

GEOMETRIC REPRESENTATION AND SET STRUCTURE IN THE STUDY OF ETHNOMATHEMATICS OF THE TRADITIONAL GUNUNGAN OF MERTI VILLAGE BATANG REGENCY

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ABSTRAK

Artikel ini membahas representasi geometri dan struktur himpunan dalam gunung hasil bumi pada tradisi Merti Desa Bawang Kabupaten Batang melalui perspektif etnomatematika. Penelitian ini bertujuan mengkaji bagaimana bentuk, pola visual, serta pengelompokan bahan pada gunung mencerminkan konsep-konsep matematis yang digunakan masyarakat secara intuitif dalam praktik budaya. Pendekatan kualitatif dengan metode etnografi digunakan untuk memahami makna budaya sekaligus struktur matematis yang terintegrasi dalam proses penyusunan gunung. Data diperoleh melalui observasi langsung, wawancara dengan perangkat desa dan panitia pelaksana, serta dokumentasi foto pembuatan gunung. Hasil penelitian menunjukkan bahwa gunung memuat representasi berbagai konsep geometri, termasuk bentuk kerucut-limas sebagai struktur utama, pola simetri rotasi, pola radial, dan susunan berlapis. Selain itu, pola perulangan dan pengelompokan bahan menunjukkan penerapan prinsip dasar teori himpunan melalui pembentukan subhimpunan, klasifikasi berdasarkan atribut, serta relasi dan irisan antarhimpunan. Temuan ini menegaskan bahwa praktik budaya masyarakat Desa Bawang mengandung pengetahuan matematis lokal yang tidak hanya relevan untuk kajian etnomatematika, tetapi juga berpotensi dimanfaatkan sebagai konteks pembelajaran geometri dan matematika diskrit di sekolah.

Kata kunci : Etnomatematika, Geometri, Gunung Hasil Bumi, Tradisi Merti Desa, Teori Himpunan.

ABSTRACT

This article examines the representation of geometric concepts and set structures embedded in the gunung of agricultural produce featured in the Merti Desa tradition in Bawang Village, Batang Regency, through an ethnomathematical lens. The study aims to analyze how shapes, visual patterns, and material groupings within the gunung reflect mathematical ideas intuitively applied by the community in their cultural practices. A qualitative approach using ethnographic methods was employed to explore both the cultural meanings and the mathematical structures integrated into the process of constructing the

gunungan. Data were collected through direct observation, interviews with village officials and ceremony organizers, and photographic documentation of the construction process. The findings reveal that the gunungan embodies various geometric representations, including a cone–pyramid form as its main structure, rotational symmetry, radial patterns, and layered arrangements. In addition, the repetition and grouping of materials indicate the application of fundamental set theory principles through the formation of subsets, classification based on attributes, and relations or intersections among sets. These results demonstrate that the cultural practices of the Bawang community contain local mathematical knowledge that is relevant not only to ethnomathematical studies but also as a contextual resource for teaching geometry and discrete mathematics in schools.

Keywords: *Ethnomathematics, Geometry, Mountain of Agricultural Produce, Set Theory, Village Merti Tradition.*

INTRODUCTION

The mathematical education method known as ethnomathematics emphasizes the relationship between mathematical ideas and the customs of society. D'Ambrosio says that mathematics originates from human social and cultural activities, not from a vacuum. He believes that each community has a unique way of understanding, classifying, measuring, and solving problems due to mathematical mindsets that have been passed down from generation to generation. Ethnomathematics can be used to understand cultural activities such as crafts, traditional rituals, traditional architecture, and community symbols as dynamic and living representations of mathematics (D'Ambrosio & Ubiratan, 1985).

The ethnomathematics approach is becoming increasingly important with the development of learning paradigms in the 21st century (Antara et al., 2025). This approach has the ability to connect abstract concepts with students' experiences. Mathematics learning that involves local culture helps provide a concrete context that is close to students' lives. This can increase student motivation, sense of identity, and understanding of concepts. Cultural artifacts are natural media that contain mathematical structures such as symmetry, patterns, geometry, proportions, and transformations. Students can more easily understand geometric concepts that are often considered abstract through the real visual representations provided by these cultural objects, which open up great opportunities for learning (Budiarto, 2016). Local crafts, folk games, traditional architecture, weaving, and batik are some of Indonesia's cultural artifacts that have

undergone significant development in recent years. Studies of traditional woven fabric motifs reveal symmetrical structures, fractal patterns, and geometric transformations that can be mapped as mathematical learning materials. On the other hand, research on traditional houses or buildings has found a relationship between roof shapes, floor patterns, and building structures with the concepts of spatial geometry and architectural proportions of local communities. The results show that culture holds rich aesthetic values and mathematical knowledge (Laowo, 2024).

Ethnomathematics offers greater benefits in geometry learning (Masjudin et al., 2024). One of the most easily found aspects of mathematics in everyday life is the concept of geometry. Architecture, crafts, traditional clothing, and traditional ceremonies use shapes, patterns, and spatial structures. The “Merti Desa” ceremony, a community ceremony that expresses gratitude for the earth's bounty and the safety of the village, is one of the Javanese cultural traditions that has many geometric elements. In this tradition, the *gunungan*, a pyramid or cone-shaped structure made of agricultural produce with a radial pattern and rotational symmetry, is one of the most prominent visual elements. The *gunungan* follows cultural and aesthetic rules that have been passed down from generation to generation. (Herminingrum, 2021).

Research on the geometric structure of natural landforms is very important for cultural documentation, in addition to its educational value. Local sustainability traditions are challenged by modernization and technological advances. Using ethnomathematics studies, scientific documentation can help preserve traditions and introduce younger generations to the fact that their cultural practices contain mathematical knowledge that can be explained using scientific methods (Barton, 2009). Therefore, conducting mathematical analysis on *gunungan* helps preserve the cultural heritage of the Javanese people while also improving mathematics education. This research is based on the need to understand how the Merti Desa tradition, particularly in the creation of *gunungan* from agricultural produce, embodies cultural practices that are rich in value and at the same time contain structures that can be studied mathematically. This tradition is not only a ceremonial ritual, but also presents a systematic cultural form, starting from the process of

arrangement, selection of materials, to the visual form of the resulting gunungan. Therefore, this study focuses on describing how these cultural practices are carried out by the community, while also examining the geometric patterns that appear in the physical form of the gunungan and their relationship with the community's way of thinking as reflected in these activities. Thus, this study aims to provide a comprehensive description of the tradition and process of making gunungan from agricultural products, identify various geometric concepts that appear in the shape and arrangement of gunungan, and analyze them through an ethnomathematics perspective. This analysis is expected to show how cultural elements can contain meaningful mathematical representations and how these traditional geometric forms can be used as a source of contextual and relevant learning for the development of mathematics education.

METHOD

This study uses a qualitative approach with ethnographic methods. This approach was chosen because it allows researchers to understand the cultural meanings, symbolism, and geometric patterns that emerge in the process of arranging the mounds of crops in the Merti Desa tradition. The study was conducted in Bawang Village, where Merti Desa is held, which was the main source of data. The research subjects in the context of ethnomathematics were not limited to the physical objects of the mounds of crops, but also included cultural actors who had direct knowledge and roles in the implementation of the tradition. The research informants consisted of three main parties who had different roles and knowledge related to the Merti Desa tradition. The village head was a key informant because he understood the history, cultural values, and philosophical meaning of the tradition that had been passed down from generation to generation. The Chief Executive provides information about the entire series of activities, from preparation to implementation, and ensures that each stage runs according to custom. Meanwhile, committee members are sources of technical data related to the process of making the mounds of agricultural produce, from collecting and sorting materials to arranging the structure of the mounds, thus providing a detailed picture of the visual aspects and geometric shapes that appear in this cultural practice. Data

collection was carried out through participatory observation, in-depth interviews, and documentation in the form of photographs, field notes, and recordings of the process of making the gunungan.

The data analysis process in this study followed the Miles and Huberman model, which includes data reduction, data presentation, and conclusion drawing in a cyclical manner. In the data reduction stage, information from observations, interviews, and documentation was selected and focused on relevant aspects, such as the geometric shape of the gunungan, the pattern of material arrangement, cultural rules, and the mathematical meaning that emerged from the practice of making gunungan. The raw data was then organized into thematic categories, such as symmetry, proportion, repeating patterns, or the sequence of steps in arranging the gunungan. The next stage is data presentation, which involves systematically organizing information in the form of tables, matrices, charts, or structured narratives so that the relationships between elements can be seen more clearly. Through this presentation, researchers can read patterns, find connections between cultural elements and geometric concepts, and formulate a more focused understanding. The final stage is drawing conclusions accompanied by repeated verification through checking field notes and discussions with informants, so that the conclusions made truly reflect cultural reality and have a strong empirical basis. To ensure the validity of the findings, this study uses source triangulation and technique triangulation. Triangulation of sources was conducted by comparing information from the village head, the chief executive, and committee members, each of whom had different roles and perspectives on the tradition and process of making gunungan. Comparing these different views enabled researchers to identify consistent information while understanding variations in its meaning. Meanwhile, technical triangulation is carried out by collecting data through direct observation, in-depth interviews, and photo and video documentation. The consistency between informants' statements, observations at the location, and visual evidence strengthens the validity of the data and reduces the possibility of perceptual bias. With a combination of these two triangulations, the research findings can be methodologically justified as an accurate representation of the cultural practices being studied.

DISCUSSION

Bawang Village is an agrarian community in which most residents earn their livelihood as farmers. The agricultural products cultivated in this village are diverse, including cabbage, scallions, chili peppers, carrots, corn, bitter melon, various tubers, and others. To express gratitude for agricultural harvests, sustenance, and the safety of the village, the community holds an annual traditional ceremony known as Merti Desa. This tradition, rooted in Javanese culture, emphasizes harmony between humans, nature, and the Creator. Merti Desa serves to maintain balance, prevent misfortune, and seek blessings for all villagers. Such activities also help preserve cultural heritage and strengthen social bonds through collective cooperation (*gotong royong*).

According to Mr. Ma'ruf Zaen, the head of the Merti Desa organizing committee, this tradition has been practiced since ancient times, originally carried out through pilgrimages and communal prayers at the grave of Sheikh Ahmad Suryo Konto located in Bawang Village. However, since 2023, the village government has begun organizing Merti Desa on a larger scale, incorporating additional events such as processions, religious gatherings, and charitable donations for orphans.

The Merti Desa procession begins with a pilgrimage and communal prayer at the grave of Sheikh Ahmad Suryo Konto, typically held between the 1st and 10th of Muharram. Prior to this, the village government forms an organizing committee and instructs each neighborhood unit (RT) to create one *gunungan* using agricultural products from the local community—such as vegetables, fruits, and sometimes traditional market snacks. On the day of the procession, all prepared *gunungan* are paraded around the village and eventually distributed to the public, who compete to obtain them.

The *gunungan* used in the ceremony symbolizes agricultural abundance and represents the community's expression of gratitude to God. Its construction is carried out collectively based on traditions passed down through generations. The process begins with creating the main structure from bamboo or wooden slats, known as *kerojot*, arranged firmly in a conical or mountain-like shape. After the frame is completed, a banana trunk (*gedebog*) is placed at the center as the core,

serving both as structural identity and the base for attaching agricultural items. The next step involves arranging the agricultural products. Tubers, fruits, vegetables, and other foods are affixed using bamboo skewers or wooden sticks. This arrangement is done meticulously from the bottom upward to form a neat, dense, and symmetrical visual pattern. Once the surface is fully covered, the top of the *gunungan* is decorated creatively by the community. In the final stage, the entire structure is inspected to ensure it is sturdy and will not collapse during the procession. Traditional rules guide how these materials are arranged, forming a conical pattern that symbolizes the relationship between humans and the Creator. A stable foundational base composed of larger agricultural items represents completeness, followed by medium-sized materials in the middle and finer elements at the top. Although no exact standards exist, *gunungan* typically range from two to four meters in height, depending on the ritual context and structural strength.

The following aspects of *gunungan* construction are considered essential: the sincere intention of its makers, the peak of the *gunungan* as a representation of perfection, and the prayers recited before and after the process to ensure that the *gunungan* serves as a sacred offering. In older traditions, those involved in its creation were required to undertake spiritual disciplines such as fasting or *tirakat*, although this practice is not always observed in Bawang Village. Throughout the process, individuals maintain mutual respect. Two prohibitions are consistently upheld: preventing any agricultural products from falling to the ground and refraining from taking any materials from the *gunungan* before the procession and distribution begin.

The conical base or *kerajat* of the *gunungan* symbolizes the central relationship between humans, God, and life. This structure is formed from a bamboo framework encasing the banana-trunk core (*gedebog*), which is later fully covered with layers of agricultural produce. All colorful vegetables and fruits are densely affixed to the middle section, creating a harmonious visual pattern. The upper part of the *gunungan* is crafted from long beans, chili peppers, or woven coconut leaves (*janur*). The overall form of the *gunungan* showcases an aesthetic blend of natural colors from the harvest and the artistry of the community in

assembling it. Thus, the *gunungan* is not only a ritual symbol but also a significant cultural art form.



Figure 1 & 2

Figure (1) The kerojot framework as the basic structure of the *gunungan*, figure (2) The fully assembled *gunungan*.

Geometric Structure of the *Gunungan*

The physical form of the *gunungan* constructed from agricultural produce in the Merti Desa Bawang tradition exhibits a clear and well-organized geometric structure. Geometrically, the *gunungan* demonstrates characteristics that correlate with the shape of a cone, widening at the base and tapering toward the peak. The conical form of the *gunungan* is built upon a foundational framework known as *kerojot*, a woven structure resembling a small pyramid or cone that functions as the main support for the overall shape. The *kerojot* has a circular base and narrows upward, enabling the agricultural products to be arranged radially around the central frame. In addition to its overall conical shape, the *gunungan* also displays visual planes resembling triangles. This appearance emerges because the *kerojot* framework consists of bamboo slats positioned diagonally from the base toward the top. These diagonal lines are then followed by the arrangement of agricultural products such as vegetables, fruits, and legumes that are attached or tied along the direction of the bamboo slats. This aligns with an interview statement from one of the organizers, who explained, “the basic frame is made of bamboo shaped into a cone, from large to small, then the vegetables and fruits are attached from the

bottom to the top.” As a result, when the gunungan is viewed from the front or side, triangular planes appear, narrowing toward the peak. These triangular surfaces reinforce the impression of a tiered structure and provide visual order to the arrangement of the produce. This finding is consistent with remarks from other informants who emphasized that the arrangement is indeed carried out “from bottom to top following the frame.” The tiered structure that follows the contours of the kerojot further highlights concepts of spatial geometry, particularly the relationship between the conical form, triangular planes, and variations in cross-sectional area.

The presence of these triangular planes in the kerojot also directly influences the symmetry and balance of the gunungan. The consistent diagonal arrangement creates rotational symmetry, giving the impression of balance when the structure is rotated around its vertical axis. In other words, although the types of agricultural products placed on each side may not be identical, the slope and direction of their arrangement produce a sense of visual equilibrium. Moreover, the produce placed along these triangular planes often forms repeating patterns, such as repeated vertical or radial arrangements of chili peppers, long beans, or leaves. These repeated patterns not only enhance aesthetic value but also help the community assemble the gunungan in a practical and orderly manner.

In several parts of the gunungan’s surface, radial patterns can be observed arrangements of materials that spread outward in a circular fashion from the center toward the edges. In mathematics, such patterns are associated with rotational symmetry, which occurs when an object appears unchanged after being rotated by a certain angle around its center. This radial pattern corresponds to fundamental geometric principles of the circle, particularly the relationship between the center, radius, and direction of element distribution. When community members arrange chili peppers, long beans, or leaves in circular patterns following the contour of the kerojot, they intuitively create a repetition pattern that reveals mathematical regularity in spatial distribution. In an interview, an informant explained that certain materials such as long beans or chili peppers are “placed in a circular pattern following the frame so that it looks neat and stays strong.” This information supports the finding that the arrangement is carried out circularly and

systematically, following the radius from the center of the *gunungan*'s base. Such patterns also emphasize visual balance, as each side maintains a relatively consistent distance and arrangement relative to the *gunungan*'s vertical axis.

In addition to the radial pattern, a layering pattern is also clearly visible from the middle to the lower sections of the *gunungan*. These layers are formed when vegetables, fruits, or other agricultural products are arranged horizontally following the contour of the framework. In mathematics, layering patterns can be associated with the concept of horizontal cross-sections in three-dimensional shapes, particularly the cross-sections of cones or pyramids that decrease in size according to the gradient of the area from the base to the peak. Each layer reflects a process of grouping (classification/partitioning) based on the type and size of the materials, thereby creating orderly tiers on the surface of the *gunungan*. The presence of these layered tiers produces visual periodicity, namely a consistent repetition from bottom to top (Basiroen et al., 2025). Mathematically, these layers illustrate how the *gunungan* undergoes scalar transformation (scaling) as the framework narrows toward the peak, forming a systematic vertical geometric structure. This aligns with statements from informants who explained that the arrangement is based on material categories: "usually the larger vegetables are placed at the bottom, then the smaller ones, so it becomes tiered." Thus, both the radial and layering patterns function not only as aesthetic and traditional elements but also reflect the application of geometric concepts, symmetry, and mathematical patterns that naturally emerge within the cultural practices of the Bawang Village community.

Concepts of Symmetry and Balance in the Arrangement of Agricultural Produce

The structure of the *gunungan* also demonstrates the application of symmetry and balance, which are essential characteristics in the study of geometry. When viewed from any direction, the *gunungan* exhibits a relatively uniform shape due to the presence of rotational symmetry around its vertical axis (Rachman, 2024). Although the materials used on each side are not always identical, the arrangement that follows the diagonal lines of the *kerojot* and the radial pattern allows the *gunungan* to maintain visual balance. In geometry, this condition can be

explained through the concept of balanced distribution, namely a state in which elements are arranged proportionally so that no part appears heavier or denser than another.

This balance is reinforced by the structured placement of elements, such as positioning larger fruits at the lower section to provide stability, while smaller materials are placed toward the upper area near the peak (Dewi et al., 2024). Mathematically, this practice aligns with the principle of size gradation and scale reduction, which naturally follows the shape of a cone. In several arrangements, groups of materials are placed repeatedly in similar patterns on all four sides of the framework, resulting in a form of quasi-reflective symmetry—symmetry that is not perfectly identical but displays structural similarity between sides.

This symmetry and balance not only enhance the visual appearance of the *gunungan* but also maintain its structural integrity, preventing it from easily collapsing. Interview data support this, particularly when the head organizer stated that the *gunungan* must “look neat from all sides,” and another committee member added that the structure “must be balanced, because if one side is too heavy, it can fall over.” These statements indicate that the community intuitively understands the concept of balanced mass distribution—the principle that materials must be placed evenly to ensure structural stability. This also relates to the geometric concept of spatial stability, in which an object with a wide base and evenly distributed load tends to be more stable. Thus, the arrangement of produce on the *gunungan* reflects the community’s intuitive grasp of geometric principles, ranging from rotational symmetry, balanced form, and classification to scale adjustment, all of which collectively form a strong mathematical representation within the cultural tradition of Merti Desa (Ningrum et al., 2018).

Repetition and Clustering Patterns

Repetition patterns and grouping are essential elements in the mathematical structure of the agricultural *gunungan* (Rahmi et al., 2025). Based on field findings, the process of constructing the *gunungan* is not carried out randomly but through an orderly and systematic organization of materials. Informants explained that materials such as vegetables, fruits, and traditional snacks are first separated

according to their types and then arranged in specific sections based on their characteristics. This practice reflects the application of the mathematical concept of classification, namely grouping objects according to shared attributes. After the grouping process, the materials are arranged using repeated patterns to create a neat and harmonious appearance. Several types of produce, such as chili peppers and long beans, are skewered and attached repeatedly along diagonal lines or in circular patterns following the *kerojot* framework. This aligns with the committee's explanation that these materials are "attached repeatedly so that they look full and neat." Repetition in the geometric arrangement produces recurring patterns that demonstrate regularity. From a geometric perspective, this regularity can be understood as the concept of periodicity, a condition in which patterns appear consistently at defined intervals

The repetition pattern is evident not only in the arrangement of smaller materials but also in the placement of larger groups of materials. For example, the lower layer typically consists of large vegetables such as cabbage or eggplant, followed by subsequent layers containing smaller vegetables or fruits, and finally the smallest materials near the peak. This tiered arrangement illustrates a recurring structure that follows a scale gradient from the base to the top of the *gunungan* (Ir Ida Bagus Idedhyana, 2024). This tiered pattern not only creates an aesthetic impression but also plays an important role in maintaining the structure's stability, demonstrating a direct connection between cultural functions and mathematical principles. Thus, the repetition and grouping patterns in the agricultural *gunungan* not only present visual order but also illustrate intuitive mathematical practices carried out by the community. These practices reflect fundamental mathematical concepts such as classification, periodicity, repetitive structures, and gradation of size, which are naturally integrated into the process of constructing the *gunungan* (Putri, 2024). This finding affirms that mathematical patterns in culture are not merely passive phenomena, but are part of the local wisdom that has long been practiced and passed down through generations.

Ethnomathematical Interpretation of Geometric Elements in Gunungan

The ethnomathematical interpretation of the *gunungan hasil bumi* in the Merti Desa Bawang tradition shows that its form, arrangement, and construction practices not only reflect technical functions but also contain culturally embedded mathematical structures. Within D'Ambrosio's (1985) framework of ethnomathematics, mathematics is understood as a cultural practice encompassing activities such as organizing space, constructing patterns, classifying objects, and performing measurements in ways that are rooted in the lived experiences of a community. From this perspective, the *gunungan* can be viewed as a representation of local mathematical knowledge expressed through ritual actions, aesthetic choices, and the community's practical reasoning.

The conical shape of the *gunungan* serves as a central element that carries both geometric and symbolic interpretations (Hariyadi, 2025). Structurally, the tapered form is chosen because it provides stability by distributing weight from the top down to the base. This was affirmed by one of the committee members, who stated that "the shape must taper so that it remains sturdy; otherwise it can easily lean or collapse." On the other hand, the conical form also carries cosmological meaning. The peak is understood as a symbol of communal prayers and hopes, as expressed by the village head: "the peak represents hope and prayers so that the community may rise in status." Thus, the cone shape of the *gunungan* functions as a medium that unifies geometric structure with spiritual symbolism, directing the community's collective consciousness toward a vertical orientation between the earthly realm and spiritual aspirations.

The layered arrangement of the *gunungan* with larger materials placed at the base and smaller ones at the top not only reflects load distribution but also conveys a cultural narrative about the ordering of sustenance (Wirasanti, 2024). A committee member mentioned that "the arrangement starts with the larger items first and then the smaller ones, so that it is strong and orderly." This practice illustrates the concepts of sequence and hierarchy, which align with the mathematical activities of ordering and visually organizing objects based on size and mass. Culturally, these layers are understood as a gradual representation of the

availability of agricultural produce and the community's hope for continually increasing prosperity over time.

The application of symmetry and repeating patterns in arranging the materials also embodies mathematical and aesthetic values that have become internalized within community practices. (Triutami et al., 2025). Rotational symmetry is visible in the uniform arrangement of materials encircling the *kerojot*, while a tendency toward bilateral symmetry emerges from efforts to equalize the quantity and type of materials on opposing sides. The Head of the Organizing Committee stated that “usually the right and left sides are made the same; for example, the number of eggplants or chilies is matched so it looks neat.” The repeated patterns of chilies, long beans, or other small materials placed at consistent intervals indicate *patterning* activities within the framework of ethnomathematics (Purbaningrum et al., 2021). A committee member explained that “the chilies are placed evenly around, the spacing is averaged so it looks nice.” These patterns and symmetries are not merely decorative elements, but forms of mathematical order that also represent the value of balance in Javanese culture. Beyond shape and pattern, informal measurement practices are an essential part of the ethnomathematical interpretation. The determination of the *gunungan*'s height, the thickness of each layer, and the proportions of the arrangement does not rely on formal measuring tools, but instead depends on visual estimation and bodily experience. The Village Head stated that “we measure by approximation; we've been used to it since long ago.” This practice aligns with the category of *measuring* in Bishop's (1990) six universal mathematical activities, which emphasizes that measurement in cultural contexts often emerges through intuition, experience, and repetition rather than formal metric systems.

The ritual dimension also provides an additional interpretive layer related to symbolic mathematical meaning (Jainuri et al., 2025). In older traditions, the makers of the *gunungan* commonly performed *tirakat* or fasting as a form of self-purification before beginning the assembly process. This ritual reflects the community's understanding of the *gunungan* peak as a symbol of spiritual orientation. The Village Head stated that “in the past, before making the *gunungan*, some people would fast or do *tirakat* first so that their intention would be pure.”

Today, although *tirakat* is no longer practiced by all makers, the process is generally still preceded by a collective prayer. A committee member explained, “now we usually just start with a communal prayer so that the process is blessed and runs smoothly.” This act of prayer reinforces the understanding that the geometric arrangement of the *gunungan* serves as a symbolic medium connecting spiritual values with social and mathematical activities.

Finally, the principle of *gotong royong* that accompanies the making of the *gunungan* demonstrates that mathematical practices manifest not only in the form of the object itself but also in the social coordination that structures its production. The division of tasks, the sequencing of work steps, and the coordination of time constitute forms of organization that inherently contain mathematical structure. In an interview, the Event Coordinator stated that “the important thing is harmony when assembling it; the work is done together.” This shows that mathematics in a cultural context does not stand as a formal entity, but is embedded in social practices that organize interaction and collaboration.

Overall, the agricultural *gunungan* is a cultural artifact that integrates geometric structure, patterns, symmetry, informal measurement, spiritual symbolism, and social organization. These findings affirm that mathematics exists not only within formal educational domains but is also rooted in the cultural practices of the community, shaping how they understand, organize, and give meaning to the world around them.

Classification of Natural Resources as the Basis for Forming Sets in Gunungan

Structures The construction of the *gunungan* is never carried out randomly. Based on field observations and interviews with the Village Head, the event coordinator, and the assembly committee, it is evident that the process follows a systematic pattern of organization, even though it is not articulated in formal mathematical terms. The community groups the materials according to shared properties such as size, shape, color, structural function, and symbolic meaning. This pattern of grouping reflects a consistent and culturally inherited classification system which, from a mathematical perspective, can be understood as the application of set theory principles.

Mathematically, a set is a collection of objects that share certain characteristics. This principle is clearly visible in the initial stages of constructing the *gunungan*, when materials are sorted based on visual attributes such as size, shape, and color, and then regrouped according to their function within the structure—whether as base supports, middle fillers, connectors between layers, or decorative elements. The next stage involves determining the order of placement in accordance with the *gunungan*'s vertical structure, such that larger and heavier items are positioned at the bottom, while smaller materials are placed at the upper sections. The entire process concludes with arranging the components into a symmetrical pattern to maintain visual balance and aesthetic harmony. Within set theory, this sequence of processes represents the formation of sets, the subdivision into subsets, the relationships among sets, and the identification of potential intersections when a single element possesses more than one relevant attribute (Nurhaswinda et al., 2025).

Set A – Large Vegetables as the Structural Foundation

This set consists of large-sized materials that possess sufficient volume and mass to serve as the supporting base of the *gunungan*. Examples include:

$$A = \{\text{cabbage, eggplant, pumpkin, large mustard greens}\}$$

The characteristics of Set A include relatively large mass that provides stability to the lower part of the *gunungan*, dense textures that do not easily deform under vertical pressure from the layers above, and dimensions large enough to enable structural locking at the foundation. From a mathematical perspective, Set A functions as the base set, containing the primary elements that form the structural core, since its attributes enable the initial stability required before additional layers are added.

Set B – Medium-Sized Vegetables as Middle-Layer Fillers

Set B consists of medium-sized vegetables that function as fillers and stabilizers in the middle layers of the *gunungan*. Elements in this set such as carrots, corn, bitter melon, and potatoes possess smaller mass than the base materials yet remain sufficiently stable to support upper layers. Mathematically, Set B can be represented as:

$$B = \{\text{carrot, corn, bitter melon, potato}\}$$

The characteristics of Set B include moderate size that facilitates even arrangement within the middle layer, relatively uniform shapes that contribute to visual consistency, and functional flexibility as a connector between the large materials at the bottom and the smaller ones at the top. From the perspective of set theory, Set B acts as a subset that strengthens the structural relation between Set A and the upper-layer materials, enabling a proportional and stable transition throughout the overall construction of the *gunungan*.

Set C – Elongated Materials as Binding Elements and Vertical Aesthetics

Set C consists of elongated materials such as long beans, chilies, and scallions, which function as binding elements as well as contributors to the vertical aesthetics of the *gunungan*. Mathematically, this set can be represented as:

$$C = \{\text{long beans, chilies, scallions}\}$$

Their elongated forms allow these materials to serve as connectors between layers, while their high flexibility enables them to follow the conical contour of the *gunungan* without easily breaking. Additionally, their striking colors provide aesthetic value that enhances the overall visual appearance.

Set D – Hard-Textured Materials as Structural Reinforcement

Set D consists of hard-textured materials such as corn, cassava, and other firm tubers that possess solid and stable characteristics, thus functioning as strengthening elements within the *gunungan* structure. Mathematically, this set can be represented as:

$$D = \{\text{corn, cassava, other hard tubers}\}$$

Several elements in Set E also appear in Set B, resulting in set–set relationships such as the intersections $A \cap E$ or $B \cap E$. This phenomenon indicates that the community intuitively understands that a single object may possess more than one relevant characteristic in the construction of the *gunungan*, aligning with the concept of multi-attribute classification in set theory. Structurally, the materials in Set E serve three primary functions: their hard texture enhances the stability of the base; their inherent firmness can be used to reinforce the middle layers of the *gunungan*; and their dense form allows them to function as locking elements, preventing other materials from shifting during the assembly process as well as throughout the ceremonial procession.

The Implications of Ethnomathematics *Gunungan* in Mathematics Education

The ethnomathematical findings on the *gunungan* of agricultural produce in the Merti Desa Bawang tradition offer significant opportunities for developing mathematics learning grounded in local cultural contexts. The representations of conical forms, rotational symmetry, repetitive patterns, informal measurement practices, and the classification processes carried out by the community can serve as authentic learning resources for introducing geometric concepts in a more meaningful way (Az-Zahra et al., 2024). Learning mathematics through local cultural contexts enables students to understand formal concepts through

phenomena that they already recognize in their daily lives, thereby strengthening the connection between concrete experiences and mathematical abstraction.

In the context of geometry instruction, the *gunungan* can serve as a medium for exploring various concepts, ranging from curved-surface solids and the relationship between base area and height to the application of balance principles in object arrangements. The rotational symmetry and repetitive patterns found in the arrangement of materials can be used to introduce concepts such as geometric transformations, periodicity, and visual regularity. (Jumiarda et al., 2025). The community's experience in determining height, estimating proportions, or arranging materials based on size and type can serve as a medium for introducing concepts such as estimation, measurement, classification, and proportional reasoning. Thus, the *gunungan* offers a rich learning resource filled with mathematical representations—visual, structural, and conceptual. In addition, using the *gunungan* as a learning context can strengthen an ethnomathematical approach, which emphasizes that mathematics is an integral part of cultural practices and social experience (Dari & Jatmiko, 2024). Teachers can develop project-based learning activities, for example by modeling the shape of the *gunungan* using simple materials, identifying symmetry and patterns from documentary images, or analyzing mass distribution in the arrangement of its layers (Barus et al., 2022). Such activities not only promote geometric thinking skills but also develop collaborative abilities and deepen students' understanding of local cultural values, such as *gotong royong* and communal solidarity, which are integral to the process of constructing the *gunungan*.

Pedagogically, integrating the *gunungan* into mathematics instruction has the potential to enhance mathematical literacy, as students are engaged in processes of analyzing, interpreting, and modeling real-world situations (Abidin et al., 2021). This is in line with the study by Karimah & Dewi, which shows that integrating the *gunungan* tradition into mathematics learning encourages students to engage in analysis, interpretation, and mathematical modeling of cultural phenomena, making the learning process more contextual and meaningful (Karimah & Dewi, 2022). Thus, in addition to enriching the learning experience, this approach helps students see that mathematical concepts are not only found in textbooks but are also present

in the practices of the surrounding community. Therefore, the main implication of this study is the need to utilize local cultural artifacts as learning resources for mathematics that are contextual, meaningful, and relevant to students' experiences, particularly in the study of geometry.

CONCLUSION

The mountain of agricultural produce in the Merti Desa Bawang tradition represents a non-formal mathematical construction that combines concepts of geometry, structure, and cultural values. Geometrically, the mountain displays a conical shape with a circular base on a bamboo frame, arranged according to principles of proportion, gradient, and stable mass distribution—from large materials at the bottom to smaller ones at the peak. Patterns of rotational symmetry, tiered arrangement, and radial repetition of elements demonstrate a consistent visual order. Furthermore, the classification of materials based on size, shape, and function reveals the application of set theory concepts, ranging from the formation of base sets and subsets to intersections in materials that serve dual roles. These findings confirm that the construction of the gunungan reflects ethnomathematical practices that have developed intuitively within the local culture and holds strong potential as a contextual learning medium for geometry and set theory in schools.

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