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# Ethnomathematics exploration of Panataran Temple and its implementation in learning

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## ABSTRACT

Mathematics and culture are inherently interconnected, with cultural heritage playing a vital role in shaping national identity and pride. Understanding the mathematical concepts embedded in cultural artifacts enhances meaningful learning and helps preserve local traditions. This study explored the ethnomathematical elements found in Panataran Temple and examined how these mathematical concepts can be integrated into learning to promote mathematical understanding and cultural appreciation. This study employed a qualitative research design with an ethnographic approach using observation, interviews, literature review, and documentation. Data validity was ensured through triangulation. The research identified mathematical concepts embedded in architectural structures, such as Bale Agung, Pendhopo Teras, Angkatahun Temple, Naga Temple, Induk Temple, and the Palah Inscription. Additionally, it examined cultural aspects related to technology, religion, art, language, and social organization. The findings reveal the presence of mathematical elements, including cuboids and quadrilateral prisms, numerical systems, geometric transformations, and probability. These elements serve as tangible learning resources applicable across various educational levels. The study concludes that integrating ethnomathematics into mathematics education enhances students' conceptual understanding while fostering cultural awareness. Its implications highlight the significant role of cultural heritage in mathematics education, promoting meaningful learning and cultural preservation amid the challenges of the disruptive era.

# *Eksplorasi etnomatematika pada Candi Panataran dan implementasinya dalam pembelajaran*

***Kata Kunci:***

*budaya, etnomatematika, konsep matematika, Candi Panataran*

## *ABSTRAK*

*Matematika dan budaya memiliki keterkaitan yang erat, di mana warisan budaya menjadi bagian penting dari identitas dan kebanggaan suatu bangsa. Memahami konsep matematika yang tertanam dalam artefak budaya dapat meningkatkan pembelajaran yang bermakna sekaligus melestarikan tradisi lokal. Penelitian ini bertujuan untuk mengeksplorasi unsur etnomatematika di Candi Panataran serta mengimplementasikan konsep matematika yang terkandung di dalamnya ke dalam pembelajaran guna meningkatkan pemahaman matematika dan apresiasi budaya. Penelitian ini menggunakan pendekatan kualitatif dengan metode etnografi, melibatkan observasi, wawancara, studi literatur, dan dokumentasi, dengan validitas data melalui metode triangulasi. Studi ini meneliti konsep matematika yang ditemukan dalam struktur arsitektur seperti Bale Agung, Pendhopo Teras, Candi Angkatahun, Candi Naga,*

*Candi Induk, dan Prasasti Palah. Selain itu, penelitian ini juga mengeksplorasi unsur budaya terkait sistem teknologi, agama, seni, bahasa, dan organisasi sosial. Hasil penelitian menunjukkan bahwa struktur-struktur tersebut mengandung konsep matematika, termasuk balok dan prisma segi empat, sistem bilangan, transformasi geometri, serta probabilitas. Unsur-unsur ini dapat menjadi sumber belajar konkret bagi berbagai jenjang pendidikan. Penelitian ini menyimpulkan bahwa integrasi etnomatematika dalam pendidikan matematika memperkuat pemahaman konsep siswa sekaligus menumbuhkan kesadaran budaya. Implikasi dari penelitian ini menyoroti peran warisan budaya dalam pendidikan matematika, mendorong pembelajaran yang bermakna serta pelestarian budaya di tengah tantangan era disrupsi.*



**Contribution to the literature**

This research contributes to:

- Exploring the integration of ethnomathematics and cultural heritage, focusing on mathematical concepts in Panataran Temple.
- Providing practical applications for mathematics education and insights into the connection between cultural artifacts and mathematics.
- Supporting local heritage preservation, culturally based teaching materials, and bridging cultural studies with modern education for meaningful learning.

## 1. INTRODUCTION

Culture is a source of pride and a defining identity for individuals and communities [1]-[3]. According to Mallinowski [4], there are seven universal aspects of culture: language, which serves as a medium of interaction, with Indonesia's linguistic diversity reflecting its cultural richness; technological systems, encompassing tools and innovations that enhance efficiency; livelihood systems, which have evolved from gathering to farming and livestock rearing for sustainability; social organization, consisting of customs and rules that guide interactions; knowledge systems, inherited and developed over time, such as agricultural calendars used by farming communities; religion, which includes belief systems and spirituality; and art, which expresses human creativity through imagination and values. These elements are universal and serve as identifiers of social groups, ethnicities, and nations within an ethnographic framework, meaning that all human activities can be classified under one of these cultural elements.

Mathematics and culture are inherently interconnected [5], [6]. Integrating culture into the learning curriculum is essential, as modern education prioritizes character development that embodies national cultural values [7], [8]. Incorporating culture into learning fosters students' motivation to recognize their heritage and instills pride in their cultural identity. Culture-based mathematics, known as ethnomathematics, explains the role of mathematics within cultural contexts. Ethnomathematics can be described as how people from various cultures apply mathematical ideas and concepts in their daily lives [6], [9]-[11]. The objects of ethnomathematical study include community activities, historical artifacts, and cultural products that embody mathematical concepts. This integration helps students see the connection between mathematics and their cultural heritage. Ethnomathematics aims to reveal the relationship between mathematics and culture, enhancing students' understanding of mathematics by making it more meaningful and contextually relevant to their social and cultural environment [10], [11].

A study by Ditasona [10] utilized gorga, an ornamental carving found in traditional Batak houses, as a cultural context in mathematics learning. The study identified that several gorga motifs incorporate geometric transformations such as reflection, rotation, translation, and dilation. As a result, gorga can serve as a culturally relevant tool for teaching geometric transformation concepts. Similarly, Budiarto's research identified cultural contexts in various Indonesian traditions, such as Toraja carvings on Tongkonan traditional houses, ornaments on the Tanleyan Lajang settlement in Madura, architectural models of Ume Kbubu houses in East Nusa Tenggara, traditional furniture at Kraton Pasuruan, pottery from the Sasak tribe in Banyumulek, West Lombok, bark paintings of the Asmat tribe, Tenun Ikat weaving from Sendang Duwur, Lamongan, traditional weaving from North Central Timor and Southwest Sumba, non-standard measurements used in Pantura fish-farming communities and Javanese rice fields, and geometric patterns in woven bamboo from Banyuwangi [12]. These communities create carvings and crafts based on their daily observations and experiences, embedding mathematical concepts such as geometric shapes (circles, triangles, squares) and right angles in their designs. Similarly, non-standard measurement systems are used in traditional farming and trade practices, such as *rean*, *bata*, and *sejinah* units.

Panataran Temple is another significant cultural site in Indonesia, offering valuable ethnomathematical insights. Located in East Java, the Panataran Temple Complex is the largest Hindu temple in the region [13]-[15]. The temple grounds are divided into three sections, corresponding to three terraces: front porch, middle terrace, and back porch [16]. The complex consists of various structures, including Bale Agung, Pendhopo Teras, Angkatahun Temple, Naga Temple, Induk Temple, and the Palah Inscription, each with unique functions and philosophical meanings. The relief carvings in Pendhopo Teras depict folk tales such as Sri Tanjung, which tells the story of a faithful wife; Babhuksah Gagangaking, which emphasizes the virtue of sincerity in worship; and Sang Setyawan, which highlights the value of humility in leadership [17]-[19]. This study explores the ethnomathematical aspects of Panataran Temple, analyzing mathematical concepts embedded in its architecture and carvings, such as three-dimensional shapes, geometric transformations, numerical patterns, and probability. The research aims to integrate these cultural elements into formal education, making mathematics more engaging and contextually meaningful.

Previous studies have examined ethnomathematics in various cultural contexts, including the Muntuk community [1], Sundanese culture [2], and Javanese traditions [6]. Research has also explored ethnomathematics as an approach in formal education [9] and integrating cultural elements such as traditional Toraja houses, Lamongan ikat weaving, and Pantura coastal communities' measurement systems in mathematics learning [12]. However, most research has focused on contemporary cultural practices and handicrafts rather than exploring historical sites as holistic mathematical learning resources.

This study contributes significantly to mathematics education by introducing historical cultural sites as contextual learning tools. It highlights the potential of Panataran Temple as an ethnomathematical case study. It opens new opportunities for developing broader culture-based learning models, ultimately enhancing students' understanding of mathematics within a rich cultural framework.

## 2. METHOD

This qualitative ethnographic study, conducted in 2020, explored the relationship between ethnomathematics and local cultural contexts at the Panataran Temple complex. The study involved informants with expertise in the temple's history and architecture.

Before conducting the research, the researcher prepared the necessary instruments, including interview and observation guidelines, and conducted a literature review to support data collection. Ethical considerations were strictly followed by obtaining official permission to conduct the study on-site, informing participants about the research objectives, ensuring the confidentiality of their identities, and guaranteeing voluntary participation [20]. Data collection methods included direct observation of the temple's architectural elements, in-depth interviews with informants (conducted on March 17, 2020, from 9:46 AM to 12:00 PM), and documentation and literature review [21]. The data were analyzed using Spradley's ethnographic approach, which consists of domain analysis to identify general terms, taxonomic analysis to establish hierarchical relationships, componential analysis to uncover specific elements, and cultural theme discovery to link mathematics with cultural contexts.

This study concludes that ethnomathematics is integrated into Candi Panataran's architectural design, highlighting its implications for formal education. Data validity was ensured through triangulation, combining interviews, literature reviews, observations, and documentation [22]. Table 1 presents the informant data for this study.

**Table 1.** List of Research Informants

| No | Informant | Domicile |
|---|---|---|
| 1 | Cultural practitioner | Blitar |
| 2 | Archival officer at the Research and Cultural Heritage Center | Mojokerto |
| 3 | Documentation Clerk at the Research and Cultural Heritage Center | Mojokerto |

The informants were selected based on Spradley's criteria, which include full enculturation, direct involvement in the culture, unique cultural insights, availability, and the ability to describe events and provide analysis in their language. This process is illustrated in Figure 1.

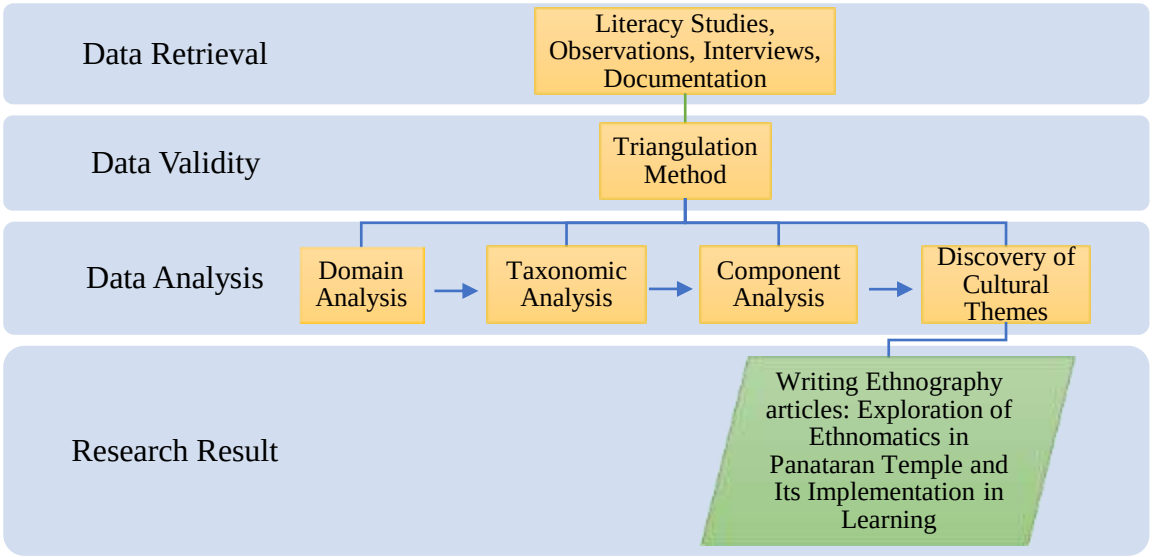


**Figure 1.** Research Flowchart

## 3. RESULTS AND DISCUSSION

Based on the obtained data, the ethnomathematics present in Panataran Temple include various mathematical concepts embedded in its architectural design and cultural artifacts.

### *3.1 Bale Agung and Pendhopo Teras*

Traditional architecture reflects the cultural values and functions embedded within a society. Figures 2 and 3 illustrate the Bale Agung and Pendhopo Teras structures constructed from stone. The Bale Agung is a gathering place for religious leaders, while the Pendhopo Teras serves as a platform for offerings and a stage for traditional dance performances. These two structures embody cultural elements within the domains of technology, religion, and art, aligning with the seven cultural elements proposed by Malinowski [23].

**Figure 2.** Bale Agung
Side View Image
Source: Documentation of the Cultural Heritage Conservation Center

**Figure 3.** Pendhopo Teras
Front View Image (South)
Source: Documentation of the Cultural Heritage Conservation Center

Figure 4 illustrates that the building forms a polyhedron, a three-dimensional shape bounded by intersecting planes [28]. Figure 5 highlights three prisms (Shapes A, B, and C): Shapes A and C are rectangular prisms, while Shape B is a cuboid. Prisms are classified based on the shape of their base plane, such as triangular, rectangular, or n-sided prisms. The structural composition of these prisms contributes to the stability and aesthetic appeal of traditional architecture. Bale Agung and Pendhopo Teras have two rectangular prisms and one cuboid [24]. These geometric characteristics play a crucial role in defining the spatial organization and functional layout of the buildings.

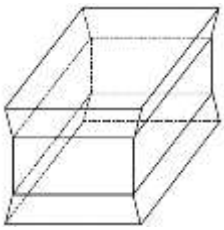

**Figure 4.** The Geometric Concept of the Bale Agung and Pendhopo Teras Buildings

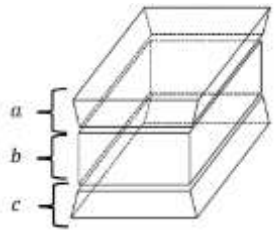


**Figure 5.** Three Prism Shapes

Figures 6 and 7 illustrate the dimensions of the Bale Agung and Pendhopo Teras buildings using geometric concepts. In school learning, these structures can serve as real-world examples in geometry lessons for sixth-grade students, aligning with Basic Competency 3.7: "Explaining three-dimensional shapes formed by the combination of several geometric figures, as well as their surface area and volume." They can also be used in eighth-grade geometry lessons, in line with Basic Competency 3.9: "Distinguishing and determining the surface area and volume of cubes, cuboids, prisms, and pyramids." By integrating cultural heritage into mathematical contexts, students can develop a deeper understanding of geometric principles while appreciating traditional architecture.

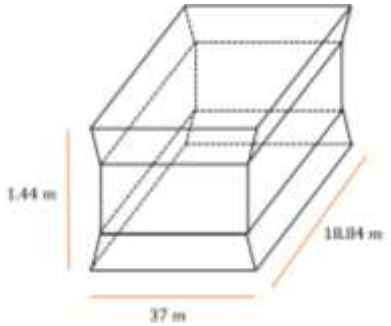


**Figure 6.** Bale Agung Building Size in Geometric Concept

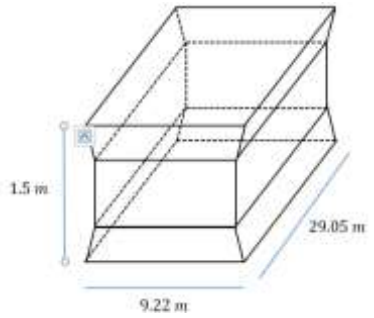


**Figure 7.** The Size of the Pendhopo Teras in Geometric Concept

Kuzniak and Auscher state that one of the fundamental challenges in geometry is the development of visual skills [25]. Ethnomathematics-based learning can serve as a bridge to enhance these skills in geometry education [26]. The Bale Agung and Pendhopo Teras buildings provide contextual learning objects, helping students recognize cuboids and rectangular prisms more easily. Additionally, these structures exemplify real-world applications of geometric shapes.

Educators can enhance students ' mathematical competence through contextual learning, various teaching methods, and media. Teachers should innovate their instructional approaches, incorporating diverse strategies to make mathematics more engaging. One such approach is ethnomathematics, which integrates cultural elements into math lessons. By applying culture-based mathematics learning, educators can create more meaningful experiences that help students construct a deeper understanding of geometry.

### *3.2 Angkatahun Temple*

The Angkatahun Temple holds historical and cultural significance. Figure 8 shows the Angkatahun Temple, named after the year 1291 Saka (1369 AD), engraved above its doorway (Figure 9). Figure 10 depicts a Kepala Kala relief with fingers forming the number 2. The stone temple was built to honor the mountain god and the ancestors of King Hayam Wuruk. Based on Malinowski's seven cultural elements, the Angkatahun Temple reflects both technological and religious systems.

**Figure 8.** Angkatahun Temple Front View Image
Source: Documentation of the Cultural Heritage Conservation Center

**Figure 9.** Year Numbers in Angkatahun Temple
Front View Image
Source: Documentation of the Cultural Heritage Conservation Center

**Figure 10.** Relief of 'Kepala Kala' with Fingers Forming the Symbol Number 2 in the Angkatahun Temple
Source: Documentation of the Cultural Heritage Conservation Center

Figure 11 illustrates numbers and number symbols from the Majapahit Kingdom. A number is an abstract concept that represents a total quantity, and in mathematics, it is used for counting and measuring [27]. Number symbols are representations of these numbers. The number system in the Majapahit Kingdom did not incorporate place value, which hindered its development [28]. According to this number system, the year indicated on the Angkatahun Temple is "*Siki Rwa Sanga Siki*" (1291 Saka). Numerals, also known as number words, refer to the basic numbers from which other numbers are derived [29]. Thus, the Angkatahun (the number of years) and Kepala Kala (the head of time) on the reliefs of the Angkatahun Temple serve as number symbols and are the primary numerals of the Majapahit Kingdom.


**Figure 11.** Numbers and Symbols Used during the Majapahit Kingdom
Source: Budiarto article (2016)

In the context of school mathematics education, the reliefs of the Angkatahun and Kepala Kala can be used as learning objects for teaching whole numbers in grade 1, based on the Basic Competency point 3.1: "Explains the meaning of whole numbers up to 99 as members of a collection of objects." A field trip to the Panataran Temple could allow students to explore the Majapahit Kingdom's historical heritage while also deepening their understanding of numbers and symbols through counting activities. For grade 1 students, the depiction of Kala's head is ideal for teaching counting, as the fingers shown in the relief represent the number 2. The Angkatahun relief features Javanese numerals, which teachers can introduce through learning media such as cards, as demonstrated by Ekowati *et al.* [30]. These cards have two sides: one side displays the standard mathematical symbols for numbers (1, 2, 3, 4, etc.), while the other side shows pictures of dancers or motifs from Madura batik.

In the study by Ekowati *et al.*, the application of ethnomathematics using Madura batik motifs, traditional trenggal dances, and Madurese cultural elements in learning enhanced students' understanding of numbers [30]. This research demonstrated that

mathematical concepts, often seen as abstract by students, became more concrete when linked to local cultural elements.

### *3.3 Naga (Dragon) Temple*

The Naga Temple is an important cultural and religious landmark. Figure 12 depicts the reliefs of nine identical figures on the Naga Temple. The Naga Temple is constructed entirely from stone and measures 4.83 m × 6.57 m × 4.70 m. Consequently, the reliefs carved on the Naga Temple are also stone-made. The Naga Temple building, a human-made structure, is a repository for heirlooms used in religious rituals. According to Mallinowski's seven elements of culture, the Naga Temple is associated with cultural elements from both the technological and religious systems.

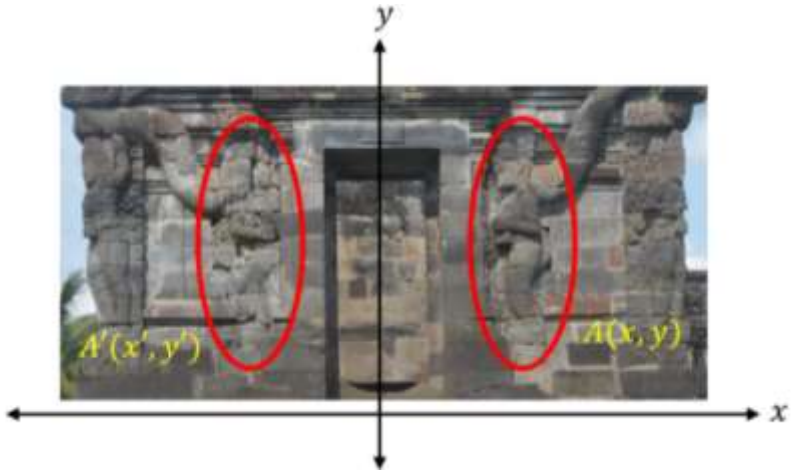


**Figure 12.** The Concept of Geometry Transformation on Nine Figures Relief
Front View Image (North)
Source: Documentation of the Cultural Heritage Conservation Center

The relief carving of the nine figures illustrates the application of a mathematical concept known as geometric transformation. Geometric transformation refers to changing the coordinates of a point (fulcrum) to new coordinates on a plane based on a specific rule [10]. For example, the transformation of $(T)$ to $P(x, y)$

$$P(x, y) \rightarrow P'(x', y') \qquad (1)$$

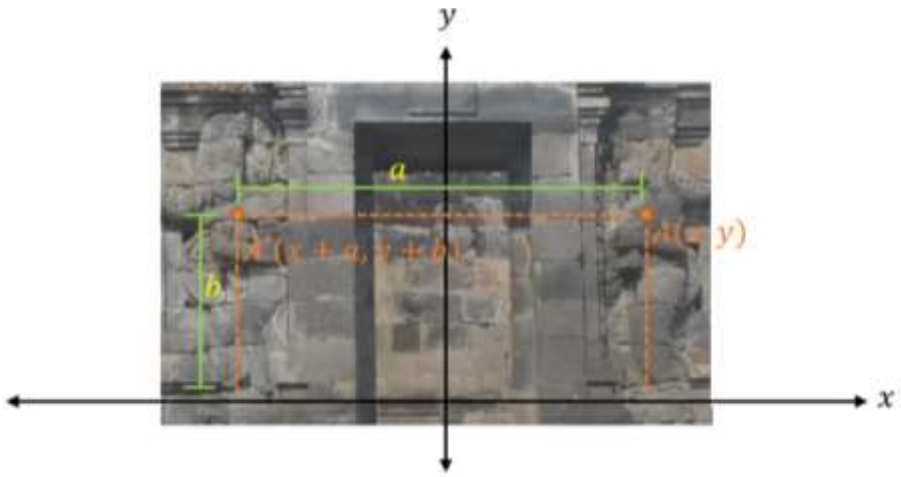


**Figure 13.** The Translation of Nine Figures Relief
Front view photo (north)
Source: Documentation of the Cultural Heritage Conservation Center

Equation (1) is a transformation of $(T)$ into $P(x, y)$ became $P'(x', y')$. Figure 13 shows the reliefs of nine figures with the concept of geometric transformation, namely translation. Translation is a transformation that moves every point on a plane with a certain distance and direction [10]. The distance and direction in translation can be shown as a direct line.

$$A(x, y) \xrightarrow{T=\binom{a}{b}} A'(x', y') = A'(x + a\,, y + b) \qquad (2)$$

Equation (2) is an operation of translation. For example, $\overrightarrow{AB}$ or $\binom{a}{b}$, where "a" indicates the horizontal distance and direction of movement, while "b" represents the vertical distance and direction. In every translation, the shape itself remains unchanged. The relief of the nine figures is created through the translation of a single object. Figure 10 illustrates the translation process along a horizontal line to form a new object, essentially repeating the previous object with the same direction and shape. This suggests that people during the Majapahit era applied the concept of translational geometric transformation when creating the reliefs of the nine figures at the Naga Temple. In an educational context, the relief of the nine figures at the Naga Temple can serve as a learning object for geometric transformations in grade IX, in line with Basic Competency point 3.5, which involves "explaining geometric transformations (reflection, translation, rotation, and dilation) in relation to contextual problems."

According to the research by Sudirman *et al.*, motifs from Indramayu Batik, such as Sawat Riwog, Setaman flowers, and Obar Abir, can be used as learning media for teaching translational geometric transformations [31]. Students were tasked with identifying motifs that utilize the principle of translation and the geometric shapes in the batik motifs [32]. Similarly, the reliefs of the nine figures at the Naga Temple can be used to learn the concept of translation. Fitriyah *et al.*'s research indicated that after learning through discovery-based teaching materials and an ethnomathematics approach, students could easily recall the concept of geometric transformation through the Lampung batik patterns they frequently encountered [33].

### *3.4 Induk (Main) Temple*

**Figure 14.** Main Temple
Front View Image
Source: Documentation of the Cultural Heritage Conservation Center

Figure 14 shows the main temple (Candi Induk) building. The temple is constructed from stone and consists of three terraces totaling 7.19 meters. The first terrace features reliefs depicting scenes from the Ramayana, the second terrace illustrates the Kresnayana and the third terrace displays Naga Wardhaya and Singa Naramurti reliefs. The folklore engraved on these three terraces serves as a communication medium, allowing humans to convey thoughts, feelings, and ideas. The main temple building functions as a site for religious ceremonies. According to Mallinowski's seven elements of culture, the main temple incorporates cultural aspects related to the technological system, language, and religious practices.

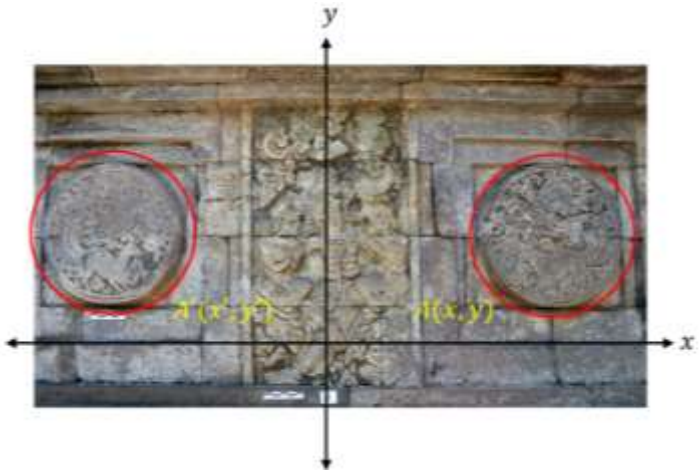


**Figure 15.** The Concept of Geometric Transformation in the Medallion Relief on the First Terrace of the Induk Temple (Main Temple)
Source: Documentation of the Cultural Heritage Conservation Center

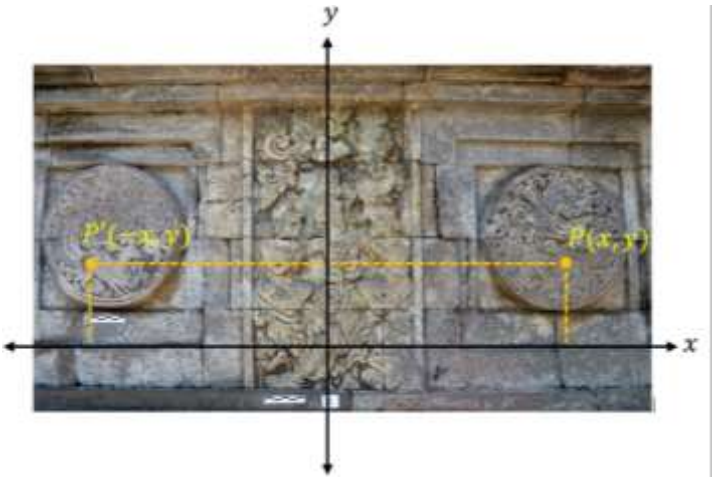


**Figure 16.** Reflection on the Medallion Relief on the First Terrace of the Induk Temple (Main Temple)
Source: Documents from the Cultural Heritage Conservation Center

At the main temple, reliefs featuring a medallion motif act as a barrier between the story scenes depicted in the carved reliefs along the walls. Figures 15 and 16 illustrate that the shape of the relief medallion at the main temple is similar in design. From this observation, it becomes evident that ancient societies utilized the concept of geometric transformation, specifically reflection. Reflection is a transformation in which each point on a plane is mapped to its mirror image [10]. For example, a reflection across the y-axis (vertical) will transform a point P(x, y) to P'(x,' y'), where P'(x,' y') = P'(-x, y). This transformation can be expressed in matrix form as follows:

$$x' = -x \quad (3)$$
$$y' = y \quad (4)$$
$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \quad (5)$$

Figures 15 and 16 demonstrate that people in ancient times applied the concept of transformation in creating the medallion reliefs at the main temple. In an educational context, the medallion reliefs at the main temple can serve as a learning object for teaching geometric transformations to Grade IX students, in line with Basic Competency 3.5: "explaining geometric transformations (reflection, translation, rotation, and dilation) in relation to contextual problems."

### *3.5 Prasasti Palah (Palah Incription)*

The Palah inscription holds historical significance in understanding the governance of temple communities. Figure 17 shows the Palah inscription building. The Palah inscription, part of the Panataran Temple complex, records King Srengga's decree granting Sima (tax-exempt status) to four village heads responsible for managing the temple, thus shifting its oversight from the kingdom to local authorities. This inscription reflects cultural elements of social organization, as it outlines the customs and rules governing community unity and responsibilities [34]. Additionally, the Palah inscription includes regulations on the management of buildings within the Panataran Temple complex, thus representing elements of social organizational culture.

**Figure 17.** Palah Inscription
Front View Image
Source: Documentation of the Cultural Heritage Conservation Center

The granting of Sima to the four village heads at that time involved a mathematical concept: probability. Probability is a mathematical concept used to assess the likelihood of an event occurring [35]. The probability of an event can be defined as: If n represents the number of sample points in the sample space S of an experiment, and A is an event with the number of outcomes n(A) in the experiment, then the probability of A is given by the formula $P = \frac{n(A)}{n\,(S)}$.

In terms of education, the Palah inscription can serve as a learning object for teaching probability in grade VIII, according to Basic Competency 3.11, which involves "explaining the empirical and theoretical chances of an event from an experiment." In grade XII, it aligns with Basic Competency 3.4, which focuses on "describing and determining the probability of multiple events (including the probability of mutually independent events, mutually exclusive events, and conditional events) in random experiments." Akbar *et al.* reported that, based on an analysis of students' errors in solving

mathematical problems on probability, students' abilities were as follows: 48.75% (low) for understanding the problem, 40% (low) for planning solutions, 7.5% (very low) for solving problems, and 0% (very low) for evaluating solutions [36]. These results suggest that the topic of probability remains a challenging concept for students to grasp.

The Palah inscription can be a valuable tool for teaching mathematics, especially in the context of probability. By visiting cultural sites such as the Panataran Temple, students can gain practical experiences that enhance their learning. In addition to studying the cultural history of the Majapahit kingdom, students can also learn the mathematical concept of probability through direct observation. Outdoor learning activities offer an alternative to traditional classroom instruction, which can help prevent student boredom and foster engagement.

This study's limitations include its narrow geographical focus and the absence of direct experimentation in applying ethnomathematics-based learning. Therefore, further research is needed to evaluate the effectiveness of cultural heritage-based learning models in improving students' mathematical understanding. This study underscores the importance of incorporating cultural heritage into mathematics education, as it promotes meaningful learning while supporting the preservation of cultural traditions in an era of disruption.

## 4. CONCLUSION

The research concludes that the Panataran Temple complex integrates cultural elements and mathematical concepts in its structures. First, the Bale Agung and Pendhopo Teras buildings reflect cultural aspects of technological systems, religious practices, and the arts, with mathematical concepts represented through cuboids and quadrilateral prisms. Second, the Angkatahun Temple building incorporates cultural elements of technological and religious systems, mathematical concepts represented by numbers, and symbolic representations of numbers. Third, the Naga Temple building embodies cultural elements from technological and religious systems and integrates the mathematical concept of translation. Fourth, the main temple building presents cultural aspects through technology, language, and religious systems while incorporating the mathematical concept of reflection. Fifth, the Palah inscription building reflects cultural aspects of social organization and integrates the mathematical concept of probability. The buildings within the Panataran Temple complex can serve as effective learning resources for students in grades I and VI of Elementary School, grades VIII and IX of Junior High School, and grade XII of Senior High School.

## 5. AUTHOR CONTRIBUTION STATEMENT

JM contributed to leading the research, designing the framework, coordinating the study, drafting the manuscript, and analyzing the data. MTB contributed to refining the methodology, developing qualitative protocols, assisting with data collection, and revising the manuscript.

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