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Exploring Motifs In Towe Songke, Manggaraian Ethnic Woven Fabric, In Mathematics Perspective

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ABSTRACT

Connection between mathematical content and the cultures of learners in mathematics education should be acknowledged and explored. This research, conducted using a qualitative research approach, with ethnographic methods, explored the relationship between formal mathematics especially geometric patterns and Motifs of Manggarai Ethnic Woven Fabric, known as Towe Songke in Cibal, Manggarai Regency, a rural area in East Nusa Tenggara Indonesia. Total 3 weavers of the age ranging from 20 to 40 selected based on their weaving knowledge and communication skills. Data were obtained through interviews, observations, field notes, and documentations. The research resulted in how mathematics learning on subjects such as geometry and geometry transformation was associated with the local cultural context of Manggarai. This study identified the line symmetry and the effect of geometric transformations (translations, reflections, rotation, and reflection) of several motifs in Towe Songke. Most of motifs which are found in Towe Songke forms Frieze Pattern F7 because these motifs can be seen as translation, horizontal reflection, vertical reflection and half turn rotation symmetry.

INTRODUCTION

Mathematics, more than any subjects, was considered to be culture-free; result in the perspective of many educators was that mathematics education had no need to take culture of student into account (Kusuma et al., 2017; Pablo-hoshino, 2009; Presmeg, 2014). But now, the need for connection between mathematical content and the cultures of learners in mathematics education is being acknowledged and explored. Mathematics learning needs to provide content/bridging between mathematics in the everyday world based on local culture and mathematics in school (Hanim et al., 2019). The connection between mathematics and culture, according to experts, was known as ethnomatematics (Abdullah, 2017; Biembengut, 2016; Rosa & Orey, 2013). Biembengut (2016) defined ethnomathematics as a way for a culture to understand and use mathematics in everyday

life which is usually related to interesting and informative cultural issues and mathematically rich information. Futhermores, Rosa & Orey (2013) stated that ethnomatematics were mathematical practices of cultural groups that could be identified and considered as studies of mathematical ideas found in certain cultures. Meanwhile, Abdullah (2017) stated that ethnomathematics shifted mathematics from the places where it has been established and developed (university and schools) and spread it to the world, in their cultural diversity and daily activities. So, it can be concluded that ethnomatematics is the study of mathematical concepts and activities that are rooted in people's cultural context in which people try to understand and explore the culture that exists in everyday life in relation to formal mathematics so that mathematics becomes contextual, interesting and informative. In order to accommodate the role of culture in mathematics learning, researchers need to find the link between teaching materials and students' culture to encourage student's development of conceptual learning materials (Makur et al., 2019)

The research conducted in Manggarai Regency, East Nusa Tenggara, was designed to explore the relationship between formal mathematics (*e.g* geometric shapes, patterns, and area) and Manggaraian Ethnic Woven Fabric, known as *Towe Songke*. *Towe Songke* (as seen in Figure 1) was traditionally done by mothers in certain areas in Manggarai-Flores-NTT especially in Todo and Cibal. This study in particular discussed the motifs found in the *Towe Songke*.

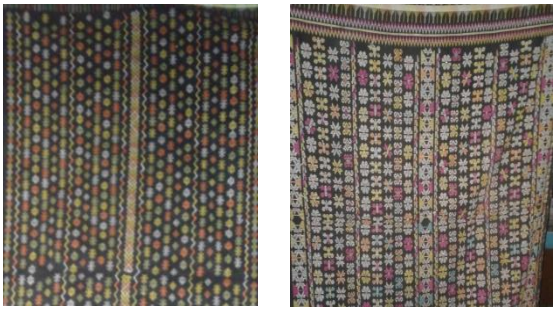

Figure 1 *Towe Songke*, Manggarai Ethnic Woven Fabric

Towe Songke, Manggarai ethnic woven fabric, is very familiar with the lives of Manggarai people. Manggarai people, men and women, wear *Towe Songke* at the time of traditional rituals, liturgical ceremonies in the church, at birth, marriage, and to wrap people who had died. It is also used by dancers in war dances known as Caci. In daily life, *Towe Songke* is also used by the Manggarai people when they bathe and sleep. *Towe Songke* is commonly used by the Manggarai community as a gift between families on various occasions or given to honored guests who come to visit. Nowadays, it is modified into a woven fabric as material for making a suit, shirt, and dress. In short, this is one of the mandatory attributes that are used on various occasions which became the character of Manggarai culture. *Towe Songke*, as seen in Figure 1, has a black base color. The colour black is used because according to Manggarai beliefs, the black color shows the greatness or majesty of the Manggarai people. But some weavers began to use basic colors like maroon, blue, pink and orange, instead of black for their weaving. This is tailored to meet market demands that want bright colors. Usually, woven fabrics like this will be used as material for making suits or dresses used in certain formal events. Although the colors used are different, *Towe Songke* basically has a unique motifs that is full of meaning.

Towe Songke has various motifs and patterns namely the motives usually used are *Jok* motifs, *Wela Kaweng* motifs, *Ranggong* motifs, Su'i motifs, *Ntala* motifs, *Wela Runu*

motifs, and *Mata Manuk* motifs (Senita & Neno, 2018). The *Jok* motif is the basic motifs that shows unity within the Manggarai community, namely unity with God as the ruler of the universe, with humans as the inhabitants of the universe, as well as the unity of human beings with their natural surroundings. The *Wela Kaweng* Motifs shows the relationship of interdependence between humans and the surrounding environment, especially plants, in this case *Kaweng* plants, both their leaves and flowers are believed to be able to treat wounds from pets / livestock. The *Ranggong* motifs is is a motif that resembles the image of a spider as a symbol of honesty and hard work undertaken by the Manggarai community to get fortune in their lives. The *Ntala* motifs is a motif that is closely related to sky-high hopes reaching stars (*Ntala*) that are often echoed in the prayers of the Manggarai people to get health, longevity, and success in their lives. The *Wela Runu* motifs describe the humility of the Manggarai people who want to be like a small flower that is beautiful and beneficial to the surrounding. The Sui motifs that is always present in every *Towe Songke* symbolizes the end of everything, namely that everything has an end and a limit.

The link between *Towe Songke*'s motifs and mathematics seemed to be important since it could be used as a bridge in teaching mathematics from contextual situations that were close to students' lives. It was interesting to see the accuracy of the calculations in making *Towe Songke* by using simple tools since ancient times because it required a fairly good mathematical ability for weavers. Learning mathematics in the context of Manggarai culture is intended to instill a sense of love for culture, make the educated and the younger generation aware that they want to preserve and develop cultural values, and realize that culture is the main and first place to shape one's character and personality. The focus of this research was trying to uncover mathematical facts in the motifs of *Towe Songke*. Knowledge gained from this first study might produce a new approach to learning mathematics, both from a mathematical or mathematical education perspective. The second focus of the problem seeks to reveal the extent to which Songke's motifs were used to facilitate students' understanding in mathematics learning. It was hoped that this research would provide an interesting perspective on how to explore mathematical concepts based on the situation of Manggarai culture. Specifically, the following research questions were addressed: (1) how to make songke motifs in relation to geometric shapes?, (2) how songke motifs were used in facilitating student understanding in mathematics learning?

METHOD

There were two concepts that suited this research well. First, spontaneous mathematics which meant each human being and each cultural group develops spontaneously certain mathematical methods (D'Ambrosio, 1985). In the Manggarai culture, unit lengths are not standardized. For example, unit of length in the daily life of students are paga and depa. Or suppose the division of land using the thumb (*ponggo*). Second, Oral mathematics Carraher in (Gerdes, 2000) : "*in all human societies there exists mathematical knowledge that is transmitted orally from one generation to the next. For example, the exact planting time was passed down from generation to generation by basing it on the full moon."* It is important to study the relationship between the history of mathematics and the reality of students. This dimension directs students to examine the nature of mathematics in terms of understanding how mathematical knowledge is allocated in their individual and collective experiences. Thus, knowledge is built from the interpretation of the way humans have analyzed and explained mathematical phenomena throughout history. This is why it is necessary to teach mathematics in a historical context so that students can understand the evolution and

contributions made by others for the development of ongoing mathematical knowledge (Rosa & Orey, 2013).

This research was conducted using a qualitative research approach, with ethnographic methods. According to Jerome Kirk and Marc Miller in (Kirk & Miller, 1986), qualitative research is a social science approach that observes humans in their territory and interacts with them in their own language and terms. Ethnography was originally developed by anthropologists, but with corresponding adaptations researchers in other fields including mathematicians began using it. Gall, Gall, Borg in (Gall et al., 2007) specifically states that ethnographic methods of research are qualitative research procedures to describe, analyze, and interpret patterns of behavior, beliefs, and languages of a particular cultural group that develop over time. Ethnography involves intensive study of certain cultural features and patterns in these features.

Based on the definition above, researchers in this study used ethnographic methods because this study examined the relationship between Manggaraian culture and mathematics specifically to explore mathematical concepts and ideas contained in motifs of *Towe Songke*, weaving ethnic woven fabric in Manggarai. Furthermore, this research focused on the relationship between motifs of *Towe Songke* and the mathematical concepts, particularly the geometry. By using the ethnographic method of qualitative research methods, researchers will provide a cultural perspective in the contextual learning process.

Quantitative data collection can employ interview approaches, by using more closed-ended procedures in which the researcher identifies set response categories (Creswell, 2012). Data collection in this research was conducted using ethnographic principles, namely interviews, observations, field notes, and documentation. Data were collected with semistructured interviews since the interview is considering as one of the most powerful ways in which researchers try to understand fellow human beings. The one-on-one interview approach is using since during the data collection process the researcher asked questions to and records answers from only one participant in the study at a time. Foster & Cresap (2012)) states that observations, namely researchers directly go to the field to observe the behavior and activities of individuals in the study location. Observations carried out in this study were frank observations, namely researchers in collecting data said frankly to the data source, that researchers were conducting research. While doing this observations, researchers make field notes to write all the informations. At this stage the researcher observes dan takes notes about all the informations related to Manggaraian Etnic Woven Fabric.

Once the data is collected, then analyzed with the measures, namely reducing the data, present data in a short description and a table, and draw conclusions. Test validity of the data is done by using credibility test, transferability test, dependability test, and confirmability test.

RESULTS AND DISCUSSION

The primary purpose of the present study was to explore mathematics element found in Manggarai Ethnic Woven Fabric, *Towe Songke*. Songke motifs can be used in facilitating student understanding in mathematics learning. The research was carried out in the Compang Cibal Village and Lenda Village, Cibal Barat District, Manggarai Regency, East Nusa Tenggara. To obtain research data, the researchers targeted three informants who worked as weavers and were able to explain the meaning of each motif printed on *Towe Songke*. But in the process of carrying out the research, there was another informant who was able to explain the meaning of each motif found in *Towe Songke*. This informant was not targeted as a data source and also not as a weaver, but had knowledge of the Manggarai culture. The information provided by the additional informant was quite accurate in answering the

questions given and justified by the first informant so that the researcher was concerned as an informant. The presence. There were three phases in this research namely : (1) Research Planning Phase, (2) Data Collecting Phase, and (3) Data Analysis Phase. In phase 1, research planning phase, researchers formulated the problems and purpose of the research and spesifically determined focus and scope of the reseach. While formulating the problems and purposes of the reseach, researches conducted several interviews with culutural expert and some literature reviews to strengten knowledge about Manggarai Culture. At this stage, the researcher conducts this analysis to determine the focus of the research so that it can narrow the area of research so that it becomes more focused.

In phase 2, researchers determined the subject of research, conducted interviews with research subjects and asked several descriptive questions, made the observations regarding the process of weaving *Towe Songke*, made field notes, and took some pictures supporting the data. The research was carried out in the Desa Compang Cibal and Desa Lenda, Kecamatan Cibal Barat, Manggarai Regency. Site selection is based on the consideration that since generations, women in this area have woven *Towe Songke*bal. To obtain research data, the researchers targeted three informants who worked as weavers and were able to explain the meaning of each motif printed on *Towe Songke*. But in the process of carrying out the research, there was another informant (brother-in-law of the first informant) who was able to explain the meaning of each motif found in *Towe Songke*. This informant was not targeted as a data source and also not as a weaver, but had knowledge of the Manggarai culture. The information provided by the additional informant is quite accurate in answering the questions given and justified by the first informant so that the researcher is concerned as an informant. The presence of these additional informants was not planned but was in one place when the researcher conducted the interview. During interview, researchers asked questions, made field notes and took some pictures to support research data.

In phase 3, after reducing the data researchers analyzed the results of ethnographic interviews dan observations during the research, conducted analysis, made the conclusions including the link between mathematics espesially Frieze Pattern and motif of *Towe Songke*, and then wrote research reports. Researchers also interviewed customary figures to confirm the data mentioned by the weavers. Reduced interview transcripts along with pictures was analyzed and elaborated to explain the motifs of *Towe Songke*. At this stage,the presentation of this data is in the form of combining information that has been obtained in the form of narrative text. In this study, researchers did not only use narrative text in presenting research data. However, it supports it with a matrix that contains research questions, informant answers, theories that are likely to be related and researchers' interpretations of the informant's answers and the theories obtained.

Data obtained in this study through interviews conducted openly, namely researchers observed songke cloth (*Towe Songke*) and the weaving process and then asked the meaning of each motif printed in the *Towe Songke* as well as the weaving process to form motifs with patterns that were quite neat in *Towe Songke*. The results of the interview with the first informant were reinforced by the second and third informants when the researchers asked "Why is *Towe Songke* colored black? The three informants explained that black as the base color symbolizes greatness, majesty, strength, and submission. Through this black color the Manggarai people were aware of the greatness, majesty and power of God the Creator (*Mori Jari Dedek*). Manggarai people consider themselves to be only a small part of the vast world.

On the second question "Does the motif found in *Towe Songke* have its own meaning or is it just a design to make it look attractive? The second and third informants explained that the motifs found in *Towe Songke* were not just motifs to look beautiful but had conditions in the culture of the Manggarai community. *Towe Songke* motif is also a symbol

that represents the form of traditional houses of the Manggaraian people known as Mbaru Niang as seen in Figure below.

Figure 2 Motifs that represents Mbaru Niang

Towe Songke is also a symbol that describes the process of division of land and the form of traditional houses of the Manggarai people as seen in figure below.

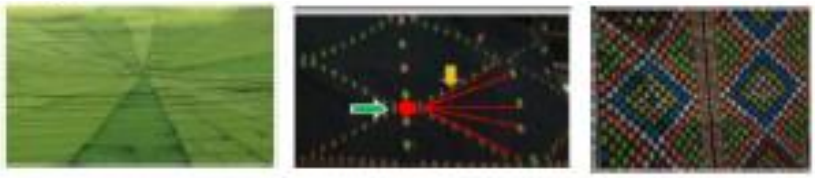

Figure 3 Motifs that represents Lingko

The results of this interview were justified and reinforced by additional informants who said that in the local culture there was a term that said that "mbaru one, uma peang, and towen use". Mbaru one is a house of residence, uma peang is a garden (lingko) where farming is planted, while *Towe Songke* is a body armor. In addition, *Towe Songke* also represented Lodok which is a symbol that describes the process of how the Manggarai community divides land into several parts based on the number of community members who have the right to obtain land ownership. The Manggarai people believe that their life is a network of relations where every aspect of their lives is always related to the other 4 components in the circle of life, with every element of nature, animals, plants, spirits, and God as the center of everything (Sutam, 2012).

Towe Songke has many motifs and the motifs discussed in this paper are *Wela Runu* motif, K*a*li Motif, *Impung* Motif, *Rempa Teke* Motif, 8-*symbol* motif, *Letik* motif, and *Kapal* Motif. We will discuss the philosophical meanings and geometric transformation of each motifs. This geometric transformation will be viewed mathematically as a two-dimensional pattern known as Frieze Pattern. There are seven isomorfic groups of Frieze patterns that will emerge when the symmetries in the frieze patterns identified. Mathematicians have shown that these are the only possible combinations of symmetry for frieze patterns.

The Frieze group is a part of a symmetry group that is built by one-way translation that will form a linear pattern that repeats itself in one direction. Frieze Group or commonly referred as a frieze pattern has a special characteristic that is always built by translation. There are seven different patterns that may be formed from existing isometric combinations. Isometry that can build frieze patterns namely horizontal reflection, vertical reflection, rotation, and glide. The seven frieze patterns can be classified as cyclic or dihedral groups which can be seen in the following pictures.

1. Frieze Pattern with translation symmetry only (Frieze Pattern I, F_1).

The F_1 pattern does not have other isometry other than translation. The symmetry group in this pattern is an infinite cyclic group formed by the composition of the translation function. Illustration of an F_1 pattern using the “footprints” that uses translation information looks like Figure 4.

Figure 4 Frieze Pattern I

2. Frieze Pattern with translation and glide reflection symmetry (Frieze Pattern II, F_2).

The F_2 pattern have with translation and glide reflection symmetry. Illustration of an F_2 pattern using the "footprints" that uses translation looks like Figure 5.

Figure 5 Frieze Pattern II

3. Frieze with translation and horizontal reflection symmetry (Frieze Pattern III, F_3).

The F_3 pattern have with translation and reflection symmetry. This pattern has a reflection whose symmetry axis is parallel to the translation direction. Illustration of an F_3 pattern using the "footprints" that uses translation information looks like Figure 6.

Figure 6 Frieze Pattern III

4. Frieze with translation and half turn rotation symmetry (Frieze Pattern IV, F_4).

The F_4 pattern have with translation and half turn rotation (180^0) symmetry. Illustration of an F_4 pattern using the "footprints" that uses translation information looks like Figure 7.

Figure 7 Frieze Pattern IV

5. Frieze with translation and vertical reflection symmetry (Frieze Pattern V, F_5).

The F_5 pattern have with translation and vertical reflection symmetry. Illustration of an F_5 pattern using the "footprints" that uses translation information looks like Figure 8.

Figure 8 Frieze Pattern V

6. Frieze with translation, vertical reflection, glide reflection and half turn symmetry (Frieze Pattern VI, F_6).

The F_6 pattern have with translation and vertical reflection, glide reflection and half turn symmetry symmetry. Illustration of an F_6 pattern using the "footprints" that uses translation information looks like Figure 9.

Figure 9 Frieze Pattern VI

7. Frieze with translation, horizontal reflection, vertical reflection and half turn rotation symmetry (Frieze Pattern VII, F_7).

The F_7 pattern have with translation and horizontal reflection, vertical reflection and half turn rotation symmetry symmetry. Illustration of an F_7 pattern using the "footprints" that uses translation information looks like Figure 10.

Figure 10 Frieze Pattern VII

The first motive that was discussed was the *Wela Runu* Motif. *Wela Runu* is a kind of small flower plant. This motif means that even if it seems meaningless, every life in this world has benefits. There is no need to be discouraged if it is not considered, because in a certain momentum someone's existence will give great meaning to others. This *Wela Runu* motif belongs to a group of geometric motifs because it is composed of 3 basic geometric shapes, namely, 1 rhombus, 1 regular hexagon, and 6 equilateral triangles. By assuming that the motifs for compiling the Wela Runu motif as in figure 1, it is concluded that Wela Runu motif follows the provisions of the Frieze 7 Pattern because of this motif Frieze with translation, horizontal reflection, vertical reflection and half turn rotation symmetry. Also The *Kali* motif, The *Impung* motif, The *Rempa Teke* motif, The *Letik* motif, The *Kapal* motif which are found in *Towe Songke* also forms Frieze Pattern F7 because these motifs can be seen as translation, horizontal reflection, vertical reflection and half turn rotation symmetry. All motifs can be seen in Figure 11.

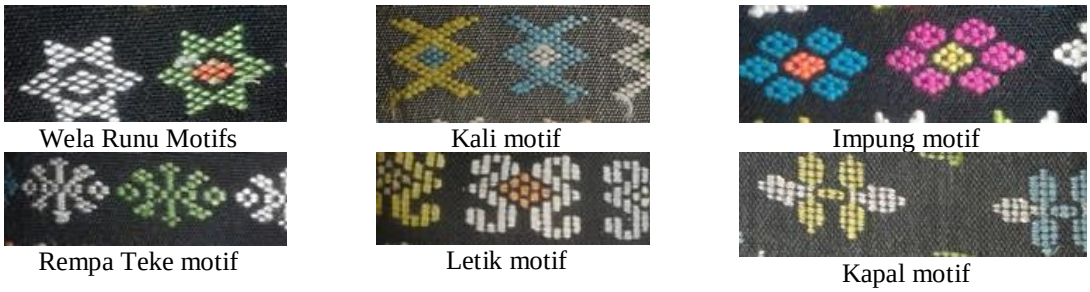

Figure 11 Motifs in Towe Songke, Manggarai Ethnic Woven Fabric

By studying the existing motives and combining them with the Frieze pattern that has been learned, students can create new motifs that are interesting and can be a reference for weavers when weaving modern *Towe Songke*.

CONCLUSION

The results drawn from this study have implications in which ethnomathematics has a significant role in providing the necessary contextual meaning to abstract mathematical concepts. In order to accommodate the role of ethnomathematics in mathematics learning, researchers and teachers need to find the link between teaching materials and students' culture to encourage student's development of conceptual learning materials. Most of motifs which are found in Towe Songke forms Frieze Pattern F7 because these motifs can be seen as translation, horizontal reflection, vertical reflection and half turn rotation symmetry. The findings lead to the recommendation to design a new approach in mathematics educators by engaging students' culture to learning process mathematics.

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ABSTRAK

Hubungan antara konten matematika dan budaya peserta didik dalam pendidikan matematika perlu dieksplorasi dan dikembangkan. Penelitian ini menggunakan pendekatan penelitian kualitatif, dengan metode etnografi untuk mengeksplorasi hubungan antara matematika formal terutama pola geometris dan

Motif Kain Tenun Etnis Manggarai, yang dikenal sebagai Towe Songke di Cibal, Kabupaten Manggarai, daerah pedesaan di Nusa Tenggara Timur Indonesia. Terdapat 3 penenun berusia 20 hingga 40 tahun yang dipilih berdasarkan pengetahuan menenun dan keterampilan berkomunikasi yang baik. Data diperoleh melalui wawancara, observasi, catatan lapangan, dan dokumentasi. Penelitian ini memberikan gambaran bagaimana pembelajaran matematika pada mata pelajaran seperti geometri dan transformasi geometri dapat dikaitkan dengan konteks budaya lokal Manggarai. Studi ini mengidentifikasi garis simetri dan transformasi geometris (translasi, refleksi, rotasi, dan dilatasi) dari beberapa motif di Towe Songke. Sebagian besar motif yang ditemukan di Towe Songke membentuk Frieze Pattern F7 karena motif-motif ini dapat dilihat sebagai translasi, refleksi horizontal, refleksi vertikal dan simetri setengah putaran.

Kata Kunci: Motif, Manggarai, Towe Songke.

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