain, for example, has a center of mass located at 1/4 of a height, which illustrates the balance between the temporal and the spiritual. In addition, the ratio of height and radius of mountains reflect the visual harmony and spiritual symbolism in Javanese culture, which symbolizes the relationship between heaven and earth. The vertical symmetry of the mountains and the costumes of the warriors also reflect the balance of life between the temporal and the spiritual. The tessellation patterns found in gamelan ornaments and kencana trains show the use of mathematical principles to create visual harmony, while the geometric transformation principle in batik motifs reflects the philosophical value of constancy and harmony of life. On the other hand, the movement of the procession in Grebeg Maulud can be modeled through position and orientation vectors, with an emphasis on path optimization that indicates efficiency and balance in the organization of events. In addition, the tradition of "mountain scrambling" can be analyzed using the concept of probability and optimization strategies that show how mathematics plays a role in understanding the social dynamics that occur in the tradition.

Based on these findings, several recommendations can be made for further development. First, it is important to integrate mathematics in cultural education, such as in a curriculum that combines mathematical concepts with local traditions. This will help students understand the depth of culture while also appreciating the role of mathematics in everyday life. Second, the Grebeg Maulud tradition can be enriched with a STEM approach, so that the younger generation can more easily connect cultural and scientific values. Technology can also be utilized in cultural processions to improve efficiency, such as by mapping the procession's route using GPS or route optimization software. In addition, further research on the relationship between mathematics and culture in Indonesia can enrich the understanding of the application of mathematical principles in local traditions. The development of e-books or digital platforms that discuss ethnomathematics in Grebeg Maulud will make it easier for the public to learn more about the relationship between mathematics and culture. Finally, social awareness about the importance of preserving traditions with an approach relevant to the development of the times needs to be increased. Through counseling on the philosophical and mathematical meanings in traditions, people can better appreciate and preserve the culture.

Glossary

Ethnomathematics: The study of how mathematical concepts are applied in a particular cultural context, often unwittingly by the perpetrators.

Grebeg Mulud: The tradition of the traditional ceremony of the Yogyakarta Palace to commemorate the birth of the Prophet Muhammad SAW, is marked by a procession of mountains.

Mountains: A cone-shaped pile of produce that symbolizes well-being and blessings, usually consisting of food and agricultural products.

Cone: A three-dimensional geometric shape used in the calculation of mountain volume ($V = 1/3 \times \pi \times r^2 \times t$).

Symmetry: The nature of a pattern or shape that remains constant when transformed such as mirroring or rotation.

Tesselation: A pattern consisting of repeated shapes without gaps or overlaps, often found in batik motifs or traditional ornaments.

Volume: A measure of the capacity of a three-dimensional object; In the context of mountains, it is used to estimate the "content" of mountains.

Probability: The chance of an event occurring; in Grebeg, it is used to estimate the likelihood of a person getting a piece of the mountain.

Repetitive Patterns: Visual elements or forms that are repeated regularly, creating a rhythmic structure like in warrior costumes and gamelan.

Visual Representation: Images or illustrations to convey mathematical ideas, such as symmetrical lines on cultural ornaments.

Social Mathematics: A branch of mathematics that studies fair distribution, social statistics, and community-based calculations.

Batik: A traditional Indonesian fabric with motifs that often contain tessellation and mathematical symmetry.

Javanese philosophy: The system of thought and values of the Javanese people that often manifests in cultural symbolism such as in the form of mountains.

Distribution: The division of resources or objects, in this context refers to the distribution of the contents of mountains to the community.

Ritual: A series of customary or religious actions carried out in regular order, often with a logical structure or mathematical sequence.

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