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Exploring ethnomathematics in the rongkong woven cloth ulu karua motif for mathematics learning

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ABSTRACT

Indonesia's cultural diversity is reflected in its various local traditions and cultural products, including Rongkong woven cloth from the mountainous areas of North Luwu Regency, South Sulawesi Province. Preserving Rongkong woven cloth is important for maintaining local cultural heritage while providing opportunities to integrate local culture into mathematics learning. Ethnomathematics refers to the study of mathematical concepts embedded in the cultural practices and artifacts of a community, such as traditional weaving. This study aims to explore the ethnomathematics embedded in Rongkong woven cloth, particularly in the Ulu Karua motif. It employs a qualitative approach with an ethnographic design. The research participants were two key informants of the Rongkong community who are still actively engaged in weaving Rongkong cloth. Data were collected through literature review, observation, interviews, and documentation, and analyzed using data reduction, data display, and conclusion drawing. The findings show that the ethnomathematics found in the Ulu Karua motif of Rongkong woven cloth includes lines, triangles, rhombuses, and translation reflected in the process of composing the motif. These concepts are related to mathematics content taught at the junior and senior high school levels and meet the indicators of a mathematics learning resource, as they can be developed into contextual learning activities while introducing local cultural values to students. Nevertheless, the exploration of the mathematical potential of the Ulu Karua motif and its use in mathematics learning remains limited to conceptual identification and has not yet extended to classroom implementation.

1. Introduction

Indonesia is a multicultural nation whose cultural diversity has emerged through centuries of historical processes, inter-ethnic interaction, and nationalization development [1]. This diversity is reflected in various cultural forms across the archipelago, including regional languages, traditional houses, traditional clothing, customary ceremonies, arts, traditional games, and traditional woven cloth, comprising hundreds of distinct types that represent the cultural identity of communities throughout the country [2]. The cultural wealth is a national asset that carries not only historical and aesthetic value but also a body of local knowledge passed down through generations. Preserving this local culture is therefore not solely the responsibility of indigenous communities, it needs to be systematically integrated into education, so that it remains known, valued, and passed on to future generations [3]. This is supported by empirical evidence from a meta-analysis of 11 studies conducted between 2014 and 2024, which found that integrating local culture into mathematics teaching has a significant positive effect on students' mathematics achievement, with effect sizes ranging from 0.561 to 2.698 and an average effect size of 1.22, indicating a strong positive impact across various educational contexts [4].

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One form of Indonesian cultural heritage that continues to be preserved to this day is traditional woven cloth. Weaving has been known since prehistoric times, roughly 3,000 years ago, and has become part of the cultural identity of communities across Indonesia [5]. Beyond its function as clothing material, woven cloth also represents social values, life philosophy, and community identity through its motifs [6]. Each region has distinctive motifs shaped by its geographical conditions, history, and worldview [7, 8, 9, 10, 11, 12]. In South Sulawesi, alongside the well-known Lippa Sabbe and Toraja weaving there is also Rongkong woven cloth from Rongkong District, North Luwu Regency. This cloth is a cultural heritage of the Rongkong community that continues to be produced across generations in several distinctive motifs, such as Sekong Sirenden Sipomandi, Rundun Lolo, and Ulu Karua, each carrying its own symbolic meaning and representing the identity of the Rongkong people.

Behind the beauty of its motifs, both the weaving process and the resulting patterns essentially involve mathematical activities that community members carry out naturally. Counting threads, determining motifs, comparing color compositions, and arranging repeated patterns into geometric shapes are all examples of such cultural practices. The study of the relationship between culture and mathematics is known as ethnomathematics.

Hardiarti [13] explains that ethnomathematics is a field of study that connects mathematical concepts with the culture that develops within a community. From this perspective, mathematics is no longer viewed merely as an abstract science but as knowledge that grows out of people's everyday activities. This is consistent with Mendoca [14], who found that weaving involves various mathematical concepts, including number patterns, geometric patterns, measurement, and the systematic arrangement of patterns in the process of creating woven motifs.

Integrating local culture into mathematics learning through an ethnomathematics approach plays an important role in creating meaningful, contextual learning that is close to students' lived experience. When mathematics learning is connected to culture, students can understand mathematical concepts through objects they already recognize from daily life, making abstract concepts easier to grasp. Beyond strengthening conceptual understanding, the ethnomathematics approach also contributes to students' problem-solving ability, mathematical literacy, and appreciation of local culture.

Angga [15] found that ethnomathematics-based learning has a significant positive effect on students' mathematical literacy across educational levels. Similarly, a literature study by Kusuma [16] revealed that Indonesian cultural objects contain a wide range of mathematical concepts that can be integrated into various topics from geometry to algebra and statistics, opening broad opportunities for developing culture-based mathematics learning. Furthermore, Sarah & Batiibwe [17] argue that ethnomathematics plays a key role in bridging school mathematics with students' cultural experience, making learning more relevant, inclusive, and meaningful while encouraging the preservation of local knowledge through mathematics education. Drawing on local culture as a learning resource, therefore, not only improves the quality of mathematics learning but also strengthens students' cultural identity through more contextual learning experiences.

Prior studies have shown that traditional woven cloth contains various mathematical concepts that can be explored for learning. Banase [18] found concepts of counting, measurement, comparison, points, lines, and plane shapes in the woven cloth of the Oeolo community in East Nusa Tenggara. Manda [19] identified transformation geometry concepts; reflection, rotation, translation, and dilation in the woven cloth of Wolotopo Village, Ndona District, Ende Regency. A study by Purnama [20] similarly found concepts of transformation, measurement, precision, and congruence in the process of creating Lunggi cloth motifs. Mendoca [14] found concepts of plane shapes, points, lines, and geometric patterns in the woven cloth of the Lamaksenulu Village community in the Belu region, East Nusa Tenggara. These findings collectively indicate that woven cloth is a cultural object rich in mathematical concepts, with strong potential to serve as a culture-based mathematics learning resource.

Although ethnomathematics studies on various types of Indonesian woven cloth are already numerous, most have focused on identifying the mathematical concepts embedded in the motifs. Research that comprehensively links such exploration with its use as a mathematics learning resource remains relatively limited. Furthermore, to the researchers' knowledge, no study has specifically examined the ethnomathematics of the Ulu Karua motif in Rongkong woven cloth from a mathematics education perspective. Existing studies on Rongkong weaving have mainly discussed its symbolic meaning and cultural value [21], while its mathematical potential remains largely unexplored. This gap is particularly pressing given that the number of active Rongkong weavers has been reported to be declining, prompting local efforts such as the establishment of a weaving craft center and the recognition of Rongkong weaving as the official batik motif of the Luwu Utara Regency government [22]. Yet the Ulu Karua motif has a systematically arranged pattern that represents various mathematical concepts with the potential to serve as a culture-based mathematics learning resource.

The novelty of this study therefore lies not only in examining a previously unexplored cultural object, but also in extending the analytical scope of prior ethnomathematics research on woven cloth, from concept identification toward an explicit assessment of pedagogical relevance for culture-based mathematics learning. Within this study, the ethnomathematics approach is used to examine the visual patterns, geometric shapes, and structural relationships embedded in the Ulu Karua motif, drawing on the weavers' own cultural practice and knowledge. The resulting mathematical concepts are then interpreted from a mathematics education perspective and translated into a culture-based mathematics learning resource by examining their alignment with school mathematics content, their potential to be represented as learning

activities or contextual problems, and their connection to local culture as a means of stengthening the meaningfulness of learning.

This study therefore aims to explore the ethnomathematics concepts embedded in the Ulu Karua motif of Rongkong woven cloth, and (2) analyze the relevance of these concepts as a contextual, culture-based mathematics learning resource based on the alignment of the concepts with school mathematics content, their potential to be developed into contextual learning activities, and their connection to local cultural preservation.

2. Method

2.1. Research design

This study employed a qualitative exploratory with an ethnomathematical approach. The qualitative approach was chosen to gain an in-depth understanding of the cultural practices of the Rongkong community in producing the Ulu Karua motif, while the ethnographic design was used to examine this cultural activity as part of a living body of local knowledge passed down across generations. Prior to fieldwork, researchers conducted a two-month literature review to gain preliminary background knowledge of the Rongkong weaving tradition and the Ulu Karua motif. Fieldwork was carried out over one month, beginning with securing formal research permits, followed by direct observation of the weaving process, in-depth interviews with the weavers, and visual documentation.

This understanding of the motif-making process formed the basis for exploring the mathematical concepts embedded in the Ulu Karua motif. The results of this ethnomathematics exploration were then interpreted from a mathematics education perspective, to examine the relevance of these mathematical concepts as a mathematics learning resource.

2.2. Research Setting and Participants

The study was conducted from April to June 2024 in Salurante Village, Rongkong District, North Luwu Regency, South Sulawesi. The unit of analysis in this study was the Ulu Karua motif as a cultural and visual object, with a specific focus on its visual structure.

The research participants were two key informants, selected through purposive sampling on the basis that both were still actively producing Rongkong woven cloth, understood the process of creating the Ulu Karua motif, and had weaving experience passed down through generations. Given the highly specialized and localized nature of Ulu Karua motif production, knowledge held by only a small number of practicing weavers in Salurante Village, the two participants were regarded as key informants whose in-depth, generationally transmitted knowledge provided sufficient information power for the purposes of this study, consistent with Malterud [15] concept of information power in qualitative research, wherein studies with highly specific, narrow, and information-rich participants can achieve analytic sufficiency with a small sample size.

A brief profile of the two key informants is presented in the table below:

Table 1. Profile of the Two Key Informants

Informant	Age	Gender	Years of Weaving Experience	Role/Position in Community
Weaver 1 (W1)	59	Female	17	Weaver and Head of "Bunga Risin" weaving group
Weaver 2 (W2)	48	Female	10	Weaver and owner of the "Rundun Lolo" brand shop

Prior to data collection, the researchers obtained informed consent from both participants, explaining the purpose of the study, the voluntary nature of participation, and the use of photographic and audio documentation.

2.3. Research Procedure

Data collection was carried out in three sequential stages during the April–June 2024 research period. Stage 1 Preliminary and literature stage: A literature review was conducted prior to fieldwork to establish the study's conceptual foundation, the details of which are described in the instruments and data collection section.

Stage 2 Field data collection: Direct observation and semi-structured interviews were conducted concurrently with the weavers during their weaving activities, using the observation guide and interview guide, the details of which are described in the Instruments and Data Collection section. The entire research process was supported by documentation, including photographs of weaving activities and motifs, field notes, and interview recordings used as supporting material for the analysis.

Stage 3 Verification and triangulation: To ensure the credibility of the findings, the researchers applied technique triangulation and source triangulation. Technique triangulation was carried out by comparing primary data obtained through observation, interviews, and documentation with secondary data obtained through the literature review, to examine the consistency between data collected directly in the field and existing written sources. Source triangulation involved cross-checking the primary data obtained from both informants to identify consistent, mutually reinforcing information regarding

the Ulu Karua motif.

2.4. Instruments and Data Collection

Data were collected through four techniques: literature review, observation, semi-structured interviews, and documentation. The literature review involved examining references related to ethnomathematics, weaving culture, and culture-based mathematics learning to build the study's conceptual foundation.

Direct observation of the weaving activity was carried out using an observation guide developed by the researchers based on a synthesis of the literature review, focusing on mathematical activities such as measuring, arranging patterns, repeating motifs, and determining thread composition. The observation guide was reviewed by an expert in ethnomathematics through direct discussion to examine its content relevance prior to use in the field.

Semi-structured interviews were conducted using an interview guide developed based on the study's conceptual framework, covering the meaning of the Ulu Karua motif, the stages of cloth production, the considerations behind motif arrangement, and the weavers' local knowledge. The interview guide was reviewed by an expert in ethnomathematics through direct discussion to examine its content relevance prior to use in the field.

Documentation instruments included a digital camera/smartphone for photographing weaving activities and motifs, a voice recorder for interviews, and a field note template for recording observational data.

2.5. Data Analysis

Data analysis followed the Miles and Huberman (1994) interactive model, comprising three stages: data reduction, data display, and verification. Data reduction: Data from observation, interviews, documentation, and the literature review were repeatedly read and listened to in order to identify recurring cultural activities containing mathematical concepts. These activities were then categorized, based on which the underlying mathematical concepts embedded in them were identified.

Data display: Data were presented through narrative description combined with visual documentation to show how the identified mathematical concepts are represented in the Ulu Karua motif.

Conclusion or verification: The researchers interpreted the mathematical concepts identified from an ethnomathematics perspective and examined their relationship to school mathematics content. This stage involved matching the findings against relevant learning outcomes and mathematics content, and cross-checking these interpretations against the triangulated data to verify their consistency, allowing the potential of the Ulu Karua motif as a culture-based mathematics learning resource to be formulated. The findings of this ethnomathematics exploration were reviewed by a mathematics education expert through discussion and interview, in which the appropriateness of the mathematical concepts identified in the Ulu Karua motif and their relevance as a mathematics learning resource were examined. Based on the expert's feedback, the findings were subsequently revised.

3. Results and discussion

3.1. Rongkong Woven Cloth with the Ulu Karua Motif as a Representation of Rongkong Cultural Identity

The Rongkong people are one of the indigenous communities in North Luwu Regency that continue to uphold ancestral traditions, including the tradition of cloth weaving. For them, weaving is not merely an activity of producing cloth but part of a cultural identity passed down from one generation to the next. Every motif produced carries values and philosophical meaning rooted in the community's lived experience and its relationship with the surrounding environment. This is what gives Rongkong woven cloth its high cultural value and makes it a symbol of local wisdom that is still preserved today.

Observation and interview results show that Ulu Karua is one of the motifs still in use today and carries strong philosophical meaning. It is a traditional motif long recognized by the Rongkong community and is still used in various customary activities and events. The Ulu Karua motif is built on a pattern arrangement that carries symbolic meaning, so its production is never done carelessly to set it apart from motifs created purely for aesthetic purposes. As a form of respect for the cultural values it embodies, weavers preserve the original pattern inherited from their predecessors.



Figure 1. The Ulu Karua Motif

According to W1, the term Ulu Karua comes from the local Rongkong language and means "eight parts" or "eight directions." This information was corroborated by W2, who confirmed that in the community's worldview, the number eight represents balance, unity, and order. This philosophy is expressed throughout the cloth through a motif arrangement that is repeated in a balanced composition. According to the informants, this

balance is intended not only to produce a visually pleasing result but also to symbolize the hope that community life will remain harmonious, respectful, and peaceful.



Figure 2. Weaver 1 weaving on a backstrap loom. Source: documentation by the author(s), 2024.

Field observations of the weaving process, as shown in Figure 2, confirmed the care weavers take in refining each motif, reflecting this cultural value. Weavers attend not only to color combinations but also to ensuring that the size, orientation, and position of each shape fit together to form a complete pattern, as illustrated in the motif shown in Figure 1. Arranging the threads must be done carefully, since observation showed that a small error in motif placement can affect the appearance of the entire cloth. This shows that the weavers' local knowledge is acquired through long practice and experience rather than formal instruction.

These findings indicate that Rongkong woven cloth, particularly the Ulu Karua motif, is a symbol of the community's cultural knowledge rather than simply a traditional craft product, reflecting a combination of aesthetic value, philosophy, and technical skill inherited from earlier generations. This is evidenced by the regularity, repetition, symmetry, and proportional relationships found in the motif's composition, which stem from the philosophy underlying its arrangement. From an ethnomathematics standpoint, this indicates that mathematical ideas can be embedded within cultural practice without practitioners necessarily being consciously aware of them. It is therefore essential to understand the cultural meaning behind the Ulu Karua motif before identifying the mathematical ideas embedded within it, since the mathematical concepts and cultural values in this motif are inseparable from one another. This clarifies that the mathematical ideas found in this study originate from Rongkong cultural practices that have developed and been passed down across generations. This finding reinforces Hardiarti's [13] view that ethnomathematics is part of a community's cultural activity, and is consistent with Banase [18] and Manda [19] regarding mathematical concepts in traditional weaving motifs.

3.2. Ethnomathematics Exploration in the Ulu Karua Motif

3.2.1. Basic Geometric Concepts in the Ulu Karua Motif

Observation of Rongkong woven cloth with the Ulu Karua motif shows that it carries aesthetic value while also representing a range of geometric concepts arranged in a regular manner. This is evident in the arrangement of lines, the formation of plane shapes, and the regularity of the pattern produced during weaving. Notably, the weavers' reasoning comes from experience, skill, and local knowledge passed down through generations rather than from formal school mathematics. Even so, this activity indirectly shows that people use mathematics in their everyday lives.

The geometric elements that dominate the Ulu Karua motif are lines, triangles, and rhombuses. These three concepts are interrelated and form a repeating pattern, resulting in a proportional and balanced motif composition. The presence of these geometric elements shows that the motif is formed according to a specific pattern that has become a standard within the Rongkong weaving tradition. This supports the idea that cultural activities often carry a mathematical structure, even when practitioners are not aware of it.



Figure 3. Geometry Concepts on Ulu Karua Motif

In mathematics, a line is characterized by properties such as straightness, parallelism, intersection, and consistent spacing between points along its length. These properties are clearly reflected in the Ulu Karua motif, where the lines are formed from parallel and intersecting threads that function not only as boundaries between the motif's components but also as the foundation for subsequent shapes. During observation, the researchers found that weavers consistently keep the spacing between threads equal, reflecting the mathematical property of regular, consistent distance and giving the resulting pattern a neat, symmetrical appearance. For weavers, precision in arranging lines is one of the factors that determines the quality of the finished weave; the entire motif changes shape if an error occurs at this early stage. This shows that the concept of the line in weaving serves both a visual purpose and a function as a reference point for maintaining pattern regularity.

In mathematics, a triangle is a plane shape formed by three sides and three angles. In the Ulu Karua motif, triangles are formed from a combination of lines arranged repeatedly to produce the same pattern in each part of the motif, reflecting the mathematical properties of repetition

and pattern regularity. In Rongkong culture, however, the triangle is not merely decorative; it forms part of a motif sequence that expresses regularity and balance. This shows that a geometric shape can carry two meanings at once: a mathematical value and a cultural one.

In mathematics, a rhombus is a quadrilateral with four equal sides and diagonals that are perpendicular and bisect each other. The findings show that combining several triangles in a symmetrical arrangement creates a rhombus in the Ulu Karua motif that exhibits these properties: four equal sides and perpendicular diagonals that bisect each other. Weavers are able to produce patterns that meet these geometric properties through weaving experience passed down from earlier generations, even without describing the shape using formal geometric terminology. This suggests that mathematical knowledge is not always acquired through formal education; repeated cultural practice within a community can also give rise to such knowledge.

The findings show that combining several triangles in a symmetrical arrangement creates a rhombus. One distinctive feature of the Ulu Karua motif is a rhombus with four equal sides and perpendicular diagonals that bisect each other. Weavers are able to produce patterns that meet these geometric properties through weaving experience passed down from earlier generations, even without describing the shape using formal geometric terminology. This suggests that mathematical knowledge is not always acquired through formal education; repeated cultural practice within a community can also give rise to such knowledge.

Table 2. Mathematical Concepts and Characteristics Identified in the Ulu Karua Motif

Motif Part	Visual Evidence	Mathematical Concept	Mathematical Characteristics
Vertical thread dividers between repeated motif units		Line	Straight, parallel, and intersecting, with consistent spacing
Triangular elements within the repeated pattern units		Triangle	Three sides and three angles, arranged in repeated, regular patterns
Diamond-shaped elements at the base of the pattern		Rhombus	Four equal sides, with perpendicular diagonals that bisect each other

The presence of lines, triangles, and rhombuses in the Ulu Karua motif shows that weaving involves complex visual-spatial activity. Weavers must calculate the position of each thread to keep the motif's dimensions consistent and ensure that every shape is proportionally arranged. This requires the ability to observe patterns, identify relationships between shapes, and maintain consistency throughout the weaving process. Weaving skill therefore reflects both artistic ability and geometric thinking developed through cultural experience.

These findings align with D'Ambrosio [23] who described ethnomathematics as the way a cultural group uses and develops mathematical concepts within its activities. In Rongkong society, geometric ideas emerge naturally within weaving practice without needing to be represented through mathematical symbols or formulas. Like mathematics, this cultural activity is passed down from generation to generation. Consequently, the geometry found in the Ulu Karua motif can be regarded as a source of local knowledge that carries both cultural and scientific value.

This study's findings are consistent with Banase [18], who identified straight line, curved line, and rhombus concept within the nap molo weaving motif of the Oeolo community. in the presents study, this reflected specially in the rhombus shape found ini the Ulu Karua motif, alongside triangular shapes that were not reported in Banase Study. It further engages with Manda's [19] claim regarding the role of systematically arranged geometric patterns in the process of composing weaving motifs.

While these studies share similar findings regarding geometric concepts, the present study differs in that it not only identifies geometric shapes in the Ulu Karua motif of Rongkong woven cloth but also explains how these shapes emerge from the cultural habits of the Rongkong community. Geometry in the Ulu Karua motif is thus understood not merely as a visual object but also as a representation of the Rongkong community's cultural knowledge.

These findings show that geometry is one of the most important mathematical elements in the Ulu Karua motif. The regular arrangement of plane shapes indicates that weavers apply intuitive geometric thinking as they work. These findings further suggest that local culture can serve as a rich tool for teaching geometric concepts to students in a context close to their own lives.

3.2.2. Transformation Concepts in the Ulu Karua Motif

Observation shows that the Ulu Karua motif exhibits the transformation geometry concept of translation, evidenced by the sequential repetition of the motif shape across the cloth's surface. Each motif is arranged in the same pattern and then shifted to the next position without any change in shape or size, producing a visual rhythm that is one of the defining characteristics of Rongkong woven cloth.

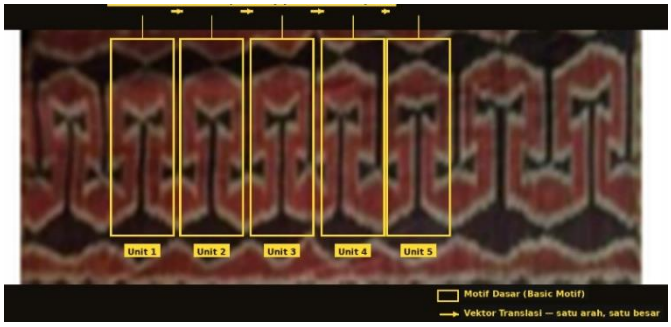


Figure 4. Translation in the Ulu Karua Motif

The motif is repeated gradually throughout the weaving process, following the arrangement of the warp and weft threads. Interview data show that weavers rely on traditional counting methods developed over many years rather than the formulas or coordinates taught in mathematics; they know when a motif should be repeated and how far the next one should be placed to keep the pattern consistent.

In mathematics, translation is a rigid transformation in which every point of a shape is moved the same distance in the same direction, without any change in shape, size, or orientation. Figure 4 demonstrates that the Ulu Karua motif satisfies this property. Five consecutive motif units (Unit 1 to Unit 5) are outlined to show that each unit is congruent to the others; identical in shape and size, with no rotation or reflection applied. The arrows connecting each pair of adjacent units represent the translation vectors: because they are parallel to one another and equal in length, every unit is shifted by the same distance and in the same horizontal direction relative to the previous one. This means that any point on Unit 1 has a corresponding point on Unit 2 located at an identical offset, and this relationship holds consistently across all five units. Such regularity confirms that the repeated arrangement of the motif across the cloth follows the mathematical structure of translation, in which a single basic motif is repeatedly displaced to generate the full pattern.

This finding shows that weavers' traditional counting practices intuitively fulfill the mathematical properties of translation, even without reference to formal formulas or coordinates. Translation thus functions both as a mathematical concept and as a principle underlying the visual beauty of the cloth, indicating that weaving requires spatial organization, consistency in distance and direction, and precision throughout production, abilities that form part of the geometric thinking that has developed naturally within Rongkong culture.

This finding is consistent with Azima et al [24], who identified fold and rotational symmetry as well as transformation geometry concepts, specifically translation, reflection, and rotation, within the motifs of Sasak woven fabric. It is also in line with Maisaroh and Permatasari [25], who identified translation, rotation, reflection, and dilation, within the motifs of Troso woven fabric. Similarly finding by Ainiyyah that reflection and translation help explain pattern repetition and balance in traditional woven cloth [26]. These findings collectively indicate that transformation geometry is embedded not only in the Ulu Karua motif but also in other Indonesian weaving traditions. Nevertheless, the present study offers a different perspective by treating transformation geometry not merely as a set of identifiable mathematical operations, but as an integral part of the philosophy and method behind composing the Ulu Karua motif. Transformation is thus understood not only as a mathematical object but also as a representation of local knowledge that has developed through the weaving practices of the Rongkong community. These facts reaffirm that weaving is a process rich in mathematical concepts

These facts reaffirm that weaving is a process rich in mathematical content. Translation in cultural practices carried out regularly within community life, not abstract concepts. This suggests that mathematics learning can genuinely begin from a cultural environment close to students. When the idea of transformation geometry is taught through the Ulu Karua motif, students gain not only an understanding of how to determine the image of a shape but also an awareness that this idea is connected to their local cultural heritage. Mathematics learning can thus become more contextual while fostering appreciation for local culture.

3.3. Recommendation the Relevance of Ulu Karua Ethnomathematics for Mathematics Learning

The exploration of the Ulu Karua woven motif indicates that the Rongkong community's weaving practice holds strong potential as a source of contextual mathematics learning. Recent developments in ethnomathematics research show that local culture is no longer merely an illustrative context for learning but a source of knowledge that helps students build meaning in their conceptual understanding [27].

This relevance analysis was based on three main indicators: the alignment of the concepts with school mathematics content [17], their potential to be developed into contextual learning activities [28], and their connection to local cultural preservation [29]. These three indicators were used to ensure that the assessment of the Ulu Karua motif's potential as a mathematics learning resource considers not only the presence of mathematical concepts but also its pedagogical and cultural dimensions.

3.3.1. Alignment with School Mathematics Content

The concepts found in the Ulu Karua motif are aligned with school mathematics content, particularly at the

junior and senior high school levels. The concepts of the line, triangle, and rhombus can support plane geometry instruction, while the concepts of reflection and translation relate directly to transformation geometry. This alignment suggests that local cultural objects carry not only aesthetic value but can also serve as a learning resource that helps students understand mathematical concepts through a real context. This finding is consistent with Banase and Manda [18, 19], who showed that traditional weaving motifs can be used as a context for geometry learning because they contain various representations of mathematical concepts close to everyday life.

Mathematics instruction has typically relied on generic examples that are often disconnected from students' real situations, leading them to view mathematics as a collection of formulas to be memorized rather than something embedded in everyday life. The present findings suggest an alternative approach. Through the Ulu Karua motif, students can directly observe how the concepts of transformation and geometry are applied in creating a cultural artifact, so learning no longer begins from formulas or definitions but from a real object close to their own experience. This supports Siregar [30] who found that when students can see the connection between mathematics and familiar real-world objects, concept formation becomes more meaningful because it is grounded in authentic experience.

These findings align with a constructivist view that treats learning experience as the foundation for building conceptual understanding [31]. When students identify triangles, rhombuses, or patterns of reflection and translation in the cloth motif, they are connecting new knowledge to learning experiences they observe directly. This process allows students to build conceptual understanding gradually, moving from concrete experience toward more abstract concepts [32].

Through this process, mathematics is no longer perceived as a rigid set of formulas and symbols but as a discipline that continues to grow and develop within society. This is consistent with recent developments in ethnomathematics research, which emphasize that culture-based learning creates more contextual learning experiences, increases student engagement, and helps students understand mathematical concepts more deeply [27].

3.3.2. Potential as a Source of Contextual Learning

Beyond its alignment with mathematics content, the Ulu Karua motif also holds strong potential as a source of contextual learning. Because it comes from a real cultural environment, it is more readily recognizable to students, particularly those in South Sulawesi. Learning that draws on local culture gives students the opportunity to connect mathematical concepts with experiences they encounter in daily life [33]. This approach is consistent with the principle of culturally responsive pedagogy, an approach that treats students' cultural experience as an important part of the learning process for building conceptual understanding, increasing participation, and strengthening the connection between knowledge and community life [34].

In practice, the Ulu Karua motif can be used in a variety of learning activities. Teachers can ask students to identify the plane shapes contained in the motif, determine which patterns represent translation, redraw the motif using transformation concepts, or discuss why the pattern is arranged repetitively. Such activities not only strengthen mathematical representation ability but also train students in observation, analysis, and mathematical reasoning based on real situations and objects.

Beyond serving as an example during instruction, the Ulu Karua woven motif can also be developed into a student worksheet, a learning medium, or a culture-based project, as demonstrated by similar efforts to design ethnomathematics based student worksheet from other local cultural contexts [35]. Its use is not limited to a single instructional strategy but can be adapted to students' characteristics and the intended learning objectives.

Learning grounded in local cultural context also has the potential to increase student engagement. When students perceive the material as relevant to their own environment, their motivation to learn tends to increase. Mathematics is no longer seen as a discipline far removed from daily life but as part of community activity that can be found all around them. This is one of the reasons the ethnomathematics approach is increasingly being developed in mathematics learning in various regions.

3.3.3. Contribution to the Preservation of Local Culture

Another important finding of this study is that using the Ulu Karua motif as a learning resource offers benefits beyond the academic domain, it also contributes to the preservation of local culture. When culture is brought into the learning process, students learn not only mathematical concepts but also the philosophy, meaning, and values embedded in the motif. Mathematics learning thus becomes a means of introducing regional cultural heritage and fostering a sense of ownership toward it.

Integrating local culture into education plays a crucial role. Schools are not merely a means of transferring knowledge but also a vehicle for shaping students' identity and character. Through ethnomathematics-based learning, students come to see that the culture around them contains knowledge relevant to present-day science. This awareness can foster greater appreciation of local culture and encourage its preservation.

This study shows that using the Ulu Karua woven motif

in learning offers two benefits at once: first, a more contextual learning experience; and second, an introduction for students to one of the Rongkong community's philosophically rich cultural heritages. Learning is thus oriented not only toward academic competence but also toward strengthening students' cultural identity.

Table 2. Mathematical Concepts, Learning Content, Activities, and Cultural Values Developed in the Ulu Karua Motif

Mathematical Concept	Learning Content	Example Learning Activity	Cultural Value Developed
Line	Plane Geometry	Identifying parallel and intersecting lines in the motif	Precision
Triangle	Plane Geometry	Identifying the properties of triangles and the relationships between their sides	Balance
Rhombus	Plane Geometry	Determining the properties of the rhombus based on its sides	Regularity
Translation	Transformation Geometry	Drawing the translation result of a motif	Consistency

4. Conclusion

Based on the findings and discussion, it can be concluded that:

1) The Ulu Karua motif of Rongkong woven cloth contains mathematical concepts such as lines, triangles, and rhombuses and translation.
2) The mathematical concepts are found in the Ulu Karua motif are aligned with mathematics content at the junior and senior high school, and can be developed into contextual learning activities that also introduce local cultural values to students.

This study contributes to the field of ethnomathematics by documenting and describing geometric concepts embedded in the Ulu Karua motif of Rongkong woven cloth, an indigenous cultural practice that has not been widely explored in mathematics education research. The findings offer a culturally grounded resource that can support teachers in designing contextual mathematics learning activities linking formal geometric and transformation geometry concepts to local cultural values.

This study is limited to identifying and describing the mathematical concepts embedded in the Ulu Karua motif and analyzing their relevance as a contextual learning resource. It does not extend to the actual implementation or testing of these concepts as learning activities in the classroom.

Future research is therefore recommended to develop and test culture-based mathematics learning activities derived from the Ulu Karua motif in actual classroom settings, in order to examine their effectiveness in supporting students' understanding of mathematical concepts as well as their appreciation of local culture.

Credit authorship contribution statement

Azmidar: Conceptualization, Methodology, Investigation, Fieldwork and data collection, Formal analysis, Writing original draft. Suhartina: fieldwork and data collection, checking, resources. Dwi Laila Sulistiowati: review and editing article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Data availability

The data supporting the findings of this study, including field observation notes, interview transcripts, and photographic documentation of the Ulu Karua weaving process obtained from the two participating weavers in Salurante Village, Rongkong District are not publicly available due to the culturally sensitive and community-specific nature of the information but are available from the corresponding author upon reasonable request, subject to the consent of the research participants.

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