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Ethnomathematics Exploration at *Air Molek* Riau Cultural Hall *Air Molek*

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Abstract

Ethnomathematics is a scientific study of the relevance of culture to mathematics. From the community's point of view, mathematics is a material that is difficult to learn and understand. The research objective in this study was to explore mathematical concepts at the *Air Molek* cultural hall in Indragiri Hulu Regency, Riau Province. This research expects a positive response from the local government to reconstruct the *Air Molek* Cultural hall building and function it properly so that its use is progressive in the socio-cultural and educational aspects. The research method used is ethnographic research, by conducting field surveys, interviews, observation, and documentation. Research data analysis employed data reduction, data presentation, and concluding. The symbolism of Malay culture at the *Air Molek* Cultural hall is a reference for research relevant to mathematics on geometric transformation. The ethnomathematics exploration in this research found transformation geometry concepts, such as the *kaluk pakis* and the hanging bee motif for translation, and Selembayung, the bamboo shoot and ant line motif for reflection.

Keywords: Ethnomathematics Exploration, *Air Molek* Cultural Hall, Geometric Transformation

Abstrak

Etnomatematika merupakan kajian ilmiah dalam relevansi antara budaya dengan matematika. Matematika dalam orientasi masyarakat merupakan materi yang sulit dipelajari dan dipahami oleh pelajar maupun masyarakat umum. Tujuan penelitian untuk melakukan eksplorasi konsep matematika pada Balai Adat Air Molek di Kabupaten Indragiri Hulu Provinsi Riau. Ekspektasi penelitian ini, adanya respon positif dari pemerintah setempat untuk merekonstruksi bangunan Balai Adat Air Molek dan mengfungsikan dengan baik agar kegunaannya mengalami progresif pada aspek sosial budaya maupun pendidikan. Metode penelitian yang digunakan merupakan penelitian etnografi, dengan melakukan survei lapangan, wawancara, observasi dan dokumentasi. Analisis data penelitian dilakukan dengan cara reduksi data, penyajian data, dan penarikan kesimpulan. Simbolis budaya melayu pada Balai Adat Air Molek menjadi acuan pada penelitian berelevansi dengan matematika pada topik transformasi geometri. Eksplorasi etnomatematika dalam penelitian ini menemukan konsep geometri transformasi, seperti motif kaluk pakis dan lebah bergantung untuk translasi, dan motif Selembayung, pucuk rebung dan semut beriringan untuk refleksi.

Kata Kunci: Eksplorasi Etnomatematika, Balai Adat Air Molek, Transformasi Geometri

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Introduction

The Riau *Malay* Cultural Hall (LAMR) is a community organization, for its history of origin enforces customary law and encourages its members to preserve and develop cultural customs in Riau (Museno, 2019). LAM Riau was formed, having several objectives. One of them, is preservation (protection, development, and utilization) of customary and socio-cultural values as a basis for strengthening the identity of the *Malay* community (Asrinaldi & Azwar, 2018). LAM Riau has several functions, one of which is as a gathering place for members of indigenous peoples and socio-cultural values (Iskandar, 2020).

LAM Riau participates in the preservation of regional culture, one of them is conducting an inventory of activities of local customs, arts, and socio-cultural values (Iskandar,2020). LAM Riau is often called the Air Molek Cultural Hall. The *Air Molek* Cultural Hall is a cultural hall located in Pasir Penyu District, Indragiri Hulu Regency, which is part of the Riau province (Dewi & Asriwandari, 2020). The *Air Molek* Cultural Hall functions as a meeting place, cultural meetings, cultural events, and *Malay* cultural arts of Riau (Dewi & Asriwandari, 2020). The architecture of Air Molek Cultural Hall has cultural characteristics that are reflected in the shape, ornaments and colors of Air Molek Cultural Hall (Ramadissa, et al, 2017). The shape of the roof of the Air Molek Cultural Hall building is in the form of a limas roof and kajang roof, while the ornaments of the Water Molek Cultural Hall building are in the form of flora and fauna (Ramadissa, et al, 2017). Riau people in making Water Molek Cultural Hall already use mathematics in making roof shapes and ornaments such as the geometric shapes in the roof and ornaments. Mathematical ideas, ways and techniques that have been used and developed by a culture in an effort to deal with the realities of life are called Ethnomathematics (D'Ambrosio, 2016; Rosa & Orey, 2016). So indirectly, the people of Riau in making Air Molek Cultural Hall already use their own ethnomathematics.

Ethnomathematics was introduced in 1977 by Brazilian mathematician Urbiratan D'Ambrosio (Rosa & Orey, 2016). Ethnomathematics idea is motivated by problems about mathematics that are taught mechanistically and far from the reality of student life, so that students become difficult to understand mathematics and use it to avoid problems in the reality of student life (D'Ambrosio, 2016; Rosa & Orey, 2016; Risdiyanti & Prahmana, 2019). Ethnomathematics that explore mathematics from mathematical ideas, ways and techniques possessed by a culture can be one of the solutions to the problem of mathematics education (D'Ambrosio, 1985).

Culture-based learning is a model of learning approach that prioritizes student activities with a variety of cultural backgrounds, integrates the learning process in certain fields of study, and able to use various assessment manifestations to assess (Wahyuni & Pertiwi, 2017). Ethnomathematics -- mathematics that arises and develops in society and is in accordance with local culture -- is the centre of learning process and teaching methods that are currently developing (Shirley, 2001). This opens a pedagogical potential that considers the knowledge students gain from learning outside the classroom (Wahyuni, *et al*., 2013). The results of the research analysis of prove that the counting system and graphic symbols have a strong correlation with the culture of the two Guarani tribes, namely the Itaty, who lives in “Morro dos Cavalos” and the M'Biguaçu tribe, located between the cities of Palhoça and Biguaçu in the state of Santa Catarina, Brazil (Silva & Caldeira, 2016; Wahyuni & Pertiwi, 2017). Some previous studies have proven that ethnomathematics can be used in developing students' mathematical understanding, among others engklek games can develop understanding of cube nets, (Ariadi, 2020), puppets can develop set understanding (Risdiyanti & Prahmana, 2021; Prahmana & Afit, 2021), traditional house lubuk

linggau can develop an understanding of line position in a field (Sari, Somakin and Yusup, 2021), Soko Tunggal Mosque can develop an understanding of two-dimensional geometry (Putra, Wijayanto & Widodo, 2020), and others.

Therefore, this research aims to explore ethnomathematics or ideas, ways and techniques that have been used and developed by riau culture in building the Molek Water Cultural Hall. The hope is that the results of this study can contribute to the treasures of science, especially the mathematical science of ethnomathematics in riau culture that can be used as a context in close learning of mathematics and can be desired by students. Thus, it can minimize the difficulty of students in learning mathematics and use it in dealing with problems in the reality of student life. In addition, the study is expected to be an inside reference for teachers and researchers in developing ethnomathematics-based learning designs.

Methods

The research method used in this study is ethnographic research methods. Ethnographic research is a method to describe culture (Sukadari, *et al*., 2015). In this study, it prioritizes the use of inductive logic, where categorization is created from the findings of field research (meeting with informants) or from available information. The approach of research will be explained descriptively, where the researcher tries to tell the current problem solving method based on the data. In terms of collecting data, the type of data collected by the researcher is a descriptive data. The data sources used by researchers are as follows:

1. Research Subject

   The subjects in this study were the Airmolek Cultural hall, Kec. Turtle Sand, Kab. Indragiri Hulu, Riau.
2. Research Informants

   In this study, Mr. Rusli Syarif was the research's informant;

   Interviews were conducted regarding the cultural values of the symbols in the Airmolek Traditional Hall building from an ethno-mathematical point of view.
3. Written Documents

   In this case, data can be obtained from related journals about the *Air Molek* Cultural hall.
4. Unwritten Documents

   In this study, data can be obtained from the symbols in the *Air Molek* Cultural hall.

As for how researchers collect data as follows:

1. In the initial stage, the research carried out is to conduct a survey of the *Air Molek* Cultural hall in the field.

2. The second stage, the researchers conducted interviews with informants about the Airmolek Cultural hall.
3. The third stage, the research conducted field observations.
4. Document the research subject.

Data collection techniques that researchers used are interview guidelines, observation guidelines, electronic devices such as smartphones, laptops and cameras. Data analysis was done by

1. Data reduction

   Researchers wrote all the results of the field data as well as summarizing, selecting and sorting out the important things and analysing them.
2. Data presentation

   Researchers carried out a complex process of compiling information into one systematic, simpler more selective form, thus the meaning could be easily understood.
3. Conclusion

   Researchers drew conclusions from the data.

The stages of determining the value of mathematics are carried out in the following manner:

1. conduct a literature review on various kinds of *Malay* traditional motifs;
2. find the mathematical elements found in the *Air Molek* Cultural Hall's; and
3. connect the mathematical elements found with mathematical concepts in learning;

Results and Discussion

The results of ethnographic research that examined the building of Air Molek Cultural Hall found that in the construction of Air Molek Cultural Hall the people of Riau have used their own mathematical ideas, ways and techniques, especially in building the roof of The Air Molek Cultural Hall and forming ornaments of flora on the walls of the building. Air Molek Cultural Hall serves as a meeting place, cultural meeting, cultural event, and cultural arts of Riau Malay (Dewi & Asriwandari, 2020). The Air Molek Cultural Hall building can be seen in Figure 1.

Figure 1. Air Molek Cultural Hall (www.lamriau.id)

Syarif (2021) stated that the characteristics of Air Molek Cultural Hall are in the architectural form of the roof, the abtuating and ornaments attached to the building. The architectural form of the Air Molek Water Cultural such as (Wahyuningsih & Abu, 1986; Felita et al, 2018; Syarif, 2021):

1. *Air Molek* Cultural Hall's roof

   There are 3 types of Riau *Malay* architectural roofs, namely: *Lipat Pandan* roof (a roof with steep angle), a *Lipat Kajang* roof (a roof with less steepness, or even almost flat), and the *Ampar Labu* (a roof that is added to support the upper roof) (Wahyuningsih & Abu, 1986; Felita et al, 2018; Syarif, 2021). Water Molek Cultural Hall roof type (Figure 2) uses a type of roof architecture.

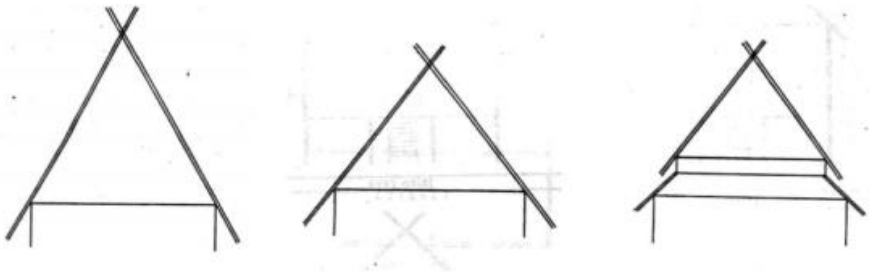

Figure 2. Cultural Hall roof type

2. *Selembayung Air Molek* Cultural hall

   Selembayung is a decoration that is located on the roof, while the decorations at the ends of the right and left sides of the roof are the wings of a *layang-layang*, drawn in Figure 3 (Wahyuningsih & Abu, 1986; Felita et al, 2018; Syarif, 2021). *Selembayung* is in the form of ornate carvings which are crossed at the two ends of the building. *Selembayung* is placed in the highest position with meaning. The carving of the spear in *Selembayung* is a symbol of authority and strength. Likewise,

the motifs of flowers, leaves and others symbolize nature, harmony and affection for the lives of various *Malay* communities (Wahyuningsih & Abu, 1986; Felita et al, 2018; Syarif, 2021).

Figure 3. Wings of *Layang-layang*

The cross shape symbolizes the wishes for happiness, perpetuity, and ancestry. *Selembayung* in cultural *Malay* houses in Riau usually uses golden yellow colour as a symbol of the courage of a close brotherhood (Wahyuningsih & Abu, 1986; Felita et al, 2018; Syarif, 2021). *Selembayung* which is found in the *Malay* Riau cultural hall has a leaf motif and golden yellow, presented in Figure 4.

Figure 4. *Selembayung* motif

3. Variety of Ornaments

   There are various types of decorations or ornaments in *Malay* architecture (Wahyuningsih & Abu, 1986; Felita et al, 2018; Syarif, 2021):

   a. Vegetation motifs

      The vegetation motifs is divided into 3 groups, namely: the *kaluk pakis* group having leaf and root motifs (Figure 5), the bamboo shoots group (Figure 6), and the flowers group (Figure 7).

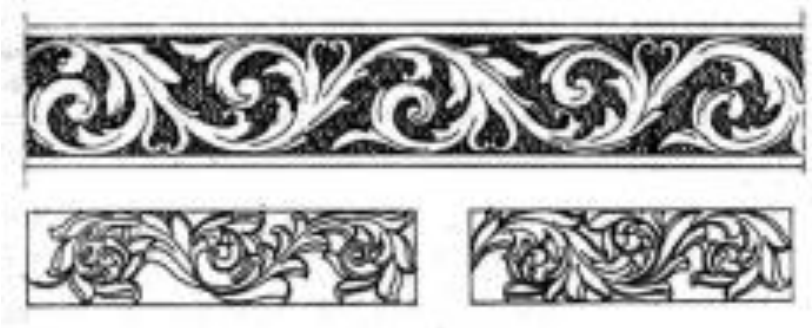

Figure 5. *Kaluk pakis*

Figure 6. Bamboo shoots motif

Figure 7. Motif bunga

b. Animal motifs

The fauna decoration is decoration with animal motifs. There are several animal motifs such as a line of ants, a raft of ducks (Figure 8), and hanging bees (Wahyuningsih & Abu, 1986; Felita et al, 2018; Syarif, 2021). The decorative motifs found at the Riau Malay Cultural hall are: kelok pisang motif, bamboo shoot motif, line of ants motif (Figure 9), and hanging bee motif (Figure 10).

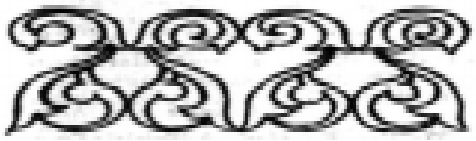

Figure 8. A raft of ducks motifs

Figure 9. line of ants motifs

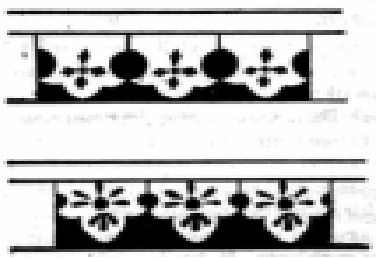

Figure 10. hanging bees motifs

There are several mathematics concepts in Air Molek Cultural Hall as follows.

a. The Mathematical Concept of Air Molek Cultural Hall Roof

At the *Air Molek* Cultural Hall, there is an application of mathematics in the *Air Molek* cultural hall building. Especially on the roof, *Selembayung* and the motifs in the *Air Molek* Cultural Hall. *Air Molek* Cultural Hall's roof Atap balai adat *Air Molek*

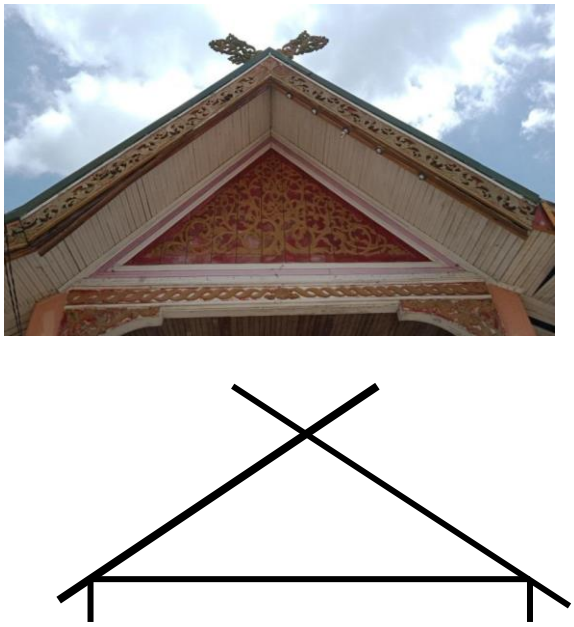

Figure 11. The triangle on the roof of the *Air Molek* traditional hall

Figure 11 shows that the roof of the Air Molek Cultural hall is a triangle whose angles sum to 180 degrees. This is related to Euclid's geometric theorem which reads "the sum of angles in a triangle is one hundred and eighty degrees". Triangles have several types, namely: a right triangle, an isosceles triangle, an equilateral triangle, etc. Each type of triangle has its own special characteristics (Hartshorne,2013).Tthe form of Air Molek Cultural Hall Roofi is an equilateral triangle sides are three equal.

b. The Mathematical Concept of Selembayung Cultural Hall Air Molek

Selembayung at the *Air Molek* Cultural hall uses leaf motif and golden yellow colour. In the form of *Selembayung*, the transformation geometry is applied in the form of reflection. Figure 12 shows the application of the reflection concept. Researcher put a imaginary y-axis on the shape of Selembayung. When the researcher places the imaginary y-axis in the middle of the Selembayung image, it can be seen that the left-hand side is the reflection of the right-hand curve and vice versa.

Figure 12. Geometry of transformations in *Selembayung*

c. The Mathematical Concept of Ornaments

1) *Kaluk pakis* motif

The decoration applied at the *Air Molek* cultural hall is the *kaluk pakis* motif. *Kaluk pakis* motif is located on the edge of the triangular ornament. The *kaluk pakis* motif contains the transformation geometry, in which applied in the form of translation (shift). Figure 13 is the application of translational concept. If we put imaginary y-axis, we can see that if we shift the left-hand side to the right, it will create the same motif.

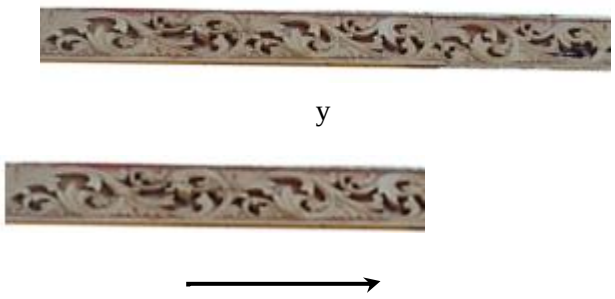

Figure 13. Geometry of transformation in *kaluk pakis* motif

2) *Pucuk rebung* motif

One of the decorations applied at the *Air Molek* Cultural Hall is the bamboo shoots. The bamboo shoots motifs are located on the roof. The motif is drawn inside a triangle. The bamboo shoot motif symbolizes fertility and happiness in life. In the bamboo shoot motif, it contains the application of transformation geometry, reflection. Reflection is where all the points of an object are reflected or flipped on a line called the axis of reflection or line of reflection (Figure 14). The researcher places an imaginary axis in the middle of a bamboo shoots motif so that they are divided into two right triangles. In this case, the part of the left side is the reflection of the right side.

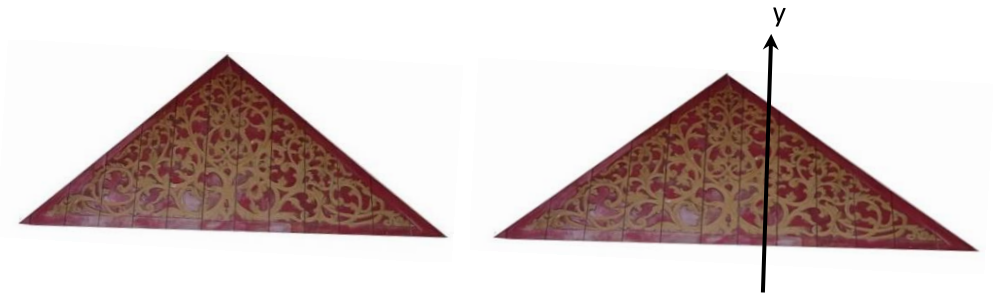

Figure 14. Geometry of transformation in bamboo shoot motif

3) Line of ants motif

One of the decorative styles applied at the *Air Molek* Cultural Hall is the line of ant motif. The line of ant motif symbolizes harmony and diligence. In the line of ant motif contains the application of transformation geometry in the form of reflection. In Figure 15, the researcher puts the imaginary y- axis in the middle of the line of ant motif, it can be seen that the right side of the image is the reflection from the left side of the image. The concept of reflection has been widely applied in everyday life, for example when we are looking in the mirror.

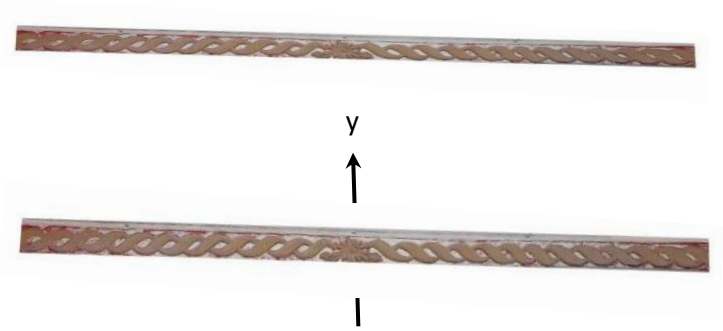

Figure 15. Geometry of transformations in the line of ant motif

4) The hanging bee motif

One of the decorations applied at the *Air Molek* Cultural Hall is the hanging bee motif. In this motif, bee is an animal that symbolizes of bringing benefits. In the hanging bee motif, it applies transformation geometry in the form of translation (shift). Translation is the movement or shift from a point on a straight line. Just like moving chess pieces (except horses) when moving the pawns, the player can only move along a straight line according to the rules. Translation takes point (x, y) to point (x + a, y + b). Translation is isometric without a fixed point. In Figure 16, the researcher places the imaginary y-axis in the middle of the hanging bee motif. It can be seen that the right image is the result of a shift from the left image. This translation concept has been widely applied in everyday life such as in escalators or elevators

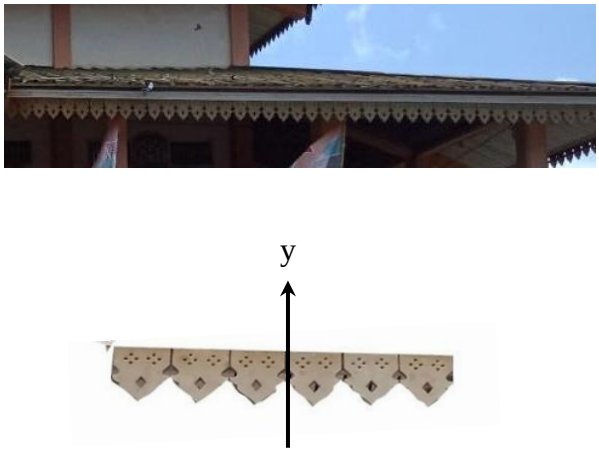

Figure 16. The transformation geometry of the hanging bee motif

The results of this exploratory ethnomathematics study contribute to complementing several previous studies that have examined ethnomathematics from various cultures in Indonesia, such as Rumah Gadang Minangkabau (Rahmawati, 2020), the Marosok traditional trading (Nurjanah, Mardua & Turmudi, 2021), the Batik Patterns of Yogyakarta (Prahmana & D'Ambrosio, 2020), Megono Gunungan (Nursyahidah & Saputro, 2020), and Pranatamangsa System and the Birth-Death Ceremonial in Yogyakarta (Prahmana, Yunianto, Rosa, & Orey, 2021). Thus, these findings can add new knowledge related to education and culture and refer to real cultural-based contexts in Indonesia that can be used as a starting point in learning mathematics.

Conclusion

There are several decorative motifs on the roof of the *Air Molek* Cultural hall that have their own meaning. The results of the exploration in the *Air Molek* Cultural Hall building were several mathematical concepts of geometric transformation, including triangle, shift (translation), and reflection. As for the study of other mathematical concepts at the *Air Molek* Cultural Hall that can be explored, namely mathematical elements for rectangular, square, and tiered shapes. From these results, we can build interconnection between local culture and mathematics to raise awareness that Air Molek Cultural Hall has applied mathematical concepts in its culture. With public awareness, researchers hopes that teachers can use these findings to teach mathematical concepts such that students can learn mathematics easier and better.

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In completing this research, researchers received a lot of guidance and assistance from various parties. Researchers would like to thank Mr. Rusli Syarif, as a resource who has helped researchers in gathering information related to the *Air Molek* Cultural hall. Pemuda Pancasila members who have assisted researchers in gathering information related to the *Air Molek* Cultural hall. Hopefully, the results of this research will become a valuable work and a historical record for readers. Especially for mathematics teachers in Indragiri Hulu District schools, such that they can implement local cultural values in mathematics learning.

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