Ethnomathematics analysis on Jambi plait art as the mathematics learning resources

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Abstract. This research was based on the fact that mathematics is considered a difficult subject and most students have less understanding of mathematics. Meanwhile, culture is believed to be a good learning resource that can help teachers to teach effectively even for mathematics. Art and culture such as plaited mats and hat could be used as a mathematics learning resource that might make mathematics easier and interesting. This qualitative research aimed to understand and analysis the mathematics aspects of the Jambi plait art for mathematics learning as well as the connection of ethnomathematics and Jambi plait art that could be used as mathematics learning resource. Research data were collected by observation, interview, and documentation technique of Jambi plait art products and artists. The result showed that three aspects of Jambi plait art could be used as mathematics learning resource: including counting, measuring, and explaining on some topics such as arithmetic, linear comparison, the surface area of 2-dimensional figures, line pattern and sequences, geometric patterns, and linear programming.

1. Introduction
Mathematics is knowledge of logical about shape, arrangement, scale, and concepts that are classified into three fields, such as algebra, analysis and geometric. Many view mathematics as a difficult subject that cannot be applied much in daily life and is not related to the cultures at all. Most people do not understand how to apply mathematics to solve any problems in daily life, wherein the advantages of mathematics are not significant and could lead to mathematics-phobia.

Based on the observation of some senior high school students, it showed that mathematics was believed as a difficult subject, even scary for the students. Students believed that when learning mathematics, they were only required to recognize many formulas, to understand counting concepts. Students also felt that mathematics is an abstract and absurd subject. The view of mathematics as a difficult subject was caused by the formal mathematics learning environment and often beyond what found in daily life [1]. Mathematics is widely used in daily life, also as a tool and language to solve problems either in mathematics subject itself or other daily life problems.

Education is a part of a culture and has many aspects that influence each other. One of the most important elements of education in the interconnection to the particular culture is the integrity of cultural values into the curriculum content [2]. Since mathematics is applied to daily life, it is needed to figure out the alternatives to make mathematics easier and culturally involved.

One of the alternatives which is growing nowadays is cultural based-mathematics. Involving culture context in teaching and learning process can give and create meaningful learning to achieve the understanding of the integrated scientific information, as well as the understanding of the
implementation of the scientific information on cultural problems context [3]. The cultural community has many mathematics ideas which can be studied and researched.

All formal mathematics was a cultural interaction process, which caused every student experienced the cultural conflicts in the learning process [4]. Education cannot be separated from the culture. There is a strong relationship between education and culture, they complete and support each other. Therefore, education has an important role in the process of cultural heritage; thus cultural values needed to implement in the learning process. Education as the cultural scaffolding, as well as the culture will develop education [5].

Ethnomathematics is a study of the differences in how society solves mathematics problems and simple algorithm according to their mathematics perspectives, which refer to various mathematical shapes as the consequences of the cultural events [6]. In relation to the previous point of view [5], it could be said that ethnomathematics is used as the tool to act in the world. Therefore, ethnomathematics contributes to the social role in an academic context. Cultural based-mathematics learning is one of the ways to create the meaningful and contextual mathematics learning that is related to cultural community, in where mathematics will be studied and implemented.

According to the meaning of ethnomathematics, a study could be conducted on the plait art as part of cultures in its relation to mathematics concept and learning. Some of the plait arts that are commonly used are plait mats and hat. These arts apply patterns which are related to mathematics. Plait is a psychomotor art which involves the common senses and awareness of the symbol with a particular meaning as a traditional art in a community. Plait art still exists until now.

Apart from many usages of the plait arts, the arts are also familiar because of the simplicity. The plait arts are developed on various shapes and motifs that make the shape and motif dynamics. Thus, plait is a society psychomotor activity to create useful objects by overlapping and folding between loom and woof that strengthen each other. This plait art could be considered as the mathematics learning resource that help students to recognize mathematics concept without starting by learning formal mathematics concepts. Jambi is one the provinces in Indonesia that still maintains the development of the plait arts. Thus, the Jambi plait art can be used as a mathematics learning resource that could make mathematics learning easier, unique, and joyful. It is also believed that the plait arts could increase motivation and self-confidence in learning mathematics.

In relation to the descriptions above, it is essential to conduct a further study of mathematical concept and learning that is related to the Jambi plait arts. This study is the preliminary stage to develop learning materials based on the cultural context. This study aims to analyze mathematics aspects of Jambi plait art and its implementation in classroom mathematics learning. Further, it is a study about the connection of ethnomathematics of Jambi plait art to the mathematics curriculum as the mathematics learning resource.

2. Research method
This research was a descriptive research by the qualitative approach. In terms of research purpose, the qualitative research means something related to quality aspect, value or meaning which exist in reality [8]. The subject of the study is the ethnomathematics analysis of plait art related to mathematics learning. The description process involved an observation of the mathematical values of plait arts. The researchers also interviewed the research informants, the artists of plait arts in one of the villages in Jambi, to dig information deeper about plait art and its relationships to the mathematics learning.

This research was conducted on the Jambi plait art workshop, Rumah Anyaman Pandan, Koperasi Usaha Bersama (KUB) Radesta at one of the villages in Jambi province. The selection of the research informants was by purposive sampling [9]. The research instruments were the observation sheet and an interview. The researchers conducted the research by observing and noting the important information and documentation, such as pictures and videotape recording. The interview was an unstructured interview. Interview result was recorded by tape recording and pictures documentation for supporting data. The data were collected from a mathematics teacher, an artist, and a culture expert. Data validity of the research was done by the credibility test using time triangulation, which was the repetition of the
process of plait art information at the different time and the same informant. The data were analyzed by categorizing the data systematically.

3. Result and discussion
The qualitative data were in the form of words and action. The words data were gained from interviews of the research informants, and the action data were acquired by observing the activities of the artist during the production process. Documentation data were gained from references and Jambi museum archives. The picture data were obtained from direct documentation on Rumah Anyaman Pandan, Koperasi Usaha Bersama (KUB) Radesta in Jambi province, as well as from the pictures archives.

3.1 Mathematics aspects in the Jambi plait art.
According to identification and coding results that were conducted by the researcher, the findings showed that there were three aspects of the plait arts that could be used as learning materials, including counting, measuring, and explaining aspects. These results are in line with Bishop [10]. The analysis result from ethnomathematics point of view revealed that culture influenced the impact of activities on a particular environment. By employing ethnomathematics, someone could see the existence of mathematics as the knowledge that can be learnt not only in the classroom but also outside the classroom. While mathematics in the school was recognized as academic mathematics, ethnomathematics is mathematics that is implemented on the cultural community and is identified as the ethnic society, the labor community, a certain age of children, professional class, etc. [6]. Mathematics aspects of the plait art included:

3.1.1 Counting. In the Jambi plait art, counting aspect is found in the raw material collection phase. This activity can be related to a cultural aspect which was done by answering the question ‘how many’, with counting tools and numbering [10,11,15]. When the process of taking pandan leaves, the plait artist usually counts how many leaves have been taken, and then selects them on the plait art. The unit of pandan leaves using “ikat” or “ikatan”. The words of the counting or numbering process can be noted as a natural number, even number and odd number as the numbering concept.

3.1.2 Measuring. Generally, measuring is related to the questions of “how long, how wide, or how many” [15], [19]. The measurement that is related to the number of leaves was used on the plaiting process. Measuring is an activity of selecting materials of the plait. Measuring aspect is also the activity of marketing process, measuring length, width, height, area, volume, speed, etc. This measuring aspect occurred in the selecting the raw materials and in creating the plait mats and hat. When selecting pandan leaves, the artist measured the length and width of the leaves that were needed. During the creating process, the artist used the measuring aspect to measure the length and width of the mat in order to make a proportional mat.

3.1.3 Explaining. In relation to ethnomathematics, mathematics can be learnt by connecting it to local culture. This connecting process is the core of teaching and learning method [12]. Based on that theory, there is the explaining aspect of the daily life activity in the plaiting process. Explaining aspect is related to the understanding of why a certain number pattern occurs, why geometrics shapes have the same patterns, why one result refers to other results, why several relations of nature are related to mathematics law. In the process of creating plait mats and hat, re some steps could be used to represent the explaining aspect. The process of creating the plait would also include an explanation of the creating process.

3.2 The relationships between the mathematics concepts with plait mats and hat as a mathematics learning resource.
Based on the identification of cultural elements that were embedded to mathematics lesson, several cultural values were related to mathematics concepts as could be seen in the following descriptions.
3.2.1 Multiply two (arithmetic) and linear comparison. Based on counting and explaining aspects, the artists have implemented mathematics concepts indirectly, which were the multiplication of two and the linear comparison when selecting the raw materials. The unit that was used on the counting the number of the leaves was “ikat”. There were 50 leaves in 1 ikat. Thus, if one mat needed 2 ikats, then the artist would need 100 leaves. In relation to the linear comparison concept, the students were asked to compare the number of ikats of pandan leaves that would be needed to make a certain number of mats.

\[ \begin{align*}
2 \text{ ikat pandan leaves} &= 1 \text{ mat} \\
4 \text{ ikat pandan leaves} &= 2 \text{ mats} \\
6 \text{ ikat pandan leaves} &= 3 \text{ mats} \\
8 \text{ ikat pandan leaves} &= 4 \text{ mats} \\
2n \text{ ikat pandan leaves} &= n \text{ mat}
\end{align*} \]

Thus, the linear comparison concept would be achieved. Meanwhile, regarding the explaining aspect, almost all mathematics learning use explaining aspect, and also on the plaiting process [15]. Plait process also needs an explanation from the plait artist.

3.2.2 Surface area and perimeter of 2-dimensional figures. According to the measuring aspect, people have used the mathematics concept such as surface area and perimeter of 2-dimensional figures when selecting the raw materials. In this case, the artist measured the length and width of pandan leaves to plait mats and hats in centimeter (cm) or meter (m). 1 pandan leave had the width of 1 cm and the length of 2 m (200 cm), and 1 mat needed 2 ikat pandan leaves or equal to 100 pandan leaves. Plaiting a mat required two ikats of the pandan leaves, 1 ikat to cover all area of the mat and 1 ikat for the plait layer. Hence, the surface area and perimeter of the mat were \(10,000 \text{ cm}^2\) and 500 cm respectively. Those results were obtained because each pandan leave had a length of 200 cm and width of 50 cm. Thus, this problem has taught the concept of surface area and perimeter, which also involved the explaining aspect.

3.2.3 Number patterns and sequences.
- **Number pattern.** The understanding of what aspects the number pattern and sequences involved could be acquired by answering the question “how many”, that is included in counting aspect. Number pattern is the rule of a group of numbers with a certain sequence rule. On the plait art, especially on plait mat, the artist made the pattern as the natural number pattern before plaiting. The basic sequence when the artist plaited the mat was 1, 2, 3, 4, 5,… and put them on a sequence. The artist then inserted other pandan leaves to the odd number of the basic sequence of 1, 3, 5, 7, 9, …, and in turn, to the even number 2, 4, 6, 8, 10, …. Thus, mathematics concept suddenly used on this process (counting process).
- **Sequences.** Likewise the number pattern, sequences also involved the counting aspect [3,10,14,15]. This counting aspect was conducted by answering the question “how many”, by using counting tools and numbering. The plait art also implemented line and sequences, which were used to arrange the distance of inserted leaves to produce the proportional mat.

3.2.4 Geometry. Tessellation principle is widely used in daily life, such as floor tile, cloth motif design, wallpaper pattern, etc.[11]. According to a theory, there is explaining aspect on plait mats and hat directly or indirectly[13].
When plaiting a hat, the artist used the reflection concept in geometry, which says that a reflection to a line $s$ is a function $M$ to the $P$ point on a side. In this case, if the plait hat were divided by 2, there would be 2 same sides in the same shape, same length, and same pattern (Figure 1 and Figure 2). This idea was in line with the findings of other ethnomathematics research [13].

3.2.5 Linear programming. Linear programming also consists of measuring aspect. In this research, there were measuring aspect in relation to the length of pandan leaves which was used in the plait art. Linear program concept was used indirectly, such as determining the patterns, the number of the materials, the timeline that needed to create 1 mat or hat [3,11,15]. Besides, a linear program could be used to minimize the production cost, and to determine material and the number of the plait artist.

4. Conclusion
Several aspects of mathematics could be explained by the use of cultural materials and arts such as plait and mat made from pandan leaves in Jambi culture. This study could give more insights for the researchers to develop meaningful and helpful teaching and learning materials of mathematics. This cultural mathematics learning material can be a good solution to improve the quality of teaching mathematics for the students. Thus, by using such learning materials, it is expected that both teachers and students will find mathematics fun, easy, and interesting to be learned, especially on topics such as arithmetic, linear comparison, the surface area of 2-dimensional figures, line pattern and sequences, geometric patterns, and linear programming.

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