Education, Social Sciences, and Linguistics: Conference Series
https://journal.ummat.ac.id/index.php/ecs
Vol. 2 No. 3, October 2026, pp. 241-248

Designing Contextual Mathematical Tasks Through Ethnomathematical Exploration of Sonobudoyo Museum Collections in Yogyakarta

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Keywords:
Contextual Mathematical' Tasks,
Cultural Heritage,
Ethnomathematics,
Sonobudoyo Museum

ABSTRACT

Abstract: Mathematics is often perceived by students as an abstract discipline disconnected from their daily experiences and cultural environments. Ethnomathematics offers an approach to connect mathematical concepts with cultural contexts by revealing mathematical ideas embedded in cultural artifacts. However, previous studies have largely focused on exploring mathematical elements within cultural objects, while the transformation of these findings into contextual mathematical tasks for teachers remains limited. Therefore, this study aims to design contextual mathematical tasks through ethnomathematical exploration of Sonobudoyo Museum collections in Yogyakarta. This study employs a qualitative exploratory approach using an ethnomathematical perspective. Data will be collected through observation, documentation, and analysis of selected museum collections. The identified mathematical ideas will be transformed into contextual mathematical tasks and presented through *Google Forms* as a digital platform to support teachers in developing culturally meaningful mathematics learning activities. This study contributes to mathematics education by extending ethnomathematical research beyond cultural exploration toward the design of contextual mathematical tasks. It highlights the potential of museum collections as meaningful resources for connecting mathematics learning with cultural heritage.

Kata Kunci:

Tugas Matematika,
Kontekstual,
Warisan Budaya'
Etnomatematika,
Museum Sonobudoyo

Abstrak*: Matematika sering dipandang oleh siswa sebagai disiplin ilmu yang abstrak dan terlepas dari pengalaman sehari-hari serta lingkungan budaya mereka. Etnomatematika menawarkan pendekatan untuk menghubungkan konsep-konsep matematika dengan konteks budaya dengan mengungkap gagasan-gagasan matematika yang tertanam dalam artefak budaya. Namun, penelitian sebelumnya sebagian besar berfokus pada eksplorasi unsur-unsur matematika dalam objek budaya, sementara transformasi temuan-temuan tersebut menjadi tugas-tugas matematika kontekstual bagi guru masih terbatas. Oleh karena itu, penelitian ini bertujuan untuk merancang tugas-tugas matematika kontekstual melalui eksplorasi etnomatematika terhadap koleksi Museum Sonobudoyo di Yogyakarta. Penelitian ini menggunakan pendekatan kualitatif eksploratif dengan perspektif etnomatematika. Data akan dikumpulkan melalui observasi, dokumentasi, dan analisis terhadap koleksi museum yang dipilih. Ide-ide matematika yang diidentifikasi akan diubah menjadi tugas-tugas matematika kontekstual dan disajikan melalui Google Forms sebagai platform digital untuk mendukung guru dalam mengembangkan kegiatan pembelajaran matematika yang bermakna secara budaya. Penelitian ini berkontribusi pada pendidikan matematika dengan memperluas penelitian etnomatematika melampaui eksplorasi budaya menuju perancangan tugas-tugas matematika kontekstual. Penelitian ini menyoroti potensi koleksi museum sebagai sumber daya yang bermakna untuk menghubungkan pembelajaran matematika dengan warisan budaya.*

Article History:

Received : 01-05-2026
Accepted : 30-06-2026

A. INTRODUCTION

Mathematics is frequently perceived by students as an abstract discipline consisting of symbols, formulas, and procedures that are separated from their everyday experiences (Andriatna et al., 2025; Li & Schoenfeld, 2019). This perception may emerge when mathematical concepts are presented predominantly through formal representations without sufficient connection to real-life situations. The lack of meaningful contexts in mathematics learning can influence students' understanding of mathematical ideas and reduce their ability to recognize the relevance of mathematics beyond the classroom (Setyawan et al., 2026). Developing learning experiences that connect school mathematics with students' social and cultural environments is therefore essential to promote more meaningful and contextual mathematics learning.

Culture provides valuable resources for creating contextual mathematics learning environments because mathematical ideas are often embedded within human activities, traditions, and cultural artifacts (Labuem et al., 2025). Ethnomathematics offers a perspective that recognizes mathematics as a form of knowledge developed within specific cultural contexts and social practices (Nugraha & Nugraha, 2024). D'Ambrosio (1985) explained that ethnomathematics serves as a bridge between cultural historians, and mathematicians to understand how differences in ways of thinking within a culture can give rise to different forms of mathematics. Ethnomathematics studies the relationship between mathematical concepts and the cultural activities of a society (Orey & Rosa, 2008; Rosa & Orey, 2011, 2021). Various cultural objects, such as traditional architecture, handicrafts, textiles, and historical artifacts, contain mathematical elements related to patterns, geometry, measurement, symmetry, and spatial relationships. The integration of these cultural resources into mathematics education enables students to understand mathematics as a meaningful human activity rather than merely an abstract academic subject.

Ethnomathematical studies have increasingly explored mathematical ideas embedded in various cultural practices and artifacts (Loviana et al., 2026; Setianingsih et al., 2026). These studies have contributed to revealing the existence of mathematical concepts within cultural objects and demonstrating the relationship between cultural knowledge and school mathematics. However, many previous studies have primarily focused on identifying and describing mathematical elements without further developing these findings into structured learning activities. Research conducted by Fathimah et al. (2025) conducted the exploration of ethnomathematics in Kasepuhan palace architecture. Further research conducted by Fuadin & Jamous (2025) revealed the ethnomathematics exploration in batu tulis site in Cipaku village Purbalingga. The transformation of ethnomathematical exploration results into contextual mathematical tasks that can be practically utilized in mathematics learning remains an important area that requires further investigation.

Museums represent potential learning environments that provide authentic cultural resources for developing mathematics learning activities. Museum collections consist of tangible cultural artifacts that preserve historical knowledge, artistic expressions, technological developments, and social values of communities. From an ethnomathematical perspective, these artifacts can be analyzed to identify mathematical structures in symmetry. The utilization of museum collections in mathematics education may create opportunities for students to engage with authentic objects while exploring mathematical concepts through meaningful cultural contexts.

Sonobudoyo Museum in Yogyakarta represents one of the cultural institutions that preserves diverse Javanese cultural collections with significant educational potential. The museum houses various artifacts that reflect cultural expressions through visual patterns, structural arrangements, and artistic designs that may contain mathematical ideas. These collections provide opportunities to develop mathematics learning resources by connecting cultural heritage with mathematical concepts taught in schools. The exploration of Sonobudoyo Museum collections can therefore contribute to the development of contextual mathematics tasks that integrate local cultural knowledge into formal mathematics learning.

The designing of contextual mathematical tasks requires a systematic process that transforms cultural exploration into meaningful learning activities (Fredy et al., 2026). This process involves identifying mathematical ideas within selected museum collections, interpreting their mathematical characteristics, connecting them with relevant school mathematics concepts, and designing tasks that encourage students to investigate and reason mathematically. The designed tasks in this study are presented through *Google Forms* as a digital platform that enables accessible organization and distribution of culturally contextualized mathematics learning resources. This approach extends ethnomathematical research beyond cultural identification by emphasizing the pedagogical transformation of cultural knowledge into mathematics learning materials.

This study aims to design contextual mathematical tasks through ethnomathematical exploration of Sonobudoyo Museum collections in Yogyakarta. The study contributes to mathematics education by demonstrating how museum artifacts can be transformed into meaningful mathematical learning resources that connect cultural heritage with school mathematics. The novelty of this research lies in shifting the focus of ethnomathematical studies from identifying mathematical elements in cultural objects toward designing structured mathematical tasks that support contextual learning. The findings are expected to provide insights for researchers and mathematics educators in developing culturally responsive learning activities that enhance the relationship between mathematics, culture, and digital learning environments.

B. RESEARCH METHOD

This study employed a qualitative exploratory research approach using an ethnomathematical perspective to investigate mathematical ideas embedded in cultural artifacts (Lim, 2025). The qualitative approach was selected because the study focused on interpreting cultural objects, identifying mathematical characteristics, and understanding the relationship between cultural practices and mathematical concepts. The ethnomathematical perspective guided the exploration process by considering cultural artifacts as representations of mathematical knowledge developed within specific social and historical contexts.

The research was conducted through several stages, including cultural exploration, mathematical identification, conceptual mapping, and the design of contextual mathematical tasks. This research design was intended to extend ethnomathematical studies from the stage of identifying mathematical elements toward the development of educational resources for mathematics learning. The final outcome of the research was a set of contextual mathematical tasks developed from selected collections of Sonobudoyo Museum in Yogyakarta and presented through a digital platform.

1. Data Collection and Ethnomathematical Exploration

The data collection process focused on selected collections from Sonobudoyo Museum in Yogyakarta that represented cultural artifacts with potential mathematical characteristics. Data were obtained through direct observation, photographic documentation, and detailed examination of artifact features in symmetry. The selection of artifacts was based on their relevance to mathematical concepts commonly taught in school mathematics.

The ethnomathematical exploration involved analyzing how mathematical ideas were manifested within the visual and structural characteristics of museum collections. Each selected artifact was examined to identify observable mathematical features and their relationships with cultural meanings. The exploration process emphasized understanding artifacts not only as physical objects but also as cultural representations containing embedded mathematical knowledge.

2. Identification and Analysis of Mathematical Ideas

The identified mathematical elements from museum collections were analyzed through an ethnomathematical interpretation process to determine their connection with formal mathematical concepts. The analysis involved examining transformation geometry especially in symmetry represented in the selected artifacts. The identified mathematical ideas were then categorized according to their relevance to school mathematics topics.

The results of the mathematical analysis were mapped to appropriate curriculum-related concepts to ensure their pedagogical relevance. This mapping process aimed to establish connections between cultural artifacts and mathematical learning objectives that can be addressed through classroom activities. The analyzed mathematical ideas became the foundation for developing contextual mathematical tasks that integrate cultural contexts with formal mathematical reasoning.

3. Design of Contextual Mathematical Tasks

The design process transformed the identified mathematical ideas from Sonobudoyo Museum collections into contextual mathematical tasks that could support meaningful mathematics learning experiences. The task development considered the relationship between artifact characteristics, mathematical concepts, learning objectives, and students' opportunities to engage in mathematical reasoning. Each task was designed to encourage students to explore, analyze, and solve mathematical problems within authentic cultural contexts.

The developed contextual mathematical tasks were organized and presented using Google Forms as a digital platform to facilitate accessibility and structured presentation. The platform was utilized to integrate artifact images, contextual descriptions, and mathematical questions into a coherent learning resource. The

final products represented the integration of ethnomathematical exploration, curriculum alignment, and digital learning support for culturally contextualized mathematics education.

C. RESULTS AND DISCUSSION

1. Results

The ethnomathematical exploration of three selected Sonobudoyo Museum collections revealed symmetry concepts that can be transformed into contextual mathematical tasks for mathematics tasks.

a. Symmetry Concept in Batik Cloth Pattern

The first selected artifact from Sonobudoyo Museum is a traditional batik cloth that contains visual patterns with mathematical characteristics, particularly related to symmetry. The arrangement of motifs, repetition of patterns, and balanced composition on the fabric demonstrate the application of geometric principles that can be explored in mathematics tasks contexts. Figure 1 presents the observed batik cloth artifact used as the basis for identifying symmetry concepts.

Figure 1. Batik Cloth Collection from Sonobudoyo Museum

The batik pattern illustrates the presence of symmetry through the organization of its motifs. The repeated arrangement of decorative elements creates a structured visual pattern that can be analyzed using transformation geometry, particularly reflection symmetry and rotational symmetry. These characteristics provide an opportunity to connect traditional cultural artifacts with formal mathematical concepts in school mathematics.

b. Symmetry Concept in Traditional Mask

The second selected artifact from Sonobudoyo Museum is a traditional mask that represents another cultural object containing mathematical ideas, particularly the concept of symmetry. The facial structure of the mask shows a balanced arrangement of visual elements, such as the position of the eyes, eyebrows, nose, and mouth, which are arranged proportionally between the left and right sides. These characteristics indicate the presence of reflection symmetry that can be explored through geometric analysis in mathematics learning. Figure 2 presents the traditional mask artifact observed from the Sonobudoyo Museum collection.

Figure 2. Traditional Mask Collection from Sonobudoyo Museum

The mask demonstrates reflection symmetry, where one side of the facial structure resembles the other side when divided by an imaginary vertical line through the center of the face. This symmetry concept can be connected to the mathematical idea of line symmetry, where an object can be divided into two congruent parts that mirror each other. Through this artifact, students can recognize that symmetry is not only found in geometric figures but also appears in cultural objects created through artistic and traditional processes.

c. Symmetry Concept in Circular Wooden Ornament

The third selected artifact from Sonobudoyo Museum is a circular wooden ornament that displays geometric arrangements through its carved decorative patterns. The circular shape and the distribution of floral motifs around the center demonstrate mathematical characteristics related to symmetry, particularly rotational symmetry. Figure 3 presents the wooden ornament artifact observed from the Sonobudoyo Museum collection.

Figure 3. Circular Wooden Ornament Collection from Sonobudoyo Museum

The ornament exhibits rotational symmetry through the repeated arrangement of its carved elements around a central point. Each decorative component is positioned at a similar angular interval, creating a balanced pattern when the object is rotated by certain degrees. This characteristic reflects the mathematical concept of rotational symmetry, where a shape appears identical after undergoing rotation less than 360°. The exploration of this artifact provides an opportunity to introduce students to symmetry concepts through a cultural context, showing that geometric principles are embedded in traditional artistic designs.

Based on the identified symmetry concepts within Sonobudoyo Museum collections, the ethnomathematical findings were further transformed into contextual mathematical tasks designed to support mathematics learning. These tasks integrate cultural artifacts as learning contexts and encourage students to explore mathematical ideas through meaningful problems related to symmetry. Figure 4 presents an example of the developed contextual mathematical tasks based on the explored artifacts.

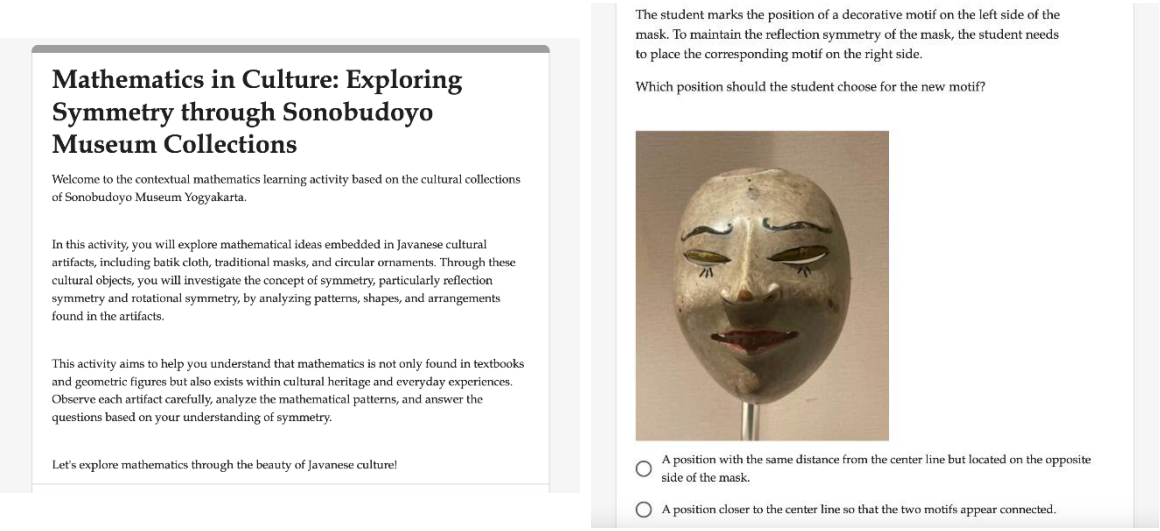

Figure 4. Example of Contextual Mathematical Tasks Developed from Sonobudoyo Museum Collections

The developed tasks are presented through *Google Forms* as a digital learning resource that combines artifact images, contextual information, and mathematical questions. The complete version of the contextual mathematical tasks can be accessed through the link: https://forms.gle/zPbZvKUnBGJb6P1c7.

2. Discussion

The findings of this study reveal that symmetry concepts are embedded in various cultural collections of Sonobudoyo Museum, including batik cloth, traditional masks, and circular ornaments. The identification of reflection symmetry and rotational symmetry in these artifacts indicates that mathematical ideas are closely connected with cultural practices through the arrangement of patterns, balance, repetition, and spatial organization. This finding supports the ethnomathematical perspective proposed by D'Ambrosio (1985), which emphasizes that mathematical knowledge develops within specific cultural contexts and human activities. Similar findings were reported by Fathimah et al. (2025), who demonstrated that cultural artifacts can contain mathematical concepts that are relevant to school mathematics tasks. Furthermore, Fuadin & Jamous (2025) identified geometric transformation concepts, including reflection and rotation, in cultural artifacts at the Batu Tulis Site in Cipaku Village, showing that traditional objects contain mathematical structures formed through systematic design processes. These similarities indicate that symmetry is not merely a formal mathematical concept but also a principle embedded in cultural creativity and traditional craftsmanship.

The findings further demonstrate that symmetry within cultural artifacts represents a form of mathematical reasoning applied in everyday cultural practices. The balanced composition of batik motifs, the proportional arrangement of facial elements in traditional masks, and the circular organization of decorative elements reflect the use of mathematical principles related to transformation, balance, and spatial relationships. This interpretation is consistent with previous ethnomathematical studies that highlight how communities apply mathematical ideas through designing, constructing, and arranging cultural objects. Fuadin & Jamous (2025) explained that cultural artifacts involve mathematical activities such as designing and measuring, where geometric concepts emerge through the process of creating meaningful cultural products. Similarly, Fathimah et al. (2025) emphasized the importance of exploring cultural objects as sources of mathematical knowledge, demonstrating that local heritage can provide meaningful contexts for understanding mathematical concepts.

Therefore, the symmetry identified in Sonobudoyo Museum collections strengthens the argument that mathematics exists as an integral part of cultural expressions rather than being separated from real-life experiences.

Furthermore, this study contributes to the development of ethnomathematics-based mathematics tasks by extending previous research from the stage of identifying mathematical concepts within cultural objects toward the development of contextual mathematical tasks. Previous ethnomathematical studies have mainly focused on exploring and describing mathematical ideas embedded in cultural artifacts (Fathimah et al., 2025; Fuadin & Jamous, 2025). However, the transformation of these mathematical findings into structured learning resources remains an important area for further development. Therefore, the integration of Sonobudoyo Museum collections in this study provides an opportunity to connect cultural heritage with formal mathematics tasks, particularly in the topic of symmetry and geometric transformations. This approach enables students to understand abstract mathematical concepts through authentic cultural contexts, positioning museum collections not only as cultural preservation objects but also as meaningful resources for contextual mathematics tasks.

D. CONCLUSION AND SUGGESTIONS

This study demonstrates that Sonobudoyo Museum collections provide meaningful contexts for exploring mathematical concepts embedded within cultural artifacts. Through an ethnomathematical perspective, three selected artifacts, namely batik cloth, traditional masks, and circular ornaments, were identified as containing symmetry concepts, including reflection symmetry and rotational symmetry. These findings highlight that mathematical ideas are not only found in formal mathematical representations but are also embedded in cultural practices through patterns, balance, repetition, and spatial arrangements. Furthermore, this study extends previous ethnomathematical research by moving beyond the identification of mathematical elements in cultural objects toward the development of contextual mathematical tasks that connect cultural heritage with school mathematics learning. The integration of museum collections into mathematics education provides opportunities for students to understand abstract concepts, particularly symmetry and geometric transformations, through authentic and meaningful cultural contexts.

Despite its contributions, this study has several limitations. First, the exploration was limited to a small number of selected collections from Sonobudoyo Museum, focusing primarily on artifacts containing symmetry-related mathematical concepts. Therefore, the findings do not represent the entire range of mathematical ideas that may exist within the museum's broader collections. Second, this study focused on the identification and design of contextual mathematical tasks based on ethnomathematical exploration but did not examine the implementation of these tasks in actual classroom settings or evaluate their impact on students' mathematical understanding and learning experiences.

Future research is recommended to expand the exploration to a wider variety of museum collections and investigate other mathematical concepts beyond symmetry, such as measurement, spatial geometry, patterns, and transformations. Further studies may also examine the implementation of the developed contextual mathematical tasks in mathematics classrooms to evaluate their effectiveness in improving students' conceptual understanding, mathematical reasoning, and appreciation of cultural heritage. In addition, future research could explore the development of digital-based ethnomathematics learning resources to enhance accessibility and support culturally responsive mathematics education.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the management of Sonobudoyo Museum Yogyakarta for providing access to the cultural collections used in this research. The authors also acknowledge the support and contributions of all parties who assisted in the process of cultural exploration, documentation, and the development of contextual mathematical tasks. Their support and cooperation contributed significantly to the completion of this study.

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