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Mathematical activities and critical thinking ability in *Lagosi* weaving process of the Buginese community

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Abstract

Lagosi, a renowned woven fabric of national significance, involves a precise calculation formula in its manufacturing process. Craftsmen must meticulously count the threads to ensure the motif aligns with the intended design. Despite its importance, this aspect has not been thoroughly examined within the framework of Ethnomathematics. Consequently, this study investigates the mathematical practices employed by the Buginese people during the *Lagosi* weaving process, focusing on both the manufacturing procedures and the resultant motifs. Employing a qualitative methodology with an ethnographic approach, this research collected data through observation, interviews, and audio-visual documentation. The analysis utilized domain and taxonomic techniques to interpret the data. To ensure validity, both source and method triangulation were employed. The findings reveal that the crafting of *Lagosi* involves integrating counting, measuring, designing, and positioning techniques. Additionally, the study demonstrates that weaving artisans apply mathematical critical thinking skills in the production of *Lagosi*. The weaving process also reflects socio-cultural values such as diligence, perseverance, discipline, and faith. These insights contribute to a deeper understanding of mathematics in cultural contexts and offer valuable perspectives for contextual mathematics education by incorporating social values.

Keywords: Buginese community, critical thinking, ethnomathematics, geometry, *lagosi* weaving process

Introduction

Mathematics is a field of science that, through a process of logical reasoning, has been developed and utilized across various facets of human life, particularly through mathematical concepts (Huda, A'yun & Marhayati 2023; Lakoff & Núñez, 2000). Research indicates that the genesis of mathematical concepts is deeply rooted in environmental experiences and is profoundly influenced by cultural contexts. Consequently, mathematics can be conceptualized as a reflection of the culture of its users (Point, 2001).

Existing literature categorizes mathematics as a domain of knowledge with significant ethnomathematical dimensions (Barton, 1996). This dimension pertains to the manner in which cultural groups develop and apply mathematical concepts in their daily lives (Barton, 1996). Moreover, ethnomathematics offers a perspective of mathematics as a cultural product (Rosa et al., 2016).

In the context of cultural groups, the Bugis people—one of the four largest ethnic groups in South Sulawesi—have preserved their local customs and wisdom over generations. These traditions provide a fertile ground for ethnomathematical studies, particularly in examining mathematical concepts within the Buginese community. Despite the potential for such research, there are limited ethnomathematical studies focused on the Buginese. Existing studies predominantly address geometric concepts found in traditional Buginese food (Asma & Kadir, 2022; Busrah & Pathuddin, 2021; Pathuddin & Nawawi, 2021; Pathuddin & Raehana, 2019; Rusli, 2023; Tando et al., 2022), geometric analyses of agricultural tools and traditional Buginese architecture (Akbar, Haidar & Hidayati, 2021; Busrah, 2023; Fahira, 2021), and the use of Lontara Pananrang in agricultural systems (Pathuddin & Mariani, 2023).

Weaving, a traditional practice maintained by the Buginese community, particularly in the Wajo district (Nur et al., 2023), involves craftsmen who apply mathematical concepts throughout the fabric production process. Previous research indicates that while these craftsmen use mathematical concepts, they do not employ formal mathematics, as most lack formal training and rely on generational skills (Griswold, 2006; Inanna, 2015). Despite this, there is a notable scarcity of ethnomathematical studies concerning Wajo woven fabric.

In Indonesia, studies on ethnomathematics related to weaving and songket have revealed various geometric concepts integrated into the processes. For example, research on Southwest Sumba fabrics identified geometric motifs such as points, lines, squares, rhombuses, and triangles, providing contextual mathematics learning resources (Bili et al., 2019). Similarly, studies on Buna woven fabric from Timor Island uncovered mathematical concepts such as geometric transformation, congruence, and similarity, which can be valuable for educational purposes (Eko, 2017). Research on Malay songket has highlighted mathematical concepts including transformation, measurement, estimation, accuracy, and similarity (Embong et al., 2010). In the Sasak tribe and Minangkabau songket, geometric concepts such as mirroring, transformation, symmetry, and repetition were observed, along with various geometric shapes (Sabilirrosyad, 2016; Syahriannur, 2019). Ethnomathematical studies on Tapis Lampung cloth and Lipa Sabbe Sengkang revealed geometric concepts including plane and space geometry, as well as transformations like reflection, dilation, and rotation (Busrah et al., 2023; Susiana et al, 2020). These findings suggest a critical thinking process employed by weavers, although this aspect has not been extensively explored in prior research. This study aims to investigate the concept of critical thinking in relation to mathematical activities within the weaving process.

In line with these studies, Lagosi woven fabric is a prominent example of renowned textiles, both within Wajo district and nationally. The intricate floral patterns are created through precise thread counting, ensuring that the motifs align with the desired design and avoiding discrepancies. This activity exemplifies ethnomathematical forms. Therefore, this study seeks to focus on the application of mathematical concepts by Lagosi weaving craftsmen and explores the mathematical activities they undertake. By examining these practices, the study aims to uncover the critical thinking skills employed by the weavers and provide new insights into the development of mathematics education.

Methods

This study employed a qualitative approach with an ethnographic methodology. Ethnographic research aims to elucidate cultural phenomena within a community (Sharma & Sarkar, 2019). This approach aligns with the objectives of the study, which sought to explore the activities involved in weaving *Lagosi* woven cloth and to understand the underlying mathematical concepts associated with these activities. The study was conducted in Wajo Regency, a prominent center for woven fabric production in South Sulawesi, particularly *Lagosi*, facilitating efficient data collection. The study's sample comprised weaving craftsmen directly involved in the *Lagosi* fabric production process.

Data were collected through a combination of observation, interviews, and documentation. Observations were conducted directly at the production sites where *Lagosi* fabric is manufactured. These observations focused on the materials and tools used, as well as the production process itself, to identify the mathematical concepts employed by the craftsmen. Additionally, interviews were conducted with three experts in *Lagosi* fabric weaving. The interviews included questions about the entire production process, from material preparation to the completion of the weaving. These interviews were conducted at various stages: before, during, and after the weaving process. To complement the data gathered through observations and interviews, documentation in the form of photographs was collected, depicting materials, tools, and stages of the production process.

To ensure the validity of the data, triangulation was employed prior to analysis (Jonsen & Jehn, 2009; Natow, 2020). This involved both source and method triangulation. Method triangulation compared data obtained from observations, interviews, and documentation, while source triangulation involved comparing responses from different interviews. Following validation, domain and taxonomic analyses were performed. Domain analysis provided a comprehensive overview of the *Lagosi* fabric production process and identified data groupings. Taxonomic analysis further detailed these categories and domains, focusing on the mathematical concepts inherent in the process. The research stages are illustrated in Figure 1.

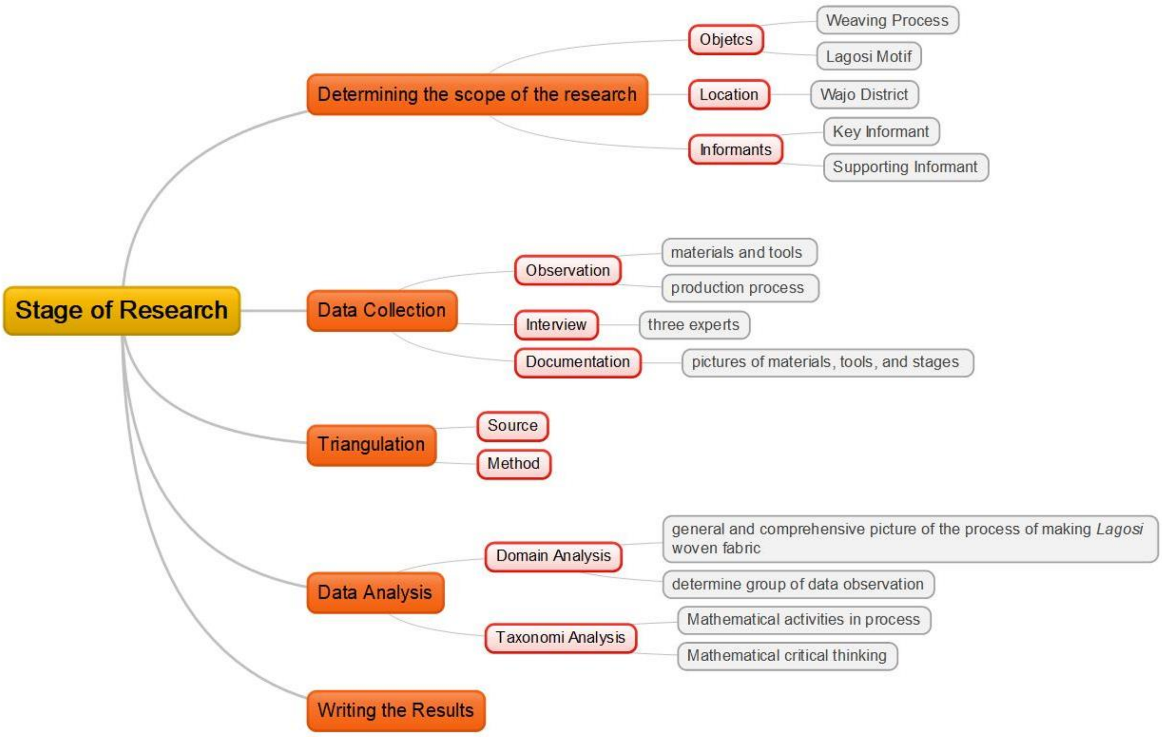

Figure 1. Research's stage

Results and Discussion

Lagosi is renowned for its distinctive woven patterns, characterized by large floral motifs surrounded by leaves and smaller flowers, and continues to be produced due to its sustained demand (Amir, 2018). However, with advancements in technology, the traditional methods used in crafting *Lagosi* fabric have evolved. Originally, the *Lagosi* fabric was produced using traditional looms known as *walida* and employed the *sobbi'* technique. This method has since been modernized with the introduction of contemporary tools, such as embroidery equipment (Akbar, 2023; Alwi, 2019). This shift towards modernization has led to a decline in both the quality and the philosophical significance of the fabric. The traditional weaving process utilizing the *sobbi'* technique with *walida* looms, as well as images of *Lagosi* woven fabrics, are illustrated in Figures 2 and Figure 3, respectively.

Figure 2. The Process of Making Woven Cloth by the *Sobbi'* Technique using *Walida*

Weaving was traditionally considered a sacred activity, symbolizing the strength, perseverance, tenderness, and humility of women (Medina, 2022). Women engaged in weaving with dedication, ensuring that their knowledge and skills were imparted to future generations as a means of preserving these traditions in the face of modernization. This study specifically focuses on the process of weaving with traditional looms, namely the *walida*, to uncover the mathematical competencies that weaving craftsmen develop through their experiential knowledge. Extensive interviews were conducted with weaving craftsmen experienced in creating *Lagosi* fabric motifs to gather detailed information and identify the forms of mathematical activities employed in the production process.

Figure 3. *Lagosi* Woven Fabrics

Mathematical Activities in the *Lagosi* Woven Fabric Making Process

Based on the results, the processes involved in the production of *Lagosi* woven fabric, and the associated mathematical activities employed by the weavers are detailed as follow.

Mappali

Mappali is the initial stage in the production of woven fabric, a term derived from the Bugis language meaning "spinning yarn." This process utilizes yarn-spinning tools of various shapes, including hexagons, circles, and rectangles (Yuliarnita, 2018). The activity embodies values of hard work and persistence (Syukur, 2015). This study specifically examined a hexagon-shaped yarn-spinning tool. An image of the yarn-spinning tool used in the *Mappali* process is presented in Figure 4.

Figure 4. Yarn Spinning Tool in the *Mappali* Process

Mathematically, the tool can be described as depicted in Figure 5.

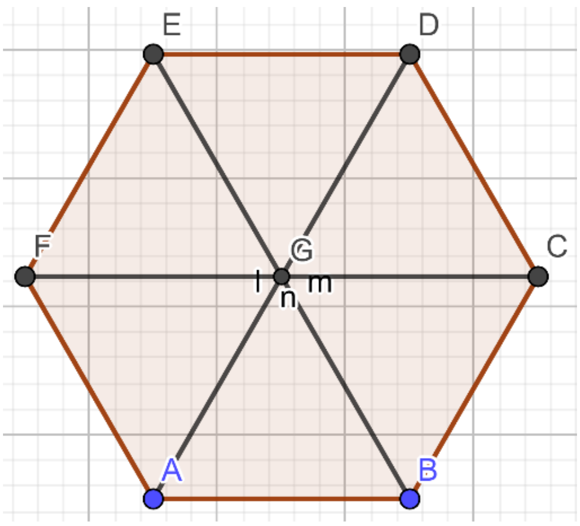

Figure 5. Geometric Shape of the Yarn Spinning Tool

The analysis revealed that the yarn-spinning tool used by the Wajo people during the mappali process incorporates a geometric concept. Specifically, the tool exhibits the properties of a regular hexagon. Based on Figure 5, the geometric properties of the regular hexagon are analyzed as follows (Prabawati, 2016).

a. The yarn-spinning tool had six equal sides, presented in Figure 6

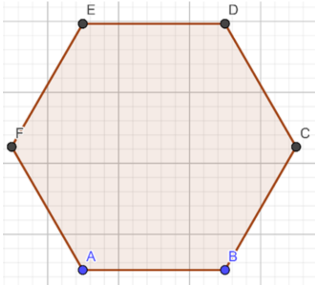

Figure 6. The Sides of a Regular Hexagon

Based on Figure 6, the results showed that:
AB=BC=CD=DE=EF=FA

b. The yarn-spinning tool had six equal angles, presented in Figure 7

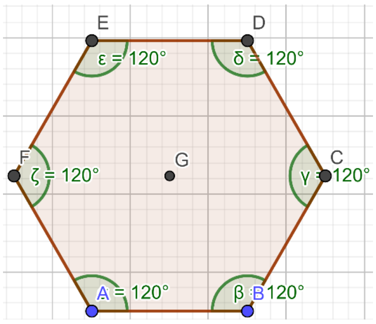

Figure 7. Angles of the Regular Hexagon

As shown in Figure 7, it could be seen that:
$\angle A = \angle B = \angle C = \angle D = \angle E = \angle F = 120°$
Therefore, the sum of the angles of a regular hexagon was:
$6 \times 120° = 720°$

c. The yarn-spinning tool had six-fold symmetries, presented in Figure 8

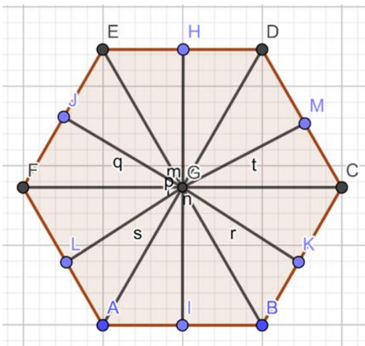

Figure 8. Folding Symmetry of the Regular Hexagon

Based on Figure 8, a regular hexagon had six axes of symmetry, namely $BE, HI, AD, CF, JK,$ and ML.

d. The yarn-spinning tool had six rotary symmetries, presented in Figure 9.

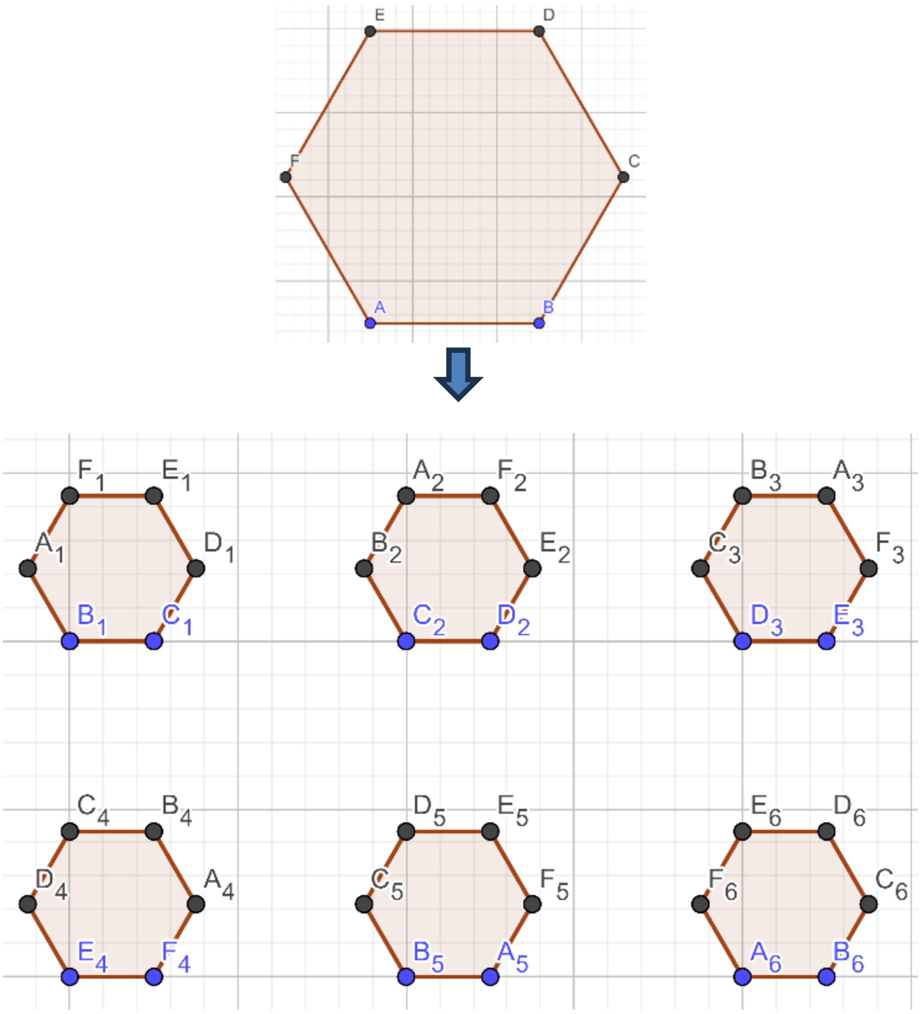

Figure 9. Rotational Symmetry of the Regular Hexagon

As presented in Figure 9, a regular hexagon $ABCDEF$ had six rotating symmetries, each of which was rotated by $60°, 120°, 180°, 240°, 300°$, and $360°$.

During the *Mappali* process, counting activities were observed, involving the rotation of the tool and the winding of yarn around it. Additionally, the length of the yarn produced could be calculated using the concept of the perimeter of a regular hexagon. Let K represent the perimeter of the regular hexagon and let s denote the length of each side of the hexagon. The perimeter can be calculated using the following equation:

$$K = 6 \times s \quad (1)$$

The length of yarn produced during the *Mappali* process can be determined by multiplying the circumference of the yarn-spinning tool by the number of turns made. If N_p represents the number of turns and P denotes the length of the yarn, the following equation can be used:

$$P = N_p \times K \quad (2)$$

By substituting equation (2) to (1), equation (3) was obtained as follows.

$$P = N_p \times 6 \times s \quad (3)$$

Equation (3) indicates that the length of yarn produced during the *Mappali* process is equal to the number of turns of the spinning wheel multiplied by the perimeter of the spinning wheel. Given that the spinning wheel is a regular hexagon with six sides, the perimeter can be expressed as six times the length of one side.

Example:

If the hexagon-shaped yarn spinning tool has a side length of 30 cm and the *Mappali* process is carried out by rotating the tool 100 times, what is the length of the yarn produced?

Answer:

The question reveals that s = 30 cm, hence, the circumference of the hexagon is calculated as follows.

$K = 6 \times s$

$K = 6 \times 30$

$K = 180$ cm

From the calculation above, the circumference of the spinning wheel is 180 cm. In addition, the spinning wheel is rotated 100 times ($N_p = 100$), and the length of yarn from one spinning process can be calculated as follows.

$P = N_p \times K$

$P = 100 \times 180$

$P = 1800$ cm

Based on these findings, in one yarn-spinning process with a total of 100 turns, 1800 cm or 1.8 meters of yarn were produced.

Massau

Massau is the process of creating motifs on Sengkang woven fabrics, including *Lagosi* woven fabrics. During this process, threads that have been rolled into *bulo-bulo* are inserted into the *jakka*. Each strand of yarn must be threaded through each eye of the comb (Yuliarnita, 2018). Additionally, the process often involves spreading thousands of threads and pulling them back and forth to ensure that each thread passes through the eyes of the *jakka*. Typically performed beneath the house, the *Massau* process can take one to two days. If the weavers miscalculate the thread or if a thread breaks, the process must be restarted. Consequently, this process embodies values of perseverance, hard work, and meticulousness required by the weaver (Syukur, 2015). The *Massau* process is illustrated in Figure 10.

Figure 10. *Massau* Process

Based on the results, the mathematical activities carried out in the process of *massau*, include:

a. Counting

The aspect of counting in the process of making woven fabric was carried out during the calculation of the warp threads to be used. If the number of strands of yarn is denoted by N, the width of the fabric to be made is denoted by L, and the size of the comb is denoted by s, then the determination of the number of strands of warp yarn to be used can be written into the following equation.

$$N = \frac{L}{2{,}5} \times s \tag{4}$$

Mathematical equation to determine the length of warp yarn to be used could be obtained as follows.

$$PB = (PP \times n) + \{(2 \times R) \times (n - 1)\} + (2 \times 20) \tag{5}$$

where:

n = Quantity of woven fabric products to be made

R = Tassel

PP = Length of the woven fabric

PB = Length of the warp yarn

Example:

What is the length of yarn and the number of strands of yarn needed to produce 4 pieces of woven fabric 2 meters long and 1 meter wide without tassels, if the length of the comb on the loom is 90 cm. Furthermore, how many turns of the spinning wheel with a side length of 20 cm in the *Mappali* process must be done to produce the required length of yarn?

Answer:

Let:
$n = 4$, because the number of woven fabrics to be made is 4 pieces
$PP = 2$ meter $= 200\ cm$
$R = 0$, because the woven fabric to be made is a fabric without a tassel
Then, the required yarn length can be calculated using equation (5) above:
$PB = (PP \times n) + \{(2 \times R) \times (n - 1)\} + (2 \times 20)$
$PB = (200 \times 4) + \{(2 \times 0) \times (4 - 1)\} + (2 \times 20)$
$PB = 800 + 0 + 40$
$PB = 840$ cm

From the calculation above, the length of yarn needed to make 4 pieces of woven fabric, each of which is 2 meters long, is 840 cm or 8.4 meters.
The number of strands of yarn required can be calculated using equation (4):
$$N = \frac{L}{2{,}5} \times s$$
Since the width of the fabric to be made is 1 meter (100 cm) and the length of the comb on the loom is known to be 90 cm, then:
$$N = \frac{100}{2{,}5} \times 90$$
$N = 3.600$ strands

To find out the number of turns of the spinning tool in the *mappali* process needed to produce 3,600 strands of yarn 840 cm long, equation (3) can be used.
$P = N \times 6 \times s$
$840 = N \times 6 \times 20$
$840 = N \times 120$
$$N = \frac{840}{120}$$
$N = 7$

From the calculation results, it takes 7 turns to produce 1 strand of yarn 840 cm long. Therefore, to produce 3,600 strands of yarn, it can be calculated using the equation below:
$7 \times 3.600 = 25.200$ rotation

b. Designing
The following was the transcript of the interview between the investigator and the informant:

Researcher : *How to create motifs on woven fabrics?*
Informant : *We must first study the motifs that will be made. Usually there is a picture that is seen, then studied by calculating the distance of each motif with other motifs. After that, determine the location.*

Research *: Have you ever made a motif that has never been made before by anyone else??*
Informant *: Yes.*
Research *: How long does it take to create an entirely new motif?*
Informant *: It usually takes 1-2 days, because we have to think about how to design it.*

Based on the interview results, designing activities were identified in the *Massau* process. Weaving craftsmen meticulously design the motifs that will be incorporated into the woven fabric. Prior to the design phase, weavers examine the motif, particularly if it is a new design that has not been previously made. This requires the application of mathematical critical thinking skills to determine the precise placement of each motif and to calculate the distances between motifs.

Mattennung

Mattennung, or weaving, is the final stage conducted by weavers following the *Massau* process (motif creation). This phase represents the most time-consuming part of the entire fabric-making process (Yuliarnita, 2018). It embodies values of persistence, hard work, discipline, and thoroughness that are essential qualities for weavers (Syukur, 2015). In this study, observations and interviews were conducted with weaving craftsmen. The analysis revealed that the *Mattennung* process carried out by the Wajo community encompasses several fundamental mathematical activities as identified by Bishop (1991), including counting, measuring, locating, designing, playing, and explaining.

a. Measuring

The interview results shows that a mathematical activity identified in the process of creating *Lagosi* woven fabric is measuring. This is evidenced by the process of weaving a plain cloth to a length of 15 cm before proceeding to weave the *Lagosi* flower motifs.

Researcher *: How is the process of making Lagosi woven fabric, from the beginning until it becomes a sarong?*
Informant *: First, the yarn is dyed, then digatti, after which the fabric is cooked, rinsed, then dyed. After dyeing, it is rinsed again and dried in the sun. After drying, it is dyed again. After that, it is saued and then woven. Now, let me explain the weaving process. First, weave the plain cloth about 15 cm. After that, we weave the flower. First, we give colorful colors according to our taste.*

Furthermore, the measurement did not rely on a standard ruler but was conducted using a manually crafted measuring instrument, as illustrated in Figure 11.

Figure 11. Measurement Tools in the *Mattennung* Process

b. Counting

The following are transcripts of interviews between the investigators and informants, which reveal the presence of counting activities involved in the *Mattennung* process.

Researcher : What is usually the minimum number of colors in a flower?
Informant : Usually, it takes 5-7 colors. It depends on the buyer's preference. There can even be up to 10 colors in one Lagosi motif flower.
Researcher : How is the process of making the Lagosi motif?
Informant : Enter the color of the flower, starting from 3 colors first, then woven. Move the flower around by alternately inserting colors according to the motif that we want big. Furthermore, after entering 3 colors, add more colors so that the flower is rather large. The longer it is woven, the bigger the flower obtained.

The interview results revealed a counting activity involving the concept of addition. In this context, adding motif threads to the woven fabric enlarges the flower motif being created. The greater the number of motif threads added, the larger the resulting flower. Weavers must exercise precision in this calculation process to avoid errors. Additionally, this task necessitates critical thinking skills to determine the appropriate quantity of color threads needed for each motif to achieve the desired size.

Mathematical Critical Thinking Ability in the Weaving Fabric Making Process

Mathematical thinking encompasses more than just memorizing formulas or applying established procedures; it involves actively engaging in mathematical processes such as problem-solving, reasoning, and critical thinking (Stein et al., 1996). Key characteristics of mathematical thinking include the ability to connect procedures, approach complex problems innovatively, reason effectively, and understand the underlying mathematical issues (Monteleone et al., 2018). Critical thinking, as described in prior research, involves "mental processes, strategies, and representations used to solve problems, make decisions, and learn new concepts" (Sternberg, 1986). This process includes constructing knowledge, comparing and identifying differences, supporting ideas with reasons and examples, and considering alternative solutions (Florea & Hurjui, 2015).

In the context of weaving, craftsmen demonstrate mathematical critical thinking skills throughout the fabric-making process. For instance, during the massau process, the complexity of the motif directly correlates with the level of critical thinking required. The relationship between mathematical activities in the weaving process and critical thinking is detailed in Table 1.

Table 1. Mathematical activities in weaving process and critical thinking

Mathematical Activities	**Critical Thinking**
	Mappali
Counting dan Measuring	This activity is undertaken by weavers to estimate the precise amount of yarn required. In terms of critical thinking, this involves procedural connection, where weavers calculate and apply the concept of multiplication systematically. Estimating yarn requirements is intrinsically linked to making decisions regarding the quantity of fabric to be produced.
	Massau
Counting, measuring, locating, and designing	This activity is performed by weavers to create motifs. In the realm of critical thinking, weavers make crucial decisions regarding the model, shape, size, and color combinations of *Lagosi* motifs. Specifically, weavers must carefully and precisely plan the placement of yarn strands that form each motif. Additionally, the process of inserting one strand of motif yarn after another into the base yarn demands a high level of cognitive skill and accuracy.
	Mattennung
Counting, measuring, and locating	This activity is undertaken by weavers to integrate three types of yarn—warp yarn, weft yarn, and motif yarn—using a *walida* loom. In the context of critical thinking, weavers demonstrate mental processes, strategies, and representations to create *Lagosi* motifs. They make decisions regarding the organization and utilization of specific parts of the loom to ensure that the motifs are produced accurately in accordance with the planned design.

Based on these findings, the traditional weaving process of *Lagosi* woven fabric represents an embodiment of mathematical critical thinking. This demonstrates that mathematics is naturally acquired through individual experiences within community groups and passed down through generations without formal education. This aligns with the fundamental concept of ethnomathematics, which refers to mathematics that evolves organically within the culture of specific community groups.

The weaving tradition among the Bugis community, which continues to be preserved, embodies social and cultural values such as *reso* (hard work), *tinulu* (persistence), accuracy, discipline, and devotion to God (Inanna, 2015; Surur et al., 2014). Weaving activities typically start at 9:00 AM and continue until sunset, with weavers—primarily women—balancing their time between weaving and household responsibilities. This practice reflects the values of *reso*, *tinulu*, and discipline. Additionally, the Bugis community's weaving process embodies the value of surrender to God, expressed in the Bugis saying, "*Resopa natinulu, natemmanginngi namalomo naletei pammase Dewata Seuwae*," meaning that hard work and persistence are paths to divine favor (Abdollah & Sulo, 2018). This aligns with the goal of ethnomathematics to restore the essence of science for peace and to ethically use mathematics to enhance human values (Risdiyanti & Prahmana, 2020).

The study also reveals that the process of making *Lagosi* woven fabric involves various mathematical activities such as counting, measuring, designing, and locating. These activities indicate that the Bugis community's weaving practices are deeply intertwined with mathematical thinking, which fosters critical thinking among weavers.

These findings are consistent with preliminary research indicating that various ethnic groups in Indonesia have applied ethnomathematics to their traditional woven fabrics. For instance, the Sumba community identifies geometric concepts in their traditional fabrics (Bili et al., 2019), while the Ende community recognizes 2D shapes in their motifs (Merdja & Restianim, 2022). Concepts of transformation geometry—such as translation, dilation, rotation, and reflection—have also been explored in woven fabrics from Sasak, Minangkabau, Tapis Lampung, and Lipa Sabbe (Busrah et al., 2023; Sabilirrosyad, 2016; Susiana et al, 2020; Syahriannur, 2019).

This study complements previous research by exploring mathematical activities in Bugis culture, specifically in *Lagosi* woven fabric, an area less commonly studied. It highlights a natural critical thinking process that arises from weavers' experiences. This critical thinking is a crucial foundation for enhancing students' mathematical skills. Therefore, the study's findings can serve as a valuable resource for incorporating the weaving process into mathematics education, providing opportunities to stimulate and develop students' critical thinking skills in mathematical problem-solving.

The results may also inspire the Bugis community to preserve their weaving tradition, particularly *Lagosi*, as a form of local wisdom that conveys mathematical concepts and fosters critical thinking. This preservation not only honors cultural heritage but also offers an educational resource that bridges culture and formal mathematics education. By integrating traditional weaving techniques into mathematics education, students can be encouraged to design simple motifs, enhancing their critical thinking abilities and understanding of mathematical concepts. Thus, this study fosters a reconnection between culture, mathematics, and learning.

Conclusion

Weaving remains a cherished tradition among the Bugis community, showcasing mathematical activities integral to the process. This study identified various mathematical activities involved in weaving, including *Mappali* process (engaged in counting and applied flat geometry concepts, specifically regular hexagons), *Massau* process (featured calculating and designing activities), and *Mattennung* process (included measuring and calculating tasks).

The findings indicate that Bugis weavers possess significant mathematical critical thinking skills. Thus, the weaving process presents a valuable opportunity for teaching students' mathematical concepts and enhancing their critical thinking abilities. However, the study's scope was limited to exploring basic mathematical activities and flat geometry within the weaving process, without delving into concepts such as geometry transformations. Future research is encouraged to explore additional mathematical concepts and transformations in weaving practices. Additionally, as most weavers are women, future studies should consider the impact of gender on the mathematical abilities of weaving practitioners to provide a more comprehensive understanding of the intersection between weaving and mathematics.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. Additionally, all ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies, have been thoroughly addressed by the authors.

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