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Ethnomathematical Exploration of the Yowa from Puncak Jaya as a Context for Learning Patterns and Relationships: A Study for Primary School Teacher Education Students at Universitas Satya Wiyata Mandala

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ABSTRACT

This study aims to explore the potential of Yowa an artifact characteristic of the Puncak Jaya region from an ethnomathematical perspective, identify its connections to concepts of patterns and relationships, and describe its application as a learning context for primary school teacher education students. The study employs a qualitative approach with an ethnomathematical design. The participants consisted of 48 students from the Primary School Teacher Education program at Satya Wiyata Mandala University. Data were collected through observation, interviews, documentation, and student learning activities, and subsequently analyzed via data condensation, data display, and the drawing and verification of conclusions. The findings indicate that the visual characteristics of Yowa including variations in color, shape, size, arrangement, and the positioning of its components can be linked to mathematical concepts such as classification, comparison, sequencing, and mathematical relationships. In the documented segments, the positional relationship is represented as B–A–B, where an elongated yellow-orange component is situated between two round, black components; however, a consistent repeating pattern across the entire structure has yet to be definitively established. This exploration provides a foundation for designing learning activities such as grouping, counting, comparing, representing sequences, and identifying patterns once the regularities have been verified. The study concludes that Yowa has the potential to serve as a context for local culture-based numeracy instruction for prospective primary school teachers. Nevertheless, its effectiveness in enhancing numeracy skills remains inconclusive and requires further instructional testing and evaluation of learning outcomes.

ABSTRAK

Penelitian ini bertujuan untuk mengeksplorasi potensi etnomatematika Yowa, artefak budaya khas wilayah Puncak Jaya, mengidentifikasi keterkaitannya dengan konsep pola dan hubungan, serta mendeskripsikan pemanfaatannya sebagai konteks pembelajaran bagi mahasiswa Pendidikan Guru Sekolah Dasar. Penelitian ini menggunakan pendekatan kualitatif dengan desain etnomatematika. Partisipan penelitian adalah 48 mahasiswa Program Studi Pendidikan Guru

Sekolah Dasar Universitas Satya Wiyata Mandala. Data dikumpulkan melalui observasi, wawancara, dokumentasi, dan aktivitas belajar mahasiswa, kemudian dianalisis melalui kondensasi data, penyajian data, serta penarikan dan verifikasi kesimpulan. Hasil penelitian menunjukkan bahwa karakteristik visual Yowa, meliputi variasi warna, bentuk, ukuran, susunan, dan posisi komponennya, dapat dikaitkan dengan klasifikasi, perbandingan, pengurutan, dan hubungan matematis. Pada bagian yang terdokumentasi, hubungan posisi direpresentasikan sebagai B–A–B, yaitu komponen lonjong berwarna kuning-oranye berada di antara dua komponen bulat berwarna hitam; namun, pola berulang yang konsisten pada keseluruhan untaian belum dapat dipastikan. Eksplorasi ini memberikan landasan untuk merancang aktivitas pembelajaran seperti mengelompokkan, membilang, membandingkan, merepresentasikan urutan, dan mengidentifikasi pola setelah keteraturannya terverifikasi. Penelitian ini menyimpulkan bahwa Yowa berpotensi menjadi konteks pembelajaran numerasi berbasis budaya lokal bagi calon guru sekolah dasar, meskipun efektivitasnya dalam meningkatkan kemampuan numerasi masih memerlukan uji coba pembelajaran dan evaluasi hasil belajar lebih lanjut.

INTRODUCTION

Numeracy is the ability to use mathematical concepts, representations, and reasoning to understand and solve problems across various life contexts. Developing this ability requires an approach to learning that goes beyond a mere focus on calculation procedures; it must also provide pre-service teachers with opportunities to connect mathematical concepts to real-world situations. In this context, ethnomathematics offers a perspective for exploring the relationship between mathematics and the cultural practices of a society. Research by Ismiasih and Hermanto (2025) discusses the relevance of ethnomathematics in mathematics education, while a meta-analysis by Pratama and Yelken (2024) indicates that ethnomathematics-based instruction has the potential to support mathematical literacy. These findings provide a foundation for exploring cultural artifacts as a source of context for mathematics learning.

Ethnomathematical research in Indonesia has identified various mathematical concepts embedded within cultural artifacts and practices, including those of the indigenous peoples of Papua. For instance, Fauzi et al. (2022) explored the mathematical ideas and educational values inherent in the traditional architecture of the Sasak people. In the context of Papua, Marlissa et al. (2024) examined the patterns found among indigenous Papuan communities through an ethnomathematical lens, while Wardoyo and Gomes (2024) investigated the mathematical concepts present in the Honai the traditional dwelling of the Dani tribe and their implications for the design of mathematics instruction. These studies demonstrate that cultural artifacts can serve as a starting point for identifying mathematical structures and linking them to the learning process. However, because different cultural objects possess distinct characteristics and contexts of use, each requires its own specific exploration before its mathematical potential can be determined.

Research on the cultures of the Papuan highlands also provides a relevant foundation for developing mathematics instruction based on local culture. Sabon and Telussa (2024) discuss an ethnomathematics-based instructional design rooted in the cultures of the Papuan highlands, aimed at fostering student engagement and meaningful learning. Meanwhile, Maryati et al. (2025) explore ethnomathematics as manifested in the traditional houses of Papuan communities. Although these studies broaden the understanding of the mathematical potential inherent in Papuan cultures, their specific subjects and research foci differ from those of the present study. Based on the references reviewed in this manuscript, there is no existing discussion specifically addressing the

Yowa a cultural element unique to the Puncak Jaya region that explicitly links its structural artifacts to the study of patterns and relationships for primary teacher education (PGSD) students. This observation points to a gap in the current body of literature, which warrants further confirmation through a more systematic literature search.

The Yowa a traditional object from Puncak Jaya serves as a relevant subject for exploration, as it can be viewed as a cultural artifact possessing a specific arrangement of components and distinct visual characteristics. Features such as shape, color, size, sequence, and potential repetition can serve as a starting point for identifying mathematical regularities. However, the mere presence of these visual characteristics does not automatically confirm the existence of a specific mathematical pattern. Identifying mathematical concepts requires careful observation of the artifact, examination of documentation, and insights from cultural informants who understand its meaning and usage. Consequently, any exploration of the Yowa must simultaneously account for two aspects: the accuracy of the mathematical interpretation and respect for the cultural significance inherent in the artifact.

The mathematical focus of this research lies in patterns and relationships. Patterns pertain to regularities or the repetition of elements, while relationships concern the connections between elements that can be observed, compared, and represented mathematically. Both aspects enable students to identify pattern units, explain rules of repetition, compare arrangements, predict subsequent elements, and communicate mathematical reasoning. Research by Latifa et al. (2024) on the development of numeracy-based worksheets incorporating sociocultural contexts specifically regarding number patterns demonstrates the relevance of cultural context in designing learning activities. However, applying such a context to Yowa requires a distinct process of identification and interpretation, ensuring that the developed activities are genuinely derived from the observed structures of the artifacts, rather than from unverified assumptions about the patterns themselves.

In addition to identifying the mathematical potential of Yowa, this study positions students from the Primary School Teacher Education (PGSD) program at Satya Wiyata Mandala University as the agents who explore and translate cultural findings into learning activities. Prospective teachers must possess the ability to select relevant contexts, connect them to mathematical concepts, and design activities that align with the learning objectives for primary education. In their research on ethnomathematics-based instruction, Payadnya et al. (2024) discuss the significance of integrating culture into mathematics education from the perspectives of educators in Indonesia and Thailand. Similarly, Sabon and Telussa (2024) utilize the culture of the Papuan highlands as a foundation for developing instructional designs. This study expands upon this focus by examining how the characteristics of Yowa can be translated into learning activities centered on patterns and relationships by PGSD students.

The research gap here does not lie solely in the use of Yowa as an object distinct from other cultural artifacts. The intended contribution encompasses three interrelated aspects: identifying the mathematically relevant characteristics of Yowa, interpreting these characteristics in terms of patterns and relationships, and translating them into learning activities designed by primary education (PGSD) students. Thus, the new knowledge sought is not merely a description of the mathematical elements present within Yowa, but rather an explanation of the connections between the structure of the cultural artifact, its mathematical representations, and its potential application in an educational setting. To ensure this does not remain a purely conceptual claim, the

contribution must be substantiated through observations, documentation, insights from cultural informants, and the work produced by the students.

Based on the description above, this study aims to explore the ethnomathematical potential of Yowa a cultural element specific to Puncak Jaya to identify its connections to the concepts of patterns and relationships, and to describe its application as a learning context by primary teacher education (PGSD) students at Universitas Satya Wiyata Mandala. The research questions guiding this study are: (1) what characteristics of Yowa can be interpreted mathematically within the context of patterns and relationships; and (2) how are these characteristics translated by the PGSD students into learning activities focused on patterns and relationships? Through these questions, this study is expected to contribute by mapping the mathematical potential of Yowa and providing examples of how local cultural artifacts can be translated into contextual mathematics learning activities.

METHOD

This study employs a qualitative approach with an ethnomathematical research design. This approach was chosen because the research aims to explore, describe, and interpret the mathematical potential inherent in the Yowa a traditional object specific to the Puncak Jaya region and to examine how this potential can be utilized as a context for numeracy instruction, particularly regarding the topics of patterns and relationships. Ethnomathematics allows for a perspective on mathematics that extends beyond formal concepts found in textbooks, viewing it instead as knowledge that emerges and is applied within the daily practices and culture of a community. In this study, the Yowa is treated as a cultural artifact, examined to uncover mathematical elements through its form, arrangement, repetition, sequence, dimensions, proportions, and the relationships between its components.

The research design consists of three primary stages: cultural exploration, identification of mathematical concepts, and pedagogical integration. The cultural exploration stage involves gathering information from relevant cultural sources regarding the meaning, usage, materials, form, and construction methods of the Yowa. The mathematical identification stage entails analyzing the structure of the Yowa to uncover potential patterns and relationships that can be represented mathematically. Subsequently, the pedagogical integration stage involves primary education teacher-training students in developing or simulating numeracy learning activities based on the Yowa context. Through this design, the research goes beyond merely documenting the mathematical elements of the Yowa; it connects these elements to the capacity of pre-service teachers to translate local culture into meaningful contexts for mathematics instruction.

The research subjects consist of 48 students from the Primary Education Teacher Training Program at Satya Wiyata Mandala University who are enrolled in a mathematics course. These students were selected as the primary subjects because the study focuses on assessing the ability of pre-service teachers to identify the mathematical potential within a cultural artifact and integrate it into the teaching of patterns and relationships.

Data collection was conducted through observation, interviews, documentation, and the analysis of the students' learning activities. Observation was employed to directly identify the characteristics of *Yowa*, including its shape, arrangement, color, size, repetition, sequence, grouping, and the relationships between its elements. Observations were also conducted on the students' activities as they examined and analyzed *Yowa*, and as they transformed these cultural findings into numeracy-related tasks. Semi-structured

interviews were held with cultural informants to gather information regarding the history, meaning, function, usage, materials, production process, and any rules or customs associated with *Yowa*. Interviews were also conducted with the students to understand how they perceived the connections between *Yowa*, mathematical concepts, and numeracy learning.

Documentation was used to reinforce the data obtained from observations and interviews; this included photographs of Yowa, field notes, recordings of activities, student work, lesson plans, and records of the process of identifying patterns and relationships. Furthermore, students were provided with Yowa based numeracy exploration worksheets, which guided them to identify pattern units, determine regularities, discover relationships between elements, predict the continuation of patterns, create mathematical representations, and design questions or learning activities for elementary school students. All research instruments were developed based on indicators for ethnomathematical exploration and numeracy skills, specifically concerning patterns and relationships. To enhance data credibility, the study employed triangulation of sources and techniques comparing information gathered from cultural informants, students, observations, interviews, documentation, and student work.

The data were analyzed qualitatively using an interactive analysis model, which encompasses data condensation, data presentation, and the drawing and verification of conclusions. During the data condensation phase, the researcher selected, focused, coded, and categorized the data in alignment with the research focus. Data concerning Yowa are categorized based on cultural characteristics and mathematical potential, while data regarding the students are categorized based on their ability to identify patterns, relationships, and mathematical representations, as well as their capacity for reasoning and integrating cultural contexts into lesson designs. Furthermore, the data are presented through narrative descriptions, tables identifying cultural elements and mathematical concepts, visual documentation, and examples of numeracy activity designs developed by the students.

RESULTS AND DISCUSSION

Results

Identification of the Mathematical Potential of the Yowa from Puncak Jaya

The identification of the mathematical potential of the Yowa a traditional item from Puncak Jaya was conducted by examining visual documentation that captures the overall form of the Yowa, the details of its constituent components, and its use during presentations by primary school teacher education students. Based on this documentation, the Yowa appears as a string of beads featuring yellow-orange and black elements. The components vary in shape and size, consisting of both elongated and spherical beads. In the detailed photographs, an elongated component can be seen positioned between black components, allowing for the visual observation of the spatial relationships between the individual elements.



Figure 1. Yowa typical of Puncak Jaya

These characteristics serve as an initial basis for identifying potential connections between Yowa and mathematical concepts. Differences in color and shape can be used for classification activities, while differences in size can provide a context for comparison. The arrangement of components can also be used to observe sequences and potential repetitions.

Table 1. Identification of Yowa's Visual Characteristics and Mathematical Potential

No	Observed Characteristics	Observation result	Potential of Mathematical Concepts
1	Component color	Yellow-orange and black beads are visible.	Classification and grouping based on color.
2	Component shape	Elongated components and round-shaped components are visible.	Classification of basic shapes and geometry.
3	Component size	Elongated components appear larger than round components.	Size comparison; direct measurement is required to obtain the exact size.
4	Component arrangement	The beads are arranged sequentially to form a chain.	Sequence and positional relationships.
5	Relationships between components	In the detail photo, an elongated component appears to be flanked by black components.	Positional relationship between elements.
6	Possibility of repetition	Some parts of the circuit appear to have a similar arrangement.	Explore recurring patterns once their regularity has been verified.
7	Overall shape	The arrangement forms a circular path or resembles a necklace.	Observation of shapes and spatial relationships.

The table above demonstrates that the mathematical potential of Yowa can be identified through visual characteristics that are directly observable. Activities such as grouping, counting, comparing, and observing positions represent potential introductory tasks that can be developed using these objects. Meanwhile, identifying recurring patterns requires a more thorough examination of the entire sequence to determine the repeating unit and the rules governing its repetition. Consequently, Yowa can be positioned as an object for numeracy exploration rooted in local culture.

Exploration of Mathematical Patterns and Relationships in Yowa

The exploration of mathematical patterns and relationships is conducted by examining the arrangement of Yowa components specifically, the relationship between the elongated yellow-orange beads and the round black beads. Detailed documentation reveals the presence of an elongated component positioned between two black components. This configuration can be analyzed in terms of the positional relationships within the observed section of the strand. Furthermore, the recurrence of similar

component arrangements across various parts may serve as a starting point for investigating the potential existence of repeating patterns.

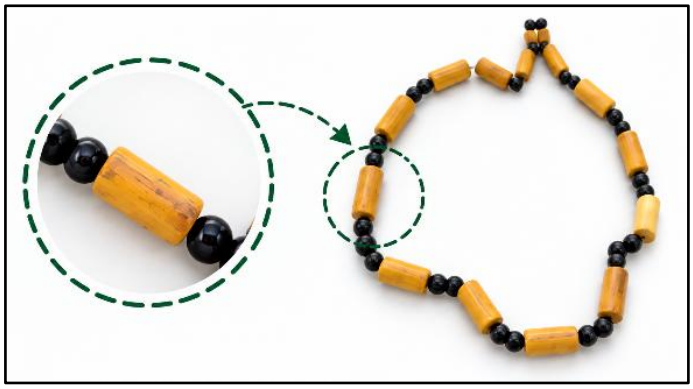


Figure 2. Exploration of Mathematical Patterns and Relationships in Yowa

To facilitate analysis, the elongated, yellow-orange components can be designated as A, while the round, black components can be designated as B. Based on the detailed photograph, the observed local arrangement can be represented as B–A–B. This representation is used to describe the positioning of components within the displayed section; it should not be inferred that the entire Yowa sequence follows the same pattern. Determining the overall pattern would require more comprehensive observations.

Table 2. Preliminary Analysis of Mathematical Patterns and Relationships in Yowa

No.	Analysis Aspects	Observations or Representations	Mathematical Concept	Information
1	Grouping of components	A = elongated component; B = black, round component.	Classification	Symbols are used to facilitate visual analysis.
2	Positional relationship	In the detail photo, component B can be seen on both sides of component A.	Positions and relationships between elements	Limited to the parts visible in the photo.
3	Local sequence	The arrangement of the observed parts can be written as B–A–B.	Order	Does not represent the entire series.
4	Possible repeating pattern	Some parts of the circuit appear to exhibit a similar arrangement.	Repeating pattern	Requires unit verification and repetition rules.
5	Size comparison	Elongated and round components exhibit a visual difference in size.	Size comparison	Numerical measurements are not yet available.
6	Quantitative relationship	Components can be calculated based on categories A and B.	Counting and comparing quantities	The actual figure needs to be obtained through direct calculation.
7	Mathematical representation	The arrangement can be presented using symbols, images, or a sequence table.	Mathematical representation	The final representation must correspond to the observed object.

The initial analysis presented above indicates that mathematical relationships can be explored by grouping components and observing their positions and sequences. If direct observation confirms that a specific unit of arrangement repeats consistently, students can further their analysis by defining the rules of the pattern and predicting

subsequent elements. Conversely, if a repeating rule cannot be established, the analysis can still focus on classification, comparison, quantification, and positional relationships.

This approach is significant in ethnomathematics education because students are not merely tasked with identifying mathematical concepts within cultural objects; they are also required to articulate the basis for their observations and the mathematical reasoning employed. Consequently, the interpretation of Yowa is conducted systematically, avoiding the imposition of patterns that lack supporting evidence.

Utilizing Yowa as a Context for Numeracy Learning



Figure 3. Use of Yowa in Learning

During a classroom learning activity, primary education students presented the Yowa a traditional artifact from Puncak Jaya as an example of local Papuan culture that can serve as a context for numeracy instruction. The students displayed the Yowa to the class, explaining its visual characteristics, such as its shape, color, and size, as well as the arrangement of its yellow-orange and black beads. Through this presentation, the students encouraged their peers to observe and identify the components of the Yowa and connect them to mathematical concepts, including grouping, counting, comparing, sequencing, and patterning. This activity provided a contextual learning experience, helping the students understand that local cultural objects can be utilized as resources for teaching mathematics in primary schools. Beyond introducing Papuan culture, the use of the Yowa also helps train prospective teachers in developing numeracy activities that are concrete, engaging, and relevant to students' daily lives.

Based on Yowa's visual characteristics, several relevant numeracy activities can be developed, including grouping components by shape or color, counting the number of components, comparing quantities or sizes, and identifying sequences and patterns provided that such regularities can be verified. These activities can be tailored to the developmental level of elementary school students and the specific learning objectives intended to be achieved.

Table 3. Examples of Yowa-Based Numeracy Activities for Primary School Learning

No.	Learning Activities	Student Assignment	Numeracy Concept	Expected Products
1	Identifying components	Mentioning the differences in the shapes and colors of Yowa components.	Classification	List of component characteristics.

No.	Learning Activities	Student Assignment	Numeracy Concept	Expected Products
2	Grouping components	Grouping components based on color or shape.	Grouping	Component category table.
3	Calculating components	Counting the number of components in each category.	Numbers and calculation	Record of the number of components.
4	Comparing quantities	Comparing the number of components from two categories.	Quantitative comparison	A comparative statement based on calculation results.
5	Observing the sequence	Record the sequence of components in the selected section of the circuit.	Sequence and relationships	Representation of a sequence using images or symbols.
6	Finding patterns	Determine the unit and the rule of repetition if a consistent pattern is found.	Patterns and relationships	Representation of the pattern and an explanation of its rules.
7	Designing numeracy tasks	Designing a mathematics activity based on the Yowa approach, aligned with primary school learning objectives.	Instructional design	Activity sheet, including objectives and questions.

The table above illustrates how the visual characteristics of Yowa can be translated into numeracy learning activities. Grouping and counting tasks can be developed based on differences in shape and color, while pattern-related activities should be based on verified sequences. Students (in a teacher-training context) may also be asked to explain the rationale behind their choice of activities, define learning objectives, and formulate questions that encourage learners to provide mathematical reasoning.

Synthesis of Findings: Yowa as a Learning Context for Pre-service Teachers

A synthesis of the findings indicates that the Yowa a traditional artifact unique to the Puncak Jaya region holds potential as a context for numeracy instruction, bridging local cultural knowledge with mathematical concepts for pre-service elementary school teachers. Through presentations and explorations of the Yowa, students in elementary education programs are encouraged to adopt the perspective that mathematics learning can be derived from cultural objects deeply embedded in the community's way of life. Utilizing such a context also enables these students to design lessons that are more concrete, contextual, and relevant to the students' own socio-cultural environment. Thus, the Yowa serves not only as a means to introduce Papuan culture but also as a learning resource that supports the development of pre-service teachers' pedagogical competence in integrating local wisdom into mathematics instruction. Further development must ensure accurate mathematical interpretation and a sound understanding of the underlying cultural meanings, so that the integration remains meaningful and academically rigorous.

Table 4. Synthesis of Research Findings on Yowa as a Context for Numeracy Learning

No.	Focus of Findings	Findings
1	Yowa's visual characteristics	The documented Yowa consist of yellow-orange and black beads that vary in shape and size. These characteristics serve as the basis for mathematical observation.
2	Classification and counting potential	Differences in the color and shape of components allow for grouping and counting based on category. The quantity for each category must be determined through direct counting.

No.	Focus of Findings	Findings
3	Potential for a mathematical relationship	The arrangement of components allows for the observation of the sequence and positional relationships among the elements. Interpretation should be based on the clearly visible parts of the configuration.
4	Potential for recurring patterns	Some parts of the sequence appear to have a similar arrangement. The units and the rules governing the pattern need to be verified before they can be declared a mathematical finding.
5	The use of Yowa in student activities	Documentation shows students carrying and presenting Yowa. The content of the students' analysis and learning outcomes still requires additional evidence.
6	Integration of culture and numeracy	Yowa has the potential to connect local cultural contexts with activities involving classification, counting, comparison, as well as patterns and relationships. The quality of its implementation needs to be examined through students' work.
7	Implications for prospective elementary school teachers	The exploration of Yowa can be directed toward training prospective teachers to observe cultural objects, identify mathematical concepts, and design contextual numeracy activities. Its effectiveness cannot be determined from visual documentation alone.

A synthesis of the findings indicates that utilizing Yowa a cultural artifact specific to the Puncak Jaya region in instruction offers primary teacher education students an opportunity to develop an understanding of the connections between local culture and mathematical concepts. The characteristics of Yowa can serve as a starting point for exploring classification, counting, comparison, and the relationships between elements relevant to numeracy education. Through activities such as presentations and the observation of cultural objects, students are able to develop instructional approaches that go beyond a mere focus on mastering mathematical concepts; they also incorporate the sociocultural context as an integral part of the learning experience. This approach is highly relevant for prospective primary school teachers, as it encourages the selection of learning resources rooted in the students' own environment, allowing mathematical concepts to be explored through meaningful, concrete objects.

Furthermore, developing Yowa as a learning context requires students to carefully identify mathematical potential, design appropriate learning activities, and ensure that their interpretations are supported by verifiable evidence. The identification of mathematical patterns and relationships must be grounded in observable regularities, while explanations regarding the meaning and function of Yowa should draw upon information from relevant cultural sources. Thus, the primary contribution of exploring Yowa lies in its potential to strengthen the pedagogical competence of prospective teachers in designing numeracy instruction that is both contextual and respectful of the local wisdom of Papua. Nevertheless, the effectiveness of using Yowa to enhance the numeracy skills of both university students and primary school pupils warrants further research, specifically through the analysis of student work, the implementation of instructional practices, and the evaluation of learning outcomes.

Discussion

Identification of the Mathematical Potential of Yowa from Puncak Jaya

The research results indicate that the Yowa a cultural artifact from Puncak Jaya possesses visual characteristics that can be linked to mathematical concepts, including variations in color, shape, size, arrangement, and the positional relationships between its components. The contrast between yellow-orange and black colors can be utilized for

classification activities, while the elongated and round shapes can serve as a basis for grouping according to geometric characteristics. Differences in visual size also allow for comparison-based activities, although direct measurement would be required for precise results. These findings reinforce the perspective that cultural artifacts can serve as resources for mathematics education, provided that their characteristics are analyzed and systematically connected to mathematical concepts. Research by Ergel (2026) and Suciptaningsih et al. (2026) suggests that local cultural artifacts can be integrated into mathematics lesson designs by pre-service teachers, particularly as a means to connect subject matter with the students' own environment. Similarly, Kabuye Batiibwe (2024) and Handaryani et al. (2026) have identified various cultural practices and artifacts such as handicrafts, textiles, games, and traditional structures that hold potential for use in mathematics instruction. Thus, the contribution of this exploration of the Yowa lies in the initial identification of characteristics within a Papuan cultural artifact that can provide a context for studying classification, comparison, and mathematical relationships. It should be noted, however, that this mathematical potential must be distinguished from the cultural significance of each component, which cannot be determined solely through visual documentation.

Interpretation of mathematical patterns and relationships. A mathematical relationship observable in the Yowa is found in the positioning of an elongated yellow-orange component between two round black components. To facilitate analysis, this relationship is represented as B–A–B, where 'A' denotes the elongated component and 'B' denotes the round black component. While this representation describes an observed local sequence, it does not yet confirm whether the entire Yowa structure follows a consistent, repeating pattern. This distinction is important because identifying mathematical patterns requires evidence of repeating units and the rules that govern their repetition. Findings from Ergel (2026) and Puniawati et al. (2026) emphasize the importance of cultural relevance in mathematics education, ensuring that the concepts taught are connected to the learners' environment and experiences. Meanwhile, Payadnya et al. (2024) and Prahmana et al. (2026) highlight the significance of considering cultural context and pedagogical application when integrating ethnomathematics into instruction. Based on this perspective, Yowa can be used to develop tasks that involve identifying sequences, explaining the positioning of components, and representing arrangements through symbols. If further observation confirms the existence of a repeating pattern, primary teacher education (PGSD) students can design tasks that require learners to extend sequences, identify missing elements, explain the rules of the pattern, and predict subsequent components. If a repeating pattern cannot be verified, instruction can still focus on classification, counting, comparison, and positional relationships, without imposing rules that lack supporting evidence.

Identifying the characteristics of Yowa provides a foundation for primary teacher education students to design numeracy activities that link local cultural objects with elementary level mathematical concepts. Such activities might include grouping beads by color or shape, counting the number of components in each category, comparing quantities or sizes, and representing sequences using images and symbols. Students can also develop activity sheets that outline learning objectives, observation steps, mathematical questions, and explanations regarding the connection between the objects and the concepts being studied. Research by Amos et al. (2020) and Wulandari et al. (2024) suggests that exploring local artifacts can assist pre-service teachers in creating lesson plans that are relevant to the learners' environmental context. Findings from

Andriono (2021). Priyani (2021) also emphasizes the need for an integration of ethnomathematics that takes into account sociocultural contexts and the practical application of instruction. In the context of this study, the primary implication is not that the use of Yowa has been proven to enhance the numeracy skills of university or school students; rather, it is that the characteristics of Yowa offer opportunities to develop instructional designs that are contextual and rooted in the local culture of Papua. Consequently, future research should analyze students' work and test the designed activities through direct instruction with elementary school students, so that the effectiveness of using Yowa can be evaluated based on empirical evidence.

Exploration of Mathematical Patterns and Relationships in Yowa

The research results indicate that the exploration of mathematical patterns and relationships in Yowa can begin by identifying the characteristics of its components, grouping them based on shape and color, and observing the positions and sequences of their constituent elements. Assigning the symbol 'A' to the elongated yellow-orange beads and the symbol 'B' to the round black beads yields a local sequence representation of B–A–B. This representation demonstrates that mathematical relationships can be discerned through the positional regularity of the components, although it is not yet sufficient to confirm the existence of a repeating pattern across the entire Yowa string. These findings align with the work of Serepinah & Nurhasanah (2023) and Fathurrochman et al. (2026), who explain that cultural artifacts from local communities can be examined to uncover connections to mathematical concepts and utilized as learning resources for pre-service teachers. Similarly, Harding (2021) and Adkhiyah et al. (2026) emphasize that ethnomathematics provides opportunities to bridge cultural practices and knowledge with formal mathematics. Thus, Yowa holds potential as a context for mathematical exploration; its visual characteristics can serve as a starting point for primary education (PGSD) students to systematically identify, categorize, and represent the relationships between its elements.

When viewed through the lens of mathematical patterns and relationships, the B–A–B sequence found in the documented portion of the Yowa should be understood as a local arrangement rather than a rule applicable to the entire string. While certain similar-looking sections may offer initial clues for testing the possibility of repetition, the establishment of a definitive pattern must be supported by a comprehensive observation of the component sequences, the repeating units, and the consistency of their arrangement. If direct observation confirms the existence of a regular repetition, students can identify the repeating unit, explain the rules governing its formation, supply missing elements, and predict subsequent ones. Conversely, if no such repetition can be established, the exploration can instead focus on classification, counting, size comparison, and positional relationships. This approach aligns with research by Solihin et al. (2025) and Machaba & Dhlamini (2021), which highlights the importance of ethnomathematics connecting mathematical concepts to cultural contexts while underscoring the need for careful pedagogical consideration in its implementation. Studies by Reyes et al. (2019) and Naqiyah (2026) further demonstrate that the connection between local artifacts and curriculum content can serve as a resource for pre-service teachers when planning mathematics instruction. Therefore, Yowa's analysis must ground the establishment of mathematical concepts in observational evidence, ensuring that mathematical interpretations do not extend beyond what is explicitly demonstrated by the objects themselves.

In the context of teacher education (PGSD), the findings from Yowa's exploration can be developed into activities that foster skills in observing, classifying, counting, comparing, and representing mathematical relationships. For instance, students could be tasked with creating a table to categorize components (e.g., A and B), recording the frequency of each category through direct counting, comparing their size characteristics, and mapping the spatial relationships between components using symbols or sequential diagrams. Once a repeating pattern has been verified, the activity can be extended to identifying the repeating unit and articulating the underlying pattern rules based on the available evidence. Such activities not only emphasize the identification process but also train students to provide mathematical reasoning and distinguish between observed facts and conjectures. Research by Simbolon (2024) further supports this perspective. Asare (2026) emphasizes the relevance of ethnomathematics in connecting mathematical understanding to diverse cultural contexts, while findings from Widada et al. (2019) and Susanti et al. (2025) outline the potential of ethnomathematics to bridge cultural knowledge with formal mathematics education. Based on these studies, Yowa holds potential as a resource for contextual learning in pre-service teacher education specifically for developing activities that explore mathematical patterns and relationships rooted in local culture. However, this potential cannot yet be taken as evidence of improved numeracy skills among students; the effectiveness of such an approach still requires empirical validation through the implementation of activities, analysis of student work, and systematic evaluation of the learning process.

Utilizing Yowa as a Context for Numeracy Learning

The research results indicate that the Yowa a traditional item from Puncak Jaya has the potential to be used as a context for numeracy learning, as its visual characteristics can be linked to concrete mathematical activities. During classroom presentations, primary education (PGSD) students introduced the Yowa by examining its shapes, colors, sizes, and the arrangement of its beads, subsequently connecting these features to concepts such as grouping, counting, comparing, sequencing, and patterning. These findings demonstrate that local cultural objects can serve as a starting point for bridging real-life experiences with formal mathematical concepts. This aligns with the work of Superfine & Pitvorec (2021) and Siregar (2025), who suggest that local cultural artifacts can be integrated into mathematics lesson planning by pre-service teachers. Furthermore, Nur et al. (2020) and Purwosetiyono (2022) highlight the importance of ethnomathematics in connecting mathematical understanding to cultural contexts. Thus, the use of the Yowa not only enriches numeracy learning resources but also helps students in this case, the pre-service teachers realize that mathematics instruction can be developed using objects closely tied to the learners' social and cultural environment.

The characteristics of the Yowa can be translated into a sequence of numeracy activities tailored to specific learning objectives and the developmental stages of primary school students. Students might be asked to identify differences in shapes and colors, categorize components based on specific criteria, count the number of items in each group, and compare these counts. Additionally, students can represent sequences of components using drawings or symbols. Activities focused on identifying patterns can be introduced once thorough observation has revealed consistent units and rules of repetition. This gradual development of activities ensures that students do not merely observe the objects, but also process information, present their findings, and articulate the underlying mathematical reasoning. Research by Habsyi et al. (2025) and Ismiasih & Hermanto (2025) explains that the connection between local artifacts and curriculum

content can be leveraged to design mathematics learning activities that are relevant to the students' environment. Meanwhile, Sulistyani et al. (2019) and Andriono (2021) outline the role of ethnomathematics in bridging cultural knowledge with formal mathematics. Based on these studies, Yowa can be developed as a resource for contextual numeracy activities, while ensuring that every concept taught aligns with the characteristics of the objects and is supported by observational findings.

Synthesis of Findings: Yowa as a Learning Context for Pre-service Teachers

The synthesis of the research findings indicates that Yowa a traditional item from Puncak Jaya has the potential to serve as a context for numeracy learning, bridging local culture with mathematical concepts for pre-service elementary school teachers. The visual characteristics of Yowa, such as the variations in the color, shape, and size of its beads, provide a foundation for exploring classification, counting, comparison, and the positional or sequential relationships between components. This potential offers pre-service elementary education students the opportunity to understand that mathematical concepts are not learned solely through symbols and textbook examples; rather, they can also be examined through objects found in the daily lives of the community. These findings align with the work of Siregar et al. (2024) and Asmara & Ellis (2026), which suggest that local cultural artifacts can be utilized by pre-service teachers as resources for designing mathematics instruction that is relevant to the students' own environment. Furthermore, research by Rudyanto et al. (2019) and Sape & Syamsuddin (2025) explains that various cultural activities and artifacts contain mathematical concepts that can be leveraged for both instruction and assessment. Thus, Yowa holds pedagogical potential as a link between local cultural experience and numeracy learning though any identified mathematical concept must be grounded in sufficient observational evidence.

From the perspective of developing pre-service teacher competencies, the exploration and presentation of Yowa provide a context for students to practice identifying the mathematical potential within a cultural object and translating it into structured learning activities. Students can design tasks involving classification based on color or shape, counting the number of components, comparing the results of such counts, and representing positional relationships through images and symbols. Meanwhile, the development of tasks concerning repeating patterns should only be undertaken once the repeating unit and the rules of repetition have been verified through observation of the entire sequence. This process is significant because the competence of prospective teachers involves not only the mastery of mathematical concepts but also the ability to appropriately select contexts, formulate questions, and provide logical mathematical justifications. Research by Mendrofa et al. (2024) and Rahmawati (2025) indicates that an understanding of local artifacts can assist prospective teachers in developing lesson plans that are relevant to the students' own environments. Similarly, Brown et al. (2019) and Lekitoo et al. (2024) emphasize the importance of integrating cultural contexts into mathematics instruction through strategies that account for cultural characteristics and their practical application in the classroom. Consequently, the exploration of Yowa can serve as a learning experience for primary education (PGSD) students, enabling them to develop numeracy-focused lesson designs that are contextual, structured, and aligned with the learning objectives of primary schools. In this regard, the primary contribution of this study lies in identifying the potential of Yowa as a context for numeracy instruction and as a resource for prospective teachers to develop their own lesson plans. Further research is required to test the implementation of these designs in actual classroom

settings, evaluate the quality of the students' work, and assess the impact on primary school students' mathematical understanding.

CONCLUSION AND SUGGESTION

The primary finding of this study is that the Yowa a traditional artifact from Puncak Jaya possesses visual characteristics that can be identified and represented through mathematical concepts, including classification, size comparison, sequencing, and the positional relationships between components; this is particularly relevant to the study of patterns and relationships for primary education (PGSD) students. Observations reveal the presence of yellow-orange and black beads some elongated and others round arranged in a local "B–A–B" sequence, where an elongated component is positioned between two round, black components. These findings suggest that the Yowa can serve as a context for numeracy instruction, facilitating activities such as categorizing components, counting and comparing quantities, representing sequences, and identifying or extending patterns once the underlying regularities and repetition rules have been verified. For primary education students, these insights provide a foundation for designing contextual mathematical activities that integrate local Papuan culture into primary school education.

Future research should involve direct observation of the entire Yowa sequence, combined with interviews with relevant cultural informants, to verify the underlying mathematical patterns and gain insight into their cultural significance. Furthermore, primary education (PGSD) students should be encouraged to develop and test Yowa based numeracy learning activities for elementary school pupils incorporating tasks such as classification, counting, comparison, and the identification of patterns and relationships. Evaluating both the work produced and the learning outcomes is essential to determine the effectiveness of Yowa as a learning resource for fostering numeracy skills in pupils and enhancing the pedagogical competence of pre-service teachers.

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