07 (1) (2024) 1-17
INDONESIAN JOURNAL OF SCIENCE AND MATHEMATICS EDUCATION
https://ejournal.radenintan.ac.id/index.php/IJSME/index
ISSN: 2615-8639
DOI: 10.24042/ijsme.v5i1.19638
March 2024

Unraveling trends in temple ethnomathematics research and the evolution of the mathematical landscape

Fuat[1*], Rohibni[2], Maya Rayungsari[3]
[1,2,3]Mathematics Education Study Program, Faculty of Pedagogy and Psychology, Universitas PGRI Wiranegara, Indonesia

Corresponding author: boozfuat@gmail.com

Article Info

Article history:

Received: October 31, 2023
Accepted: January 24, 2024
Published: March 28, 2024

Keywords:

Ethnomathematics
Mathematics
Mathematical landscape
Systematic literature review
Temple

ABSTRACT

Ethnomathematics has experienced rapid development recently and has become a trend in mathematics. This research uses a systematic literature review method to analyze the relationship between mathematics and culture, trends in mathematical findings, and conformity with ethnomathematics theory. The articles from Sinta's accredited journals over the last five years. The research results show that there is no practical connection between mathematical and cultural concepts in temple ethnomathematics research. Second, mathematical findings tend to be convergent, with most studies referring to the same material without uniqueness or novelty across cultures. Third, Indonesia's natural diversity is not always relevant in ethnomathematics, which focuses more on cultural aspects. In conclusion, there is a gap in ethnomathematics research, and it is suggested that further studies utilize Mathematical Landscape in addressing mathematics in various broader aspects of life that are not directly related to ethnomathematics. This research can serve as a foundation and be further developed to benefit society and education worldwide.

Mengurai tren dalam penelitian etnomatematika candi dan evolusi lanskap matematika

Kata Kunci:

Etnomatematika
Matematika
Lanskap matematika
Systematic literature review
Candi

ABSTRAK

Etnomatematika mengalami perkembangan pesat akhir-akhir ini dan menjadi tren dalam matematika. Penelitian ini menggunakan metode systematic literatur review untuk menganalisis keterkaitan antara matematika dan budaya, kecenderungan temuan matematis, serta kesesuaian dengan teori etnomatematika. Artikel yang digunakan berasal dari jurnal terakreditasi Sinta lima tahun terakhir. Hasil penelitian menunjukkan bahwa pertama, tidak ada keterkaitan praktis antara konsep matematika dan budaya dalam penelitian etnomatematika candi. Kedua, temuan matematis cenderung konvergen, dengan sebagian besar penelitian merujuk pada materi yang sama tanpa keunikan atau kebaruan dalam berbagai budaya. Ketiga, keanekaragaman alam Indonesia tidak selalu relevan untuk dimasukkan dalam etnomatematika yang lebih berfokus pada budaya. Kesimpulannya, terdapat kesenjangan (gap) dalam penelitian etnomatematika, dan menyarankan penelitian selanjutnya untuk menggunakan Lanskap Matematika dalam membahas matematika di berbagai bidang kehidupan yang lebih luas dan tidak relevan dengan etnomatematika. Hal ini dapat menjadi dasar dan dapat dikembangkan lebih jauh hingga bermanfaat bagi masyarakat dan dunia pendidikan.

1. INTRODUCTION

Recently, the development of ethnomathematics research in Indonesia has experienced rapid growth each year. This is due to Indonesia being a country with abundant cultural wealth, which attracts the attention of academics who want to conduct exploratory research on ethnomathematics in various existing cultures. This is further reinforced by numerous literature reviews and previous bibliometric analyses indicating the rapid trend of ethnomathematics research in Indonesia [1]–[4].

Based on its original theory, ethnomathematics originates from three Greek words: ethnic, mama, and tics, first introduced by the Brazilian mathematician d'Ambrosio in 1985 [5]. Theoretically, ethnomathematics is a field of study that examines the relationship between mathematics and culture. Ethnomathematics involves researching the mathematical practices in various diverse cultures, encompassing unique and distinct mathematical concepts practiced within a culture [5]–[7]. This indicates that the presence of mathematical elements in exploratory ethnomathematics research needs to be analyzed to determine whether these elements truly represent a culture's practices, resulting in unique mathematics, or if they are merely approximations resembling mathematical forms.

Moreover, the trends in exploratory ethnomathematics research in Indonesia have been quite diverse based on the types of material and subjects involved. These range from the cultural heritage of ancient structures such as temples and traditional houses to traditional art forms like music, weaving, dance, painting, crafts, batik, etc. Traditional games and many other diverse aspects are also explored extensively. This diversity is influenced by the abundant cultural richness found in various fields across different regions in Indonesia. However, despite this diversity, some natural subjects in Indonesia do not fall under the cultural category, making it inappropriate to include them in ethnomathematics, which primarily focuses on ethnicity or culture. Examples of such subjects include city parks, environmental planning, natural objects like mountains, tourist attractions, non-cultural occupations, and so forth, each representing Indonesia's natural wealth beyond its cultural aspects [8].

This Systematic Literature Review aims to review and analyze the trends in exploratory ethnomathematics research in Indonesia. The study focuses on articles related to exploring ethnomathematics in Indonesian temples, a recently growing field. The main objective of this research is to uncover and understand the extent of the correlation between mathematical concepts and culture, the tendencies in mathematical findings, and the alignment of trends in exploratory ethnomathematics research on temples with the theories of ethnomathematics.

This research is the first in Indonesia, as no similar studies have been conducted. It was initiated independently and stood out from previous research, which mainly focused on general topics such as bibliometrics, the application of ethnomathematics, and the types and quantities of research. Some of them are research trend on ethnomathematics from 2012 to 2022: a bibliometric analysis [1], the application of ethnomathematics in numeracy literacy perspective: a literature review [9], bibliometric analysis: trends in ethnomathematics research in mathematics education in indonesia [2], research trend on ethnomathematics from 2012 to 2022: a bibliometric analysis [3], a review of research : exploring ethnomathematics on indonesian traditional games in mathematics learning [4].

Until now, Systematic Literature Reviews that conduct in-depth analyses of the correlation between mathematical concepts and culture, the tendencies of mathematical findings, and the alignment of trends in exploratory ethnomathematics research with the theories of ethnomathematics have not been conducted. However, evaluating and reviewing the compatibility of trends in exploratory ethnomathematics research with the theories of ethnomathematics is crucial. Furthermore, this research also presents results in the form of Mathematical Landscape as a new field in mathematics research that relates to nature and culture. It is an effort and methodology to explore mathematics in various aspects of life. This can be used as a reference and contribute to improving the quality of mathematics research connected to natural objects and everyday life. This research is also expected to serve as the foundation for future research on the mathematical landscape. It can be further developed to benefit society and education, particularly in developing mathematical learning content/materials.

Contribution to the literature

This study contributes to filling the research gap in ethnomathematics; specifically, the contributions of this study are:

- Providing knowledge and perspective that not all research on ethnomathematics has a clear connection between mathematical concepts and culture.
- Showing that mathematical findings tend to converge and often refer to the same material without significant uniqueness or novelty.
- We offer recommendations for further research on using the mathematical landscape in analyzing mathematics in various fields.
- It can be used as a basis for further development in the curriculum and mathematics learning materials.

2. METHOD

The method applied in this research is the Systematic Literature Review method using the PRISMA (Preferred Reporting Items for Systematic Review and Meta-analysis) technique. This method is utilized to examine/analyze, evaluate, and draw conclusions from critically gathered research. The method involves four stages: identification, screening, eligibility, and inclusion [10], [11].

In the identification stage, the researcher searched for articles exploring ethnomathematics in temples from various journals using Google Scholar. The search process involved using the keywords "Etnomatematika Candi" in two languages, namely Indonesian and English. The next stage is screening, where all articles are filtered based on the criteria of the specified time frame (2019 to 2023) and the relevance of the title, abstract, and topics to the predetermined keywords.

The next stage involves checking the appropriateness of the article content based on the research focus. The researcher focuses on articles exploring ethnomathematics in ancient structures, specifically temples in Indonesia, accredited by Sinta Kemdikbud RI. This is done to avoid data complexity and to align with the predetermined research focus. The final stage is inclusion, where the researcher conducts a review, presents data, analyzes and synthesizes data, and critically draws conclusions from all the studies. Figure 1 is the PRISMA flowchart of the Systematic Literature Review method, illustrating the article selection process.

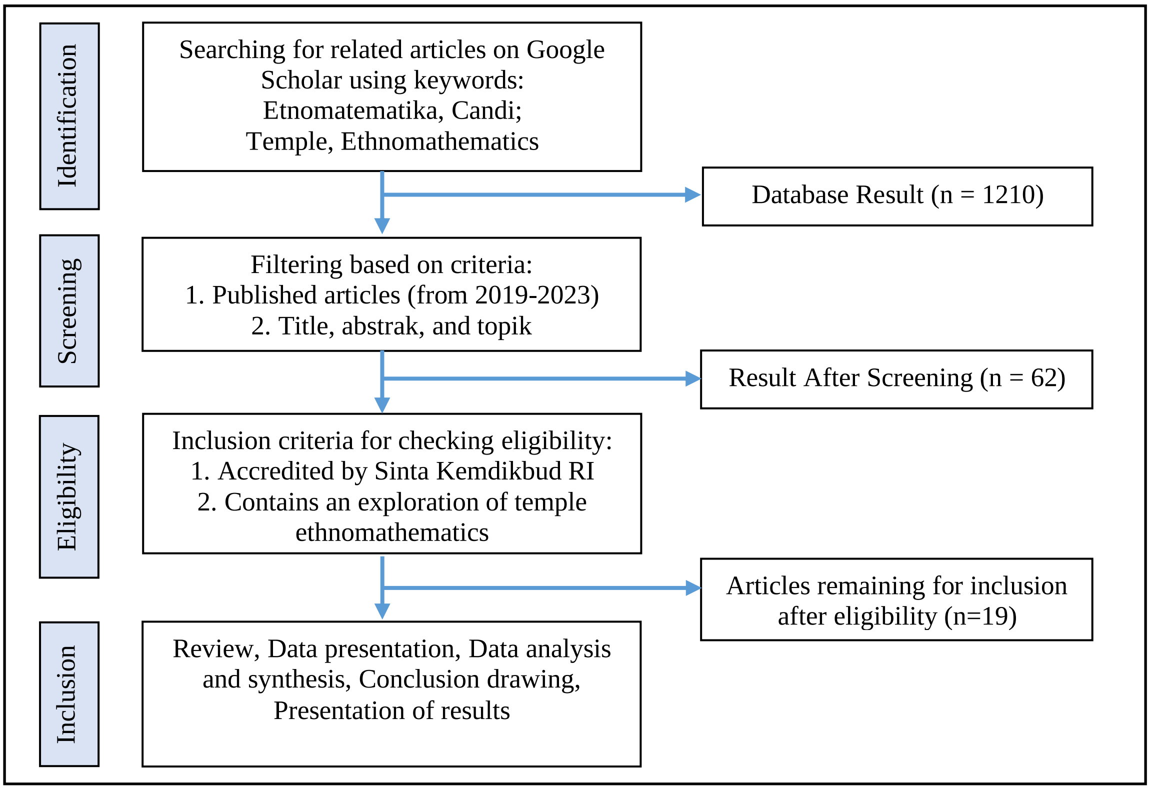

Figure 1. PRISMA flow chart describing the article selection process

3. RESULTS AND DISCUSSION

Ethnomathematics is a research field that aims to study the mathematics practiced within a particular culture [12]. Through this approach, many researchers have sought to understand the relationship between mathematics, temple architecture, and the cultural elements that surround it. In this context, the researcher has gathered ethnomathematical exploration studies on temple structures, which are ancient architectural heritage in various regions of Indonesia.

Table 1 presents research identity, mathematical findings, and cultural elements or related objects in the collected articles.

Table 1. Ethnomathematical exploration research trends in temple buildings

ID	Mathematics Finding	Cultural Elements
1	The mathematical elements found at Candi Selogending include plane geometry, spatial geometry, and reflection [9]	Some of the objects at Candi Selogending include the entrance gate, the meditation site of Mbah Tejo Kusumo, the meditation site of Mbah Pukulun, the Patrapan Pavilion, places of worship, Padma, Wadung Prabu, Linggasiwa, and the meditation site of Mbah Raden Selogending
2	The following geometric concepts were found at Candi Muaro Takus: quadrilateral shapes (square, rectangle, parallelogram, trapezium, and irregular quadrilaterals), triangles (right-angled triangles), circles, reflections, dilations, as well as lines and angles [13]	Each of these objects corresponds to the surrounding wall of the temple, the walls, the base of the Candi Tuo, the terraces of Candi Mahligai, the stairs of Candi Tuo, the stairs of Candi Bungsu, the Stupa of Candi Tuo, and the top and sides of Candi Tuo
3	There are geometric concepts related to flat shapes in the structure of Candi Pari in Sidoarjo. These concepts include square,	These geometric concepts are found in various elements of Candi Pari in Sidoarjo. They include the roof of Candi Pari, the temple's walls, the

	rectangle, trapezium, and triangle [14]	arrangement of bricks, the entrance corridor of the temple, the top surface of the temple, and the temple's ornaments.
4	Mathematical concepts found at Candi Asu include the concepts of rectangles, a combination of rectangles and trapezoids, cuboids, and reflection [15]	The objects include the relief and stones of Candi Asu, the antefix of the temple, and the well of Candi Asu.
5	The mathematical concepts include geometry, plane geometry, solid geometry, lines and angles, similarity and congruence, and geometric transformations [16]	The objects include the steps to the temple gate, the temple's main structure, the top of the temple, the temple's stone walls, its base, and temple reliefs. Additionally, the temple structure's roof, the stupa's base in the temple, steps to the main temple, and the Perwara temple building.
6	A mathematical concept is found in the Candi Portibi building, including concepts of plane geometry and geometry [17]	The objects are Candi Bahal I, Candi Bahal II, and Candi Bahal III buildings.
7	There are mathematical concepts involving geometry, such as 3D shapes like cuboids, cubes, pyramids, 2D shapes including squares, rectangles, trapezoids, circles, dodecagons, triangles, and different types of angles like right angles, acute angles, and obtuse angles, as well as geometric transformations like reflection and translation [18]	Batur (the temple's stone base), chamber roof, layout of Singosari Temple, temple roof, temple chambers and doors, Kala statue, temple peak, Yoni symbol, andesite stone, and the entire temple structure.
8	Mathematical concepts found in Pura Mandara Giri include concepts of reflection, unity, isosceles triangle, regular quadrilateral pyramid, truncated prism, and pyramid, as well as reflection, translation, and rotation [19]	The buildings Candi Waringin Lawang, Candi Kurung, Padmanabha, and Bale Ongkara, have a regular square pyramid roof. Bale Gong, Meru, and the carvings of Pura Giri Semeru are also associated with mathematical concepts.
9	Mathematical findings at Borobudur Temple include concepts of plane geometry, solid geometry, Euclidean geometry, fractals, numerical concepts, regular pattern ratios, and tessellations [20]	The design concept of Borobudur Temple, the temple's reliefs, and the overall appearance of Borobudur Temple from various angles, such as from above, the sides, vertical and horizontal views, and the temple's stupas, are associated with mathematical concepts.
10	The mathematical concepts applied to the Singosari heritage buildings include geometric concepts (cuboid, truncated square pyramid, square, circle, octagon, triangle, and rhombus), transformations (reflection and translation), number patterns, and calculations [21]	Andesite stones of the temple, the shape of the temple's tiers and reliefs, the temple's layout, base, body, and roof, as well as the Kala statue on the temple, all play a role in the mathematical concepts found in the legacy of the Singosari Kingdom.
11	The mathematical concepts found in the Gedong Songo Temple complex include concepts of plane figures, geometric shapes, symmetry, periodic patterns, and the golden ratio [22]	The entire Gedong Songo temple complex, temple reliefs, and the buildings of Bhuwarloka and Burloka in Gedong Songo temple are all part of the mathematical concepts explored in this study.
12	Candi Sewu exhibits various mathematical aspects, including concepts of plane figures such as triangles, squares, rectangles, and trapezoids. It also encompasses concepts related to solid figures like cubes, rectangular prisms, cylinders, square pyramids, and proportion [23]	The floor plan of Sewu Temple, Perwara Temples, rows of Perwara temples, Yoni, Andesite stone, and the stupa or temple roof are all considered in exploring mathematical concepts in this study.
13	There are mathematical concepts related to plane figures (square, rectangle, isosceles trapezoid, right-angled trapezoid, circle, triangle, and octagon), solid figures (cuboid,	The buildings and reliefs of Sewu Temple, the roof of Sewu Temple, the courtyard or temple grounds, the outer sides of the temple, the lower and upper walls of the temple, the well, and the

	cylinder, and square pyramid), geometric transformations (reflection, translation, and dilation), and arithmetic sequences [24]	layout of the Sewu Temple complex are elements involved in the exploration of mathematical concepts in this study.
14	The mathematical concept is related to geometry, including plane and spatial figures [25]	The buildings of Penataran Temple, Bale Agung, the terrace pavilion, Candra Sengkala Temple, Naga Temple, and the tumpal motifs on the temple doors are elements associated with exploring mathematical concepts in this study.
15	The mathematical concept found in Gumpang Temple is the concept of plane figures, specifically the concept of a rectangle [26]	The entire structure of Gumpang Temple is from the front and side views.
16	The mathematical concept found in Ngawen includes geometric concepts related to a rectangular prism and a frustum of a quadrangular pyramid [27]	The overall structure of Ngawen Temple, the temple's base, the side view of the temple, and the front view.
17	The mathematical concepts found include concepts related to plane geometry, triangles, the Pythagorean theorem, Pythagorean triples, congruence among flat shapes, flat surface sides, and curved surface sides [28]	Temple stairs, temple gates, reliefs, Kori Agung gateway, and Candi Perwara.
18	Mathematical concepts found in the Dieng Temple buildings include concepts related to transformations, geometry, plane geometry, number sequences, and sequence configurations [29]	The temple pinnacle, temple entrance gate, Kala statue, antefix, Yoni Lingga, Wadihati inscription, and the trisirah Shiva statue are also included.
19	The mathematical concepts in Ngawen include geometric concepts related to rectangular prisms, the frustum of square pyramids, and square pyramids [30]	The whole structure of Ngawen Temple, the temple's base, the side view of the temple, and the front view.

Table 1 indicates that researchers exploring ethnomathematics in ancient temple structures have revealed various mathematical findings within each temple. These mathematical elements are considered products of ethnomathematics resulting from the cultural elements or structural objects of the temples that have been studied. Furthermore, based on the table above, an analysis will be conducted to assess the trends in mathematical findings, the extent of the relationship between mathematical concepts and culture, and the alignment of research trends with the original concept of ethnomathematics.

3.1 Trends in mathematical content findings

This section presents the results of the analysis, including a tabulation of the mapping of mathematical content uncovered in various studies. This mapping is done by grouping the findings based on the type of material and its mathematical content. The mapping results are then input into the Microsoft Word feature linked with Microsoft Excel to create a pie chart with percentages for each mathematical content. As mentioned earlier, numerous mathematical elements in the context of temple structures can be categorized into mathematical content, according to Bell [31], including facts, concepts, principles, operations, and procedures in mathematics. This is done to illustrate the trends in the mathematical elements that have been uncovered and to understand the novelty of these mathematical elements and their divergence in mathematics.

Mathematical content refers to all the content or material in mathematics, including concepts, facts, principles, operations, and procedures used to understand, solve, and apply mathematical problems. Mathematical content is the foundation for understanding and using mathematics in various fields such as science, engineering, economics, and more. In mathematical terminology, facts are agreements or conventions that include terms (names), symbols or notations, and symbols. Concepts refer to abstract ideas that classify and categorize a set of objects, making it possible to determine whether a particular object is an example of a concept or not. Principles involve the relationships between several basic mathematical objects, comprising several facts and concepts and being linked to an operation. Principles can be axioms, theorems, laws, properties, etc. Furthermore, procedures in mathematics are steps or methods used to solve mathematical problems [31]. Below is the categorization of mathematical content in ethnomathematics exploration studies of temples based on material, along with mapping mathematical content.

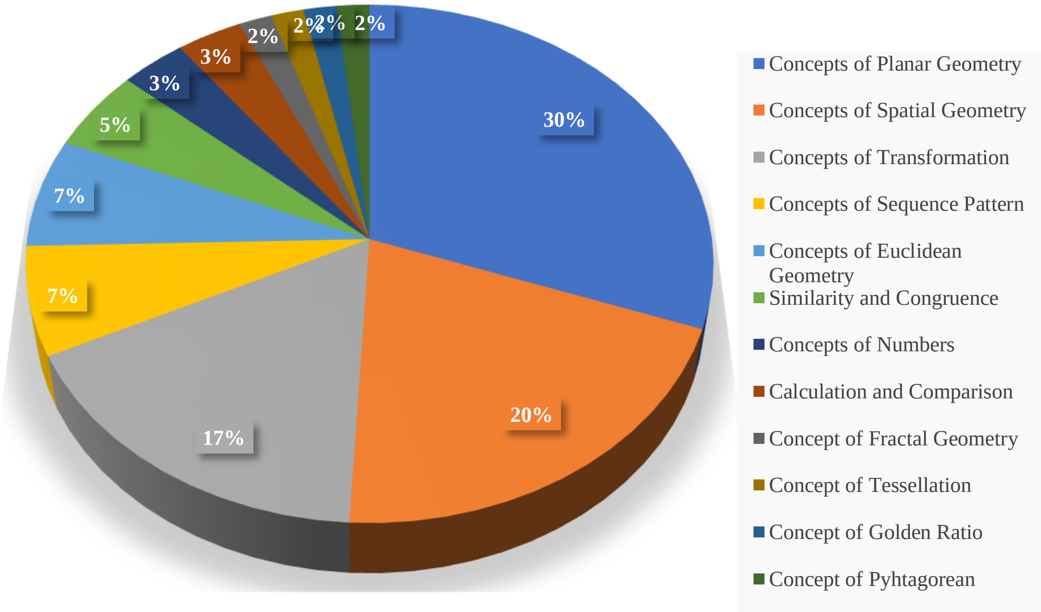

Figure 2. Diagram of mathematical contents grouping

Figure 2 shows that most ethnomathematics research on temples reveals mathematical findings in concepts related to plane geometry, spatial geometry, and transformations, each of which falls under the scope of geometric content in mathematics. Other findings include concepts related to fractal geometry, Euclid, Pythagoras, tessellations, similarity, and congruence, all of which are also within the realm of geometric content. Additionally, findings beyond geometry encompass concepts related to numbers, sequence patterns, calculations, comparisons, and the golden ratio. This indicates that the trends in ethnomathematics research on temples have been moving convergently, where most or almost all of the research tends to refer to the same mathematical content: geometry. Other mathematical content that has been uncovered remains minimal, with very small percentages. Furthermore, there hasn't been a discovery of unique or novel mathematical content specific to each culture.

On the cultural or temple structure side, when examining each research's cultural or temple objects, it becomes evident that the culture associated with mathematical findings has also been moving convergently. Some objects share commonalities in their structural aspects related to mathematics. These objects generally include the entire temple, comprising views of the temple from different sides and the temple's floor plan, often associated with regular pattern ratios, the golden ratio, and geometry, including concepts related to plane geometry, spatial geometry, transformations, congruence, fractals, lines, and angles. The temple's entrance gates and surrounding walls are often linked to geometry in plane geometry, spatial geometry, and transformations. The temple's body structure, including its base, stone blocks, body, stupa or roof, stairs, andesite, and temple rocks, is often associated with sequence patterns and geometry, including plane geometry, spatial geometry, lines, angles, and geometric transformations. The main temple is frequently connected to plane geometry, transformations, and congruence concepts. Perwara temples are related to ratios and plane geometry. Courtyards or terraces often involve plane geometry and spatial geometry. Places of worship and meditation sites are associated with concepts related to plane geometry, spatial geometry, and transformations. Various temple decorations include reliefs, carvings, and sculptures often linked to calculations and geometry, encompassing geometric transformations, plane geometry, and spatial geometry.

The above indicates that the mathematical findings in the exploration of ethnomathematics in temples that have been gathered [5], [12]–[29] are moving in a concurrent manner, where the existing objects generally share similarities as temple structures connected with mathematics in the same context. Moreover, the mathematical content revealed still does not show uniqueness or novelty in the mathematics of each culture. However, considering the original theory of ethnomathematics, it is stated that ethnomathematics is a study of mathematical practices in various cultures, resulting in unique mathematics in each culture [5]. Similarly, Kuntarto [32] and Fitriani [6] suggest that ethnomathematics can be interpreted as mathematics discovered or practiced in different cultures. This is intended to understand how unique mathematical concepts are found through the practical activities of specific groups within socio-cultural contexts. Thus, it can be concluded that the uniqueness or novelty of the revealed mathematical content is an essential aspect of exploring ethnomathematics research. As demonstrated by Azzahra [33] in her research, she discovered the novelty of a technique for painting regular hexagons that differs from the general theory, originating from the cultural activity of turning hexagonal bolts in the Ngemplakrejo Pasuruan woodturning community.

3.2 Relationship between mathematical findings and culture

Mathematical findings refer to the results of mathematical elements uncovered in various studies that have been collected. On the other hand, culture is a way of life that develops and is shared by a community or group of people, passed down from generation to generation. Culture includes religious and political systems, customs, language, tools, clothing, buildings, and art [34].

This section presents a tabulation to illustrate the extent to which mathematical elements are related to the culture explored. This tabulation includes research identities and the analytical process of discovering mathematical concepts within a culture. The purpose is to determine whether the mathematical elements uncovered are genuinely part of a related culture's practice, thus having a connection as a unique practice and contributing to the creation of distinctive mathematical concepts, or if they are merely approximations of mathematical concepts that resemble mathematical forms. Through this analysis, the research aims to demonstrate the extent to which mathematics and culture are intertwined and whether the mathematical findings genuinely reflect unique cultural practices and contribute to the understanding of mathematics within a specific cultural context.

Table 2. Mathematical analysis process and its relationship to culture

ID	Analysis Process
1	After an analysis process, the mathematical elements were found **by connecting** several objects from Selogending Temple, which have shapes and concepts related to plane and spatial geometry, as well as reflection.
2	The researcher conducted documentation and geometric **modeling** of several objects in Muara Takus Temple until they found concepts related to plane geometry and geometric transformations.
3	The concept of plane geometry was discovered after conducting **modeling**, where the objects in Pari Temple shared similarities with plane geometric shapes.
4	After documentation, researchers conducted mathematical **modeling** of the objects in Asu Temple, which led to the discovery of concepts related to plane geometry, solid geometry, and transformations.
5	In conclusion, there is a connection between Sanggrahan Temple and mathematics, primarily in the physical form of the temple. This is because the objects in the temple can be **connected** with concepts of plane geometry, solid geometry, lines and angles, similarity and congruence, and geometric transformations.
6	Mathematical concepts were obtained after analysis by **connecting** the objects in the Portibi Temple, which have geometric shapes and 2-dimensional structures.
7	The researcher conducted an ethnomathematical analysis by **identifying**, excavating, and analyzing geometric concepts in the structures that resemble 2-dimensional shapes, transformations, and angles.
8	Mathematical elements were discovered through illustrative **sketches**, leading to identifying concepts related to 2-dimensional shapes, transformations, similarity, and congruence in the Mandara Temple building.
9	Mathematical concepts were obtained after analysis by **connecting** the objects in the Borobudur Temple that resemble concepts of 2-dimensional shapes, 3-dimensional shapes, Euclidean geometry, fractals, number concepts, regular pattern ratios, and tessellation.
10	The researchers conducted a **taxonomic** analysis and **connected** the architectural forms of Singosari Temple with concepts in 2-dimensional geometry, transformations, number patterns, and calculations.
11	The researchers conducted an ethnomathematical analysis by **identifying** objects in Gedong Songo Temple with 2-dimensional geometric shapes, comparing the golden ratio, periodic patterns, and symmetrical forms.
12	The mathematical aspects are known through observation and **connecting** them with the structure of the Sewu Temple, which includes various geometric shapes, both 2-dimensional and 3-dimensional.
13	The mathematical analysis was conducted by **illustrating** various objects within the Sewu Temple until concepts related to 2D and spatial geometry, transformations, and arithmetic were identified.
14	The researchers conducted a **taxonomic** analysis to **connected** the architectural forms of the Penataran Temple with the concepts of spatial and planar geometry.
15	Mathematical concepts were discovered after analysis, where Gumpang Temple can be **connected** with the shape and concept of rectangular planar geometry.
16	Mathematical concepts were obtained after analysis by **connecting** the object of Ngawen Temple with shapes resembling rectangular prisms and frustum of square pyramids in the concept of spatial geometry.
17	It is concluded that Candi Plaosan contains mathematical concepts because several of its objects can be **interpreted** mathematically, including concepts related to planar geometry, congruence, and the Pythagorean theorem.
18	Mathematical concepts were found after the analysis by **connecting** the objects in Dieng Temple with concepts of geometric transformation, planar geometry, and sequence patterns.
19	The study contains the concept of spatial geometry because several objects in Ngawen Temple can be **connected** with the concept of rectangular prisms and the frustum of a square pyramid in 3D space.

Table 2 shows that in most ethnomathematics exploration studies of temples, there is no clear connection between the practices described in each study. There is a lack of in-depth descriptions of how the discovered mathematical concepts are practiced within the related culture. Therefore, it can be said that the mathematical elements in question do not represent a cultural practice, as there is no description of practices demonstrating that the mathematical findings are genuinely the result of practices within a specific culture. On the contrary, most research indicates that various temple objects selected for study share similar mathematical shapes and concepts. This is achieved through different mathematical analyses in each study, and it has evolved from the original theory of ethnomathematics. The following will collect the keywords used in the analysis process in the research mentioned above.

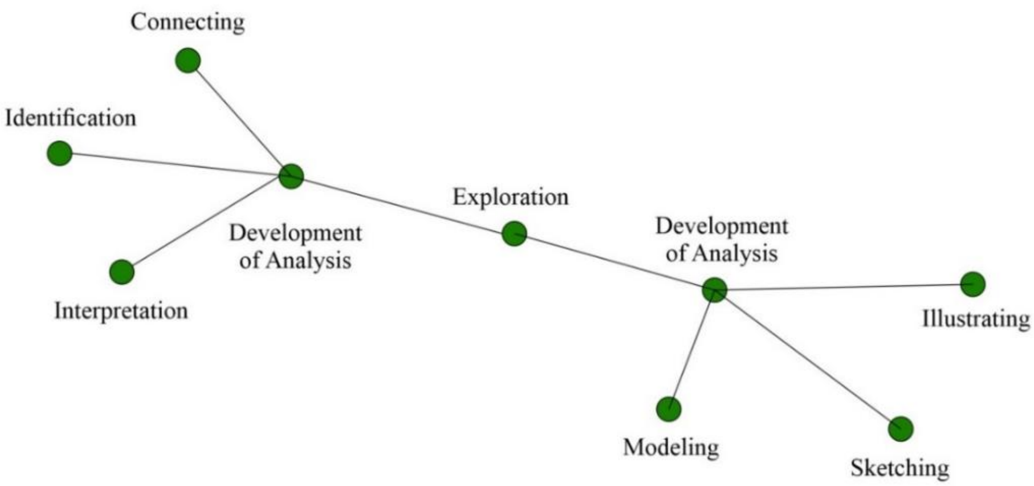

Figure 3. The development of the mathematical analysis process

Based on Figure 3, we can see the progression of the mathematical analysis process in each ethnomathematics research study of temples. An object is said to contain mathematical elements after an analysis process that includes identification, interpretation, sketching, mathematical modeling, illustration, and linking several temple objects that share similarities with mathematical shapes and concepts. This process has evolved significantly from the original theory of ethnomathematics, which primarily explored mathematical practices within a culture. The following are a few examples of the analysis process in some of the collected research studies.

In Figure 4, part (a) of the research [13] states a mathematical concept in the form of a square shape in the perimeter wall of Muara Takus Temple. Similarly, in part (b), the subsequent researchers [14] mention that there is a concept of a rectangular shape in the corridor of the entrance to Pari Temple. The same can be seen in part (c) of Figure 4 [21] in their research, where it is stated that there is a concept of reflection in the structure of Kidal Temple.

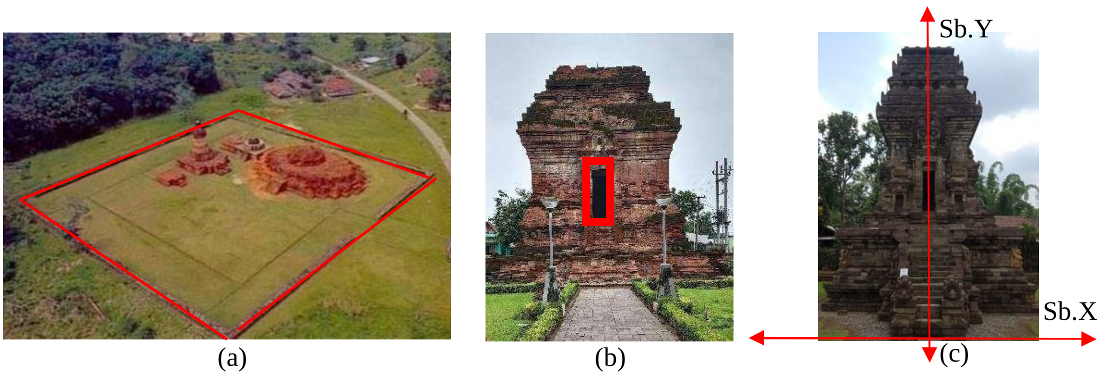

Figure 4. Example of mathematical analysis in temple ethnomathematics exploration research

These three examples represent some of the mathematical analyses conducted by researchers on temple objects. Essentially, the perimeter wall of Muara Takus Temple is said to contain the concept of a square because, after conducting an analysis using geometric modeling, it was found that the perimeter wall shares similarities with the concept and shape of a square. Similarly, the corridor of Pari Temple, which is rectangular, is linked to the concept of a rectangle. Furthermore, Kidal Temple contains the concept of reflection because the right side of the temple's structure is similar to the result of the reflection of the left side, which is associated with geometric transformation.

In conclusion, the mathematical findings in the exploration of ethnomathematics in temples that have been collected are essentially the result of mathematical analysis of objects that share similarities in form and mathematical concepts. An object is considered to have mathematical elements when it shares similar shapes or concepts in mathematics. This indicates the absence of a clear connection between mathematical concepts and culture in ethnomathematics research on temples, as there is no in-depth discussion on how mathematical concepts are applied or practiced in each culture. Instead, the mathematical findings are seen as the outcome of mathematical analysis of objects with similarities in form and mathematical concepts.

However, upon reviewing the original theory of ethnomathematics, it is understood that ethnomathematics is a study of mathematical practices in various cultures, resulting in unique mathematics in each culture [5]. Similarly, Kuntarto [32] and Fitriani [6] explain that ethnomathematics can be interpreted as mathematics discovered or practiced in different cultures. This aims to understand how mathematical concepts are found through the practical activities of specific groups within socio-cultural contexts. Thus, mathematical elements in exploratory ethnomathematics research must be ensured as a practice genuinely carried out by a culture. As demonstrated in Azzahra's research [33], a unique technique for painting regular hexagons was discovered through the cultural activity of cutting the sides of hexagonal bolts in the Ngemplakrejo Pasuruan woodturning community. Similarly, Maryati's research [35] explored mathematical concepts by designing Kebaya Kartini, a cultural activity in Indonesia.

3.3 The suitability of research trends with ethnomathematics theory

Ethnomathematics, first introduced by d'Ambrosio [12], is a research methodology that explores the relationship between mathematics and culture. Ethnomathematics involves studying various cultures' mathematical practices, including unique and distinct mathematical concepts applied within specific cultural contexts [12]. Yani & Kuntarto [32] explain that ethnomathematics is a form of practice or activity carried out by specific communities, consciously or unconsciously, to apply mathematical concepts to solve problems and develop their culture. Fitriani [6] also defines ethnomathematics as mathematics found or practiced within different cultures to understand how different mathematical concepts are derived from the practices of specific socio-cultural groups.

From the explanations above, it can be concluded that in ethnomathematics, three fundamental terms are crucial to consider as prerequisites for ethnomathematical exploration: mathematics, practice, and culture. Ethnomathematics can be defined as mathematical concepts derived from specific cultural practices. These concepts can develop uniquely according to each culture, resulting in a distinct mathematical concept that differs from the conventional theories, reflecting the uniqueness of each culture. This is also in line with the original theory of ethnomathematics proposed by d'Ambrosio [12], which consists of three words: "*ethno* (culture), *mathema* (mathematics), and tics (*techne*, which means techniques/practices)." This indicates that ethnomathematics focuses on the mathematical practices within a specific culture.

However, the limitation of this focus has indirectly led to a research gap compared to the data analysis results of ethnomathematics research trends on temples in Indonesia, as presented in the previous section. In temple ethnomathematics research, no direct link between mathematics and culture is found because there is no in-depth description of how mathematical concepts are applied within the related culture. Thus, the mathematical elements mentioned are not considered cultural practices but rather the result of mathematical analyses of objects that resemble mathematical shapes and concepts. This discrepancy contradicts the original theory of ethnomathematics, which primarily deals with mathematics practices within a specific culture.

Furthermore, it is also observed that ethnomathematics research trends related to temples have followed a convergent path. Most of these studies tend to focus on the same mathematical concepts, lacking uniqueness or novelty in the mathematical elements of each culture. Additionally, Indonesia is rich in natural diversity [7], [36], including city parks, natural sites like mountains, various other natural objects, non-cultural professions, urban planning, and more. These aspects fall outside the scope of ethnomathematics, which primarily centers on ethnic or culture. Therefore, a research gap is identified, indicating the need for another research methodology that broadly discusses mathematics, whether practiced or not, in various aspects of life and natural settings that are not limited to culture. This includes natural objects, tourism, city parks, architecture, environmental planning, non-cultural occupations, and so on, notably non-cultural ones.

Research on non-cultural objects in the natural landscape is an interdisciplinary study that has already made significant progress in other fields. This is often known by the term "landscape," such as in the field of linguistics known as linguistic landscape, in architecture referred to as architectural landscape, and so forth, each of which has explored many spatial objects in the natural landscape [37]–[44]. Unfortunately, interdisciplinary research in the context of mathematics that investigates non-cultural objects in the natural landscape has not developed well. However, interdisciplinary research in this context is crucial to expand the scope of mathematics in real-life situations [45].

3.4 Landscape of mathematics as a development and new field

Mathematics is a scientific field closely related to everyday life, playing a vital role in various aspects of human life. This is because mathematics is a crucial tool and a supporting science in various other fields for problem-solving [46]. As a result, mathematics is inseparable from human activities, with a broad scope encompassing all areas, such as culture, environmental planning, spatial organization, tourism, surrounding objects, and daily activities of society in general [47].

In spatial organization, mathematics has practical significance in landscape and architectural design, where it is employed to explore mathematical concepts and techniques in constructing, perceiving, and designing specific objects. This has led to developing a unified theory known as Landscape Mathematics. Landscape Mathematics was initially proposed by Carrero [48], who defined it as "Landscape Mathematics = Landscape Architecture + Mathematics + Engineering." In more comprehensive terms, Landscape Mathematics is an interdisciplinary STEM (Science, Technology, Engineering, and Math) field that combines landscape architecture, mathematics, and engineering knowledge to be used in designing, constructing, and perceiving the world through mathematics. Landscape Mathematics is an interdisciplinary study combining various scientific disciplines to understand mathematical phenomena within environments. These cities span public spaces, natural landscapes, environmental organizations, city parks, spatial planning, tourism, natural objects, non-cultural professions, and more [48].

Previous research on landscapes has covered various aspects, such as linguistic, architectural, geometric, and more, which explore different aspects of spatial organization in natural landscapes [37]–[44]. However, research that combines landscapes with mathematics in a broader context is still relatively rare. Combining various scientific disciplines in the context of mathematics is a novel and important endeavor. Interdisciplinary research is crucial to expand the scope of mathematics into various real-life domains. This is further supported by a study [45] highlighting the importance of interdisciplinary research practices in mathematics education to broaden the study of mathematics in various fields directly related to nature and community life. It helps mathematics become more relevant across different areas of life and provides a more tangible understanding for the general public, including students.

However, this systematic literature review is still limited to analyzing trends in the exploration of ethnomathematics in temples in Indonesia, which has indicated a gap and suggested that the mathematical landscape is a form of development. Therefore, using Mathematical Landscape, further research is needed to explore or analyze mathematical elements in various aspects of life that are not limited to culture. This research can serve as the foundation for future research on the Mathematical Landscape and can be further developed for the benefit of society and the field of education. In contemporary education, the development of mathematical learning content/materials directly related to daily life, aligned with the needs of students, and based on local wisdom is crucial as an implementation of differentiated learning, which is a key principle of the officially endorsed independent curriculum [49], [50]. For example, the geometric concepts in the mentioned mosque and temple structures can be developed as a mathematical landscape and integrated into school geometry education [20], [51].

Similarly, the mathematical patterns in batik fabrics can be developed as a mathematical landscape and connected to pattern mathematics education in schools [49]. Furthermore, various other natural objects can also be developed as mathematical landscapes and linked to relevant mathematics learning topics. These objects include city parks, tourist attractions, non-cultural occupations, and so on, each highly diverse in Indonesia [50], [52].

4. CONCLUSION

The Systematic Literature Review on exploring ethnomathematics in temples reveals several important findings. Firstly, there is no clear connection between mathematical concepts and culture in the research on ethnomathematics in temples, with no in-depth discussion on how mathematical concepts are applied in each culture. Instead, mathematical concepts result from mathematical analysis of objects with similar forms and mathematical concepts. Secondly, the mathematical findings in the trends of ethnomathematics research in temples tend to converge, with most studies referring to the same material without significant uniqueness or novelty in expressing mathematical elements across various cultures. Thirdly, the abundant diversity of Indonesia's nature is not always relevant to be included in ethnomathematics, which primarily focuses on cultural aspects. These results indicate a gap in the research on ethnomathematics in temples and suggest further research using Mathematical Landscape as a broader approach to exploring mathematics in various aspects of life and natural landscapes that are irrelevant to be covered in ethnomathematics. Mathematical Landscape is an interdisciplinary research project combining various disciplines to broadly explore and understand mathematics. It represents an evolution from ethnomathematics and is a new field of research that enhances the quality of mathematics research related to life. This research can serve as the foundation for future research on the Mathematical Landscape. It can be further developed to benefit society and the field of education, including the development of mathematical learning content/materials.

AUTHOR CONTRIBUTION STATEMENT

F contributed to conceptualization, methodology, validation, writing, and review. R contributed to formal analysis, data collecting using software, and writing original draft preparation. MR contributed to data curation, writing, review, and editing. All authors have read and agreed to the published version of the manuscript.

REFERENCES

[1] F. N. Hidayati and R. C. I. Prahmana, "Ethnomathematics' research in Indonesia during 2015-2020," *Indones. J. Ethnomathematics*, vol. 11, no. 1, pp. 29–42, 2022.
[2] I. Muhammad, F. Marchy, A. do muhamad Naser, and T. Turmudi, "Analisis bibliometrik: tren penelitian etnomatematika dalam pembelajaran matematika di indonesia (2017 – 2022)," *JIPM (Jurnal Ilm. Pendidik. Mat.*, vol. 9, no. 2, pp. 267-279, 2023, https://doi.org/10.25273/jipm.v11i2.14085.
[3] R. Rusli and T. N. Safaah, "Research trend on ethnomathematics from 2012 to 2022: a bibliometric analysis," *Indones. J. Sci. Math. Educ.*, vol. 6, no. 1, pp. 37–47, 2023, https://doi.org/10.24042/ijsme.v6i1.14794.
[4] A. P. Salsabilah, A. A. Rahmah, A. Wulandari, and J. Soebagyo, "A review of research : exploring ethnomatematics on indonesian traditional games in mathematics learning," *J. Medives J. Math. Educ. IKIP Veteran Semarang*, vol. 06, no. 1, pp. 191-202, 2022, https://doi.org/10.31331/medivesveteran.v6i1.1751.
[5] U. d'Ambrosio, "Ethnomathematics and its place in the history and pedagogy of mathematics," *Learn. Math.*, vol. 5, no. 1, pp. 44–48, 1985.
[6] L. D. Fitriani, "Eksplorasi etnomatematika tarian dalam bimbang gedang pada masyarakat di kota bengkulu," Ph.D. dissertation, Dept. Educ. Math, UIN Fatmawati Sukarno, Bengkulu, 2022, https://doi.org/10.32505/qalasadi.v6i2.4696.
[7] I. D. Puspitasari, "Faktor-faktor yang mempengaruhi interaksi sosial antara masyarakat samin dan masyarakat non samin (studi masyarakat padukuhan karangpace, desa Klopoduwur, kecamatan Banjarejo, kabupaten Blora, Jawa Tengah)," *E-Societas*, vol. 6, no. 7, pp. 1-23, 2017.
[8] A. I. Wiyanti, D. A. Wulandari, F. I. Kajori, S. I. Alfiani, and W. Wahidin, "Etnomatematika: museum fatahillah jakarta sebagai bahan pembelajaran matematika," *J. Math. Educ. Sigma*, vol. 3, no. 2, pp. 77-85, 2022.
[9] R. Ainurriza, T. Sugiarti, and F. S. Hutama, "Etnomatematika pada candi Selogending di desa Kandangan sebagai sumber belajar matematika kelas IV sekolah dasar," *Educ. J. Prim. Educ.*, vol. 1, no. 3, pp. 283–302, 2020, https://doi.org/10.35719/educare.v1i3.29.
[10] R. G. Gunawan, F. Festiyed, Y. Yerimadesi, I. Ilwandri, and R. G. Gunawan, "The problem-based learning model integrated with the integrated learning model in science learning: a systematic literature review," *Indones. J. Sci. Math. Educ.*, vol. 06, no. 2, pp. 227–237, 2023, https://doi.org/10.24042/ijsme.v6i2.17576.

[11] C. P. Nogues and B. V. Dorneles, "Systematic review on the precursors of initial mathematical performance," *Int. J. Educ. Res. Open*, vol. 2, no. 1, pp. 1-11, 2021.
[12] U. d'Ambrosio, "Ethnomathematics and Its Place in the History and Pedagogy of Mathematics," *Learn. Math.*, vol. 05, no. 1, pp. 44–48, 1985.
[13] T. Hidayat, A. Asmar, and Y. Yerizon, "Eksplorasi etnomatematika pada candi muara takus di kec. XIII Koto Kampar Riau," *J. EKSAKTA Pendidik.*, vol. 05, no. 1, pp. 77–86, 2021, https://doi.org/10.24036/jep/vol5-iss1/575.
[14] I. Ikawati and M. D. K. Wardana, "Konsep bangun datar sekolah dasar pada struktur candi Pari Sidoarjo," *J. Basicedu*, vol. 6, no. 5, pp. 8188–8198, 2022, https://doi.org/10.31004/basicedu.v6i5.3776.
[15] M. Irsyad, A. A. Sujadi, and D. S. Setiana, "Eksplorasi etnomatematika pada candi Asu," *UNION J. Ilm. Pendidik. Mat.*, vol. 8, no. 1, pp. 11–19, 2020, https://doi.org/10.30738/union.v8i1.7609.
[16] T. D. Jayanti and R. Puspasari, "Eksplorasi etnomatematika pada candi Sanggrahan Tulungagung," *JP2M (Jurnal Pendidik. dan Pembelajaran Mat.*, vol. 06, no. 2, pp. 53-66, 2020, https://doi.org/10.29100/jp2m.v6i2.1748.
[17] Nursahadah, "Ekspolarasi etnomatematika pada bagunan candi portibi," *J. MathEducation Nusant.*, vol. 2, no. 2, pp. 120-126, 2019.
[18] R. R. Safitri and Y. Sulistyorini, "Studi etnomatematika geometri pada artefak peninggalan sejarah di kota Malang," *MATHEMA J. Pendidik. Mat.*, vol. 5, no. 2, pp. 258–268, 2023.
[19] T. B. Setiawan, S. Wahyu, and S. Sunardi, "Etnomatematika pada pura mandara giri semeru agung sebagai bahan pembelajaran matematika," *KadikmA*, vol. 9, no. 1, pp. 156–164, 2018.
[20] R. N. F. Utami, D. Muhtadi, N. Ratnaningsih, S. Sukirwan, and H. Hamid, "Etnomatematika: eksplorasi candi Borobudur," *JP3M (Jurnal Penelit. Pendidik. dan Pengajaran Mat.*, vol. 6, no. 1, pp. 13–26, Mar. 2020, https://doi.org/10.37058/jp3m.v6i1.1438.
[21] D. Wulandari and M. T. Budiarto, "Etnomatematika: eksplorasi pada artefak kerajaan Singosari," *Transform. J. Pendidik. Mat. dan Mat.*, vol. 04, no. 1, pp. 203–217, 2020, https://doi.org/10.36526/tr.v4i1.905.
[22] A. M. Ali and Y. Prasetia, "Ethnomathematical studies on the Gedong Songo temple," *Union J. Ilm. Pendidik. Mat.*, vol. 11, no. 2, pp. 242–249, 2023, https://doi.org/10.30738/union.v11i2.14428.
[23] D. Zulaekha and S. Sutama, "Ethnomathematics: exploration of Sewu temple in Klaten," *BAREKENG J. Ilmu Mat. dan Terap.*, vol. 17, no. 2, pp. 1039–1048, 2023, https://doi.org/10.30598/barekengvol17iss2pp1039-1048.
[24] D. Sulistyowati and R. P. Khotimah, "An exploration of ethnomathematics at Sewu temple in Yogyakarta," *J. Ris. Pendidik. Mat.*, vol. 9, no. 2, pp. 177–190, 2022, https://doi.org/10.21831/jrpm.v9i2.51756.
[25] E. Susanti and A. P. Rahmadhani, "Concept of geometry in Penataran temple," *Math. Educ. J.*, vol. 5, no. 1, pp. 58-65, 2021, https://doi.org/10.22219/mej.v5i1.15545.
[26] S. Sutrimo, K. Kamid, A. Asrial, and B. Hariyadi, "Gumpang temple as a source of ethnomathematics learning," *Int. J. Trends Math. Educ. Res.*, vol. 06, no. 1, pp. 6–11, 2023, https://doi.org/10.33122/ijtmer.v6i1.99.
[27] M. D. Pamungkas, Zaenuri, and Wardono, "Ethnomathematics: geometric analysis of historical buildings ngawen temple in Magelang," *J. Phys. Conf. Ser.*, vol. 1918, no. 4, pp. 1-9, 2021, https://doi.org/10.1088/1742-6596/1918/4/042102.

[28] N. Kurniati, Gunawan, and R. Widagsa, “The mathematical values of the Ploasan temple,” in *Proceedings of the 1st UPY International Conference on Education and Social Science (UPINCESS 2022)*,vol. 1, no. 2, pp. 259–265, 2023, https://doi.org/10.2991/978-2-494069-39-8_25.
[29] R. L. Mahmudati, “The study of ethnomathematic objects in the dieng temple Wonosobo, Central Java,” *Mat. dan Pembelajaran*, vol. 8, no. 2, pp. 133–143, 2020, https://doi.org/10.33477/mp.v8i2.1606.
[30] R. Sariningtias, R. Indriani, A. Solihati, A. Kamila, and M. D. Pamungkas, “Analysis of historical buildings ngawen temple in Magelang,” *MaPan*, vol. 8, no. 2, pp. 236–247, 2020.
[31] F. H. Bell, *Teaching and Learning Mathematics (In Secondary Schools)*. New York : Lowa, 1978.
[32] A. Yani and E. Kuntarto, “Etnomatematika,” *J. Gantang*, vol. 2, no. 2, pp. 133–144, 2017, https://doi.org/10.31629/jg.v2i2.203.
[33] F. Azzahra, “Etnomatematika pembubut ngemplakrejo pasuruan studi melukis geometri dalam pembuatan mur berbentuk segienam,” M.S thesis, Dept. Educ. Math, Universitas PGRI Wiranegara, Pasuruan, 2022.
[34] Muslimah, “Kajian filsafat ilmu dalam kebudayaan,” *Bangun Rekaprima Maj. Ilm. Pengemb. Rekayasa, Sos. dan Hum.*, vol. 07, no. 2, pp. 105–110, 2011, https://doi.org/10.32497/bangunrekaprima.v7i2.3004.
[35] M. Maryati and R. C. Indra Prahmana, “Ethnomathematics: exploring the activities of designing kebaya kartini,” *MaPan*, vol. 06, no. 1, pp. 11–19, 2018, https://doi.org/10.24252/mapan.2018v6n1a2.
[36] A. Akmal, “Tari dero di bone-bone kabupaten Luwu Utara,” Ph.D Thesis, Universitas Negeri Makassar, Makassar, 2015.
[37] W. De Silva and N. Amarakoon, “Sustainable city geometries: sacred geometry of ritual space, architecture and city landscape in Kandy, Sri Lanka," vol. 249, no. 2, pp. 153–165, 2020, https://doi.org/10.2495/SC200131.
[38] F. Erikha, “Konsep lanskap linguistik pada papan nama jalan kerajaan (Râjamârga): studi kasus di kota Yogyakarta,” *Paradig. J. Kaji. Budaya*, vol. 08, no. 1, p. 38-52, 2018, https://doi.org/10.17510/paradigma.v8i1.231.
[39] N. N. Khoiriyah and A. D. Savitri, “Lanskap linguistik stasiun jatinegara Jakarta Timur,” *Bapala*, vol. 08, no. 3, pp. 177—193, 2021.
[40] K. B. Kuchkarovich, U. F. Bakhtiyarullaevich, and N. U. T. O'g'li, "The use of gabions in the landscape design of highways and city streets,” *Am. J. Technol. Appl. Sci.*, vol. 11, no. 1, pp. 11-17, 2023.
[41] J. Liu and M. Zhang, “The evolution and impacts of ‘complexity notions’ in landscape architecture,” *Landsc. Res.*, vol. 48, no. 6, pp. 793–810, 2023, https://doi.org/10.1080/01426397.2023.2198763.
[42] S. Sahril, S. Z. Harahap, and A. B. Hermanto, “Lanskap linguistik kota Medan: kajian onomastika, semiotika, dan spasial,” *Medan Makna J. Ilmu Kebahasaan dan Kesastraan*, vol. 17, no. 2, pp. 195-208, 2019, https://doi.org/10.26499/mm.v17i2.2141.
[43] G. Widiyanto, “Lanskap Linguistik di Museum Radya Pustaka Surakarta,” *Pros. Semin. Nas. Linguist. dan Sastra*, vol. 1, no. 1, pp. 255–262, 2019.
[44] B. Wulandari and I. Rosidah, “Reconstructing the icon of kota santri through language used in public places: a linguistic landscape in Pasuruan city,” vol. 612, no. 1, pp. 33-40, 2021, https://doi.org/10.2991/assehr.k.211212.007.
[45] E. Suazo-Flores, H. Alyami, W. S. Walker, M. Aqazade, and S. E. Kastberg, “A

call for exploring mathematics education researchers' interdisciplinary research practices," *Math. Educ. Res. J.*, vol. 35, no. 1, pp. 23–32, 2021, https://doi.org/10.1007/s13394-021-00371-0.

[46] E. Djara, N. Peni, and M. T. S. Wondo, "Eksplorasi etnomatematika ngadhu dan bhaga dalam kaitannya dengan pembelajaran matematika pada masyarakat desa Ubedolumolo kabupaten Ngada," *Jupika J. Pendidik. Mat.*, vol. 4, no. 1, pp. 92–107, 2021, https://doi.org/10.37478/jupika.v4i1.846.

[47] Y. Ba'ru and C. Ranteallo, "Penerapan konsep stewart dalam membantu tukang bangunan menentukan panjang balok siku," *J. Kegur. dan Ilmu Pendidik.*, vol. 8, no. 2, pp. 67–72, 2019.

[48] Y. Carrero, *Through The Eyes of The First Landscape Mathematician*. USA : Nasa, 2020.

[49] M. G. Astriandini and Y. D. Kristanto, "Kajian etnomatematika pola batik keraton Surakarta melalui analisis simetri," *Mosharafa J. Pendidik. Mat.*, vol. 10, no. 1, pp. 13–24, 2021, https://doi.org/10.31980/mosharafa.v10i1.831.

[50] K. P. Wicaksono, S. Y. Tyasmoro, P. N. Permanasari, A. Saitama, and Y. M. Adisurya, *Lanskap dan Ekologi Pantai*. Malang : UB Press, 2022.

[51] J. Soebagyo and F. I. Luthfiyyah, "Ethnomathematics exploration of the great mosque of al-barkah, Bekasi city, through the learning of geometry and transformational geometry," *Indones. J. Sci. Math. Educ.*, vol. 6, no. 2, pp. 152–164, 2023, https://doi.org/10.24042/ijsme.v6i2.17179.

[52] S. D. Sastrapradja, *Memupuk Kehidupan di Nusantara: Memanfaatkan Keanekaragaman Indonesia*. Jakarta: Yayasan Pustaka Obor Indonesia, 2010.