

CONFERENCE PROCEEDING

The Concept of Transformation on Pandan Mat Weaving Art

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ABSTRACT

Designing the Kelarai pattern is not easy and it requires mathematical skills to ensure a consistent design. Three key skills are required to produce the Kelarai design which are creatively to shape the pattern, ability to calculate the weave angle and arrange the colours, and efficiency in weaving to ensure that weave overlays are done consistently. In Mathematics, rotation, reflection, and enlargement are types of transformation concept to make some changes in any given geometric shape. In this research, the concept of transformation on pandan mat weaving art at Kolej GENIUS Insan was analysed. The main objective is to determine the pattern of Kelarai Kepala Gajah between the combined transformation Z , followed by Y , X and W that also can be written as transformation $WXYZ$. Under the combined transformation, Z is defined as an anticlockwise rotation of 90° about the center origin. After rotation, the image formed was reflected using Y and X transformation, which are reflection on line $x = 0$ and on line $y = x$, respectively. The transformation W described the final image of Kelarai Kepala Gajah pattern, where the concept of enlargement with scale factor 2 at center of $(7, -7)$ was applied. However, the enlargement with scale factor 2 at center $(7, 7)$ in a single transformation shows the same results as the final image under combined transformation $WXYZ$. The uniqueness of Kelarai Kepala Gajah pattern can be shown when the final image remains the same for both combined and single transformation were applied.

Keywords: *ethnomathematics; transformation; Kelarai Kepala Gajah; pandan mat; INAQ gifted education*

INTRODUCTION

Mathematics is an art that includes forms geometry that is processed and varied to produce an interesting pattern and perfect (Ismail & Atan, 2010). The application of mathematical skills has long existed among activist's art, so many geometric shapes are used as a reference for produce beautiful and symmetrical combinations of motifs and patterns (Tarmizi, 2013). The object is said to have properties symmetry if each part of the object, which is the result of division the point, line or plane that is made the center or axis of the object, consists of similar parts (Salleh, 2009).

Symmetry is a transformation that allows objects or the pattern remains unchanged by maintaining the order of the original shape and size of the motif the reversal process occurs on a plane strip. The basis of repetition to produce symmetrical patterns are through translation, reflection, rotation and sliding reflection (Ruzaika, 2008).

According to Rushana and Halim (2019), the pattern and motifs in Malay art works are rich with mathematical values which can be seen on any geometric designs. Their mathematical thinking was born in culture and value system of a race or

ethnicity. The combination study of these two aspects such as culture and mathematics known as ethnomathematics (Ismail, 2004). Ethnomathematics is defined as mathematics that is built along with a society's value system, culture and outlook on life. This means that mathematics value is supported by the science of mathematics itself and the culture of society where mathematics is taught and developed. It connects culture and mathematics from various aspects namely art, literature, religious education and thought (Ismail *et al.*, 2012).

Malay art includes the creation of carving art, weaving art, painting, architecture and textile art. It proves that the Malay community has high thinking power in the production of art. Mathematics concepts at work art can be seen through the meaning implied through the composition and pattern delicate and artistic. It can be seen in songket weaving, mengkuang weaving, art carpentry, wood carving and other arts. Artistic production requires skills, creativity, thinking and knowledge in relation to nature life (Shuhaimi *et al.*, 2011).

Geometry is one of the three decorative motifs in Islamic art that does not use figures other than calligraphy and Arabic motifs. Geometric motifs in Islamic art use the method of repeating basic shapes such as squares, triangles and circles which can eventually produce very complex and impressive patterns (Zakaria *et al.*, 2018).

Geometric motifs in Islamic art are often found in the production of handicrafts, architecture, ceramics and carpets. In traditional Malay society, the geometric patterns in Islamic art is often produced through the manufacture of daily items such as mats, baskets and pottery because the geometric patterns have their own uniqueness and attractive.

The geometric design of the Malay nature usually applied in the art of weaving. Malay weaving art has a decorative technique known as kelarai, where it is defined as a damdam-shaped woven pattern. This name comes from the word “dam” which refers to a rectangular pattern known in Malay art as a chess site. Woven is the skill of weaving leaves such as mengkuang leaves (*Pandanus artocapus*), sea pandan (*Pandanus tectorius*), rattan (*Calamus peregrinus Furtado*), oil bamboo (*Bambusa vulgaris*), and giant bamboo (*Dendrocalamus asper*).

According to Mariam and Marzuki (2021), there are three types of nature element use to produce the pattern of Kelarai which are flora, fauna and abstract. The element of nature has become a source of ideas for weavers to style images of fauna, such as birds and animals. They also use flora such as plants and flowers as sources of motifs. Some motifs are inspired by abstract elements such as cosmology and names of prominent figures.

Designing the Kelarai pattern is not as easy as it seems as it requires mathematical skills to ensure a consistent design. Weavers need to master three key skills to produce the Kelarai design, where they need to shape the pattern creatively, ability to calculate the weave angle and arrange the colours to produce a pattern, and efficiency and precision in weaving to ensure that weave overlays are done consistently.

Ahmad and Razmah (1996) stated that there are three common Kelarai pattern designs among the Malay community which are Flora (*bunga cengkeh, bunga pecah lapan, bunga cempaka, bunga durian, bunga tanjung, beras patah, cengkeh beranak*), fauna (*tapak anjing, tapak harimau, mata bilis, kepala gajah, siku leluang, kepala lalat, tulang ikan*) and abstract (*pucuk jala, kelarai putus masa, kelarai cik kedah, kelarai mak mek, kelarai sambas, kelarai tak bernama*).

In this research, the concept of transformation on pandan mat weaving art at Kolej GENIUS Insan was analysed. The main objective is to determine the pattern of Kelarai Kepala Gajah between the combined transformation Z , followed by Y , X and W that also can be written as transformation $WXYZ$. Then, the pattern of Kelarai Kepala Gajah under the combined transformations $WXYZ$ was compared to the final image of Kelarai Kepala Gajah under single transformation.

METHODOLOGY

Combined transformation

Combined transformation is defined as applying more than one transformation concept on a geometric shape. Rotation, reflection and enlargement are types of transformation concept to make some changes in any given geometric shape.

A rotation is a transformation in which the object is rotated about the center of the rotation, while the direction can be clockwise or anticlockwise. A reflection is a transformation that occurs when all the points on the plane are reversed in the same plane on a line. The properties of the image under a reflection should be similar and congruent as the object. The image has different orientations, inverted sides and forms mirror images with one another. An enlargement is a transformation which has the center of enlargement that move all points at a constant ratio known as scale factor from the center (How *et al.*, 2020).

Combined transformation $WXYZ$ means that transformation Z followed by Y , X and W . The pattern of Kelarai Kepala Gajah under the combined transformation $WXYZ$ was determined where;

W : Enlargement with scale factor 2 at center $(7, -7)$

X : Reflection on straight line on $y = x$

Y : Reflection on line $x = 0$

Z : Rotation of 90° anticlockwise about the center origin

Single Transformation

Single transformation contains only one step of transformation on a geometric shape. The pattern of Kelarai Kepala Gajah under the single transformation was compared to the final image of Kelarai Kepala Gajah under combined transformations $WXYZ$.

RESULTS AND DISCUSSION

Figure 1 shows the process of object A undergoes combined transformation $WXYZ$. Figure 1(a) is the first step of transformation Z such as rotation of 90° anticlockwise about the center origin. Then, the object of kelarai kepala gajah pattern was reflected on line $x = 0$ and on straight line on $y = x$, under transformation Y and X , respectively. This images have been shown in Figures 1(b) and 1(c). Lastly, the object was enlarged with scale factor 2 at center $(7, -7)$ in transformation W . Figure 1(d) show the last image of kelarai kepala gajah pattern under combined transformation $WXYZ$.

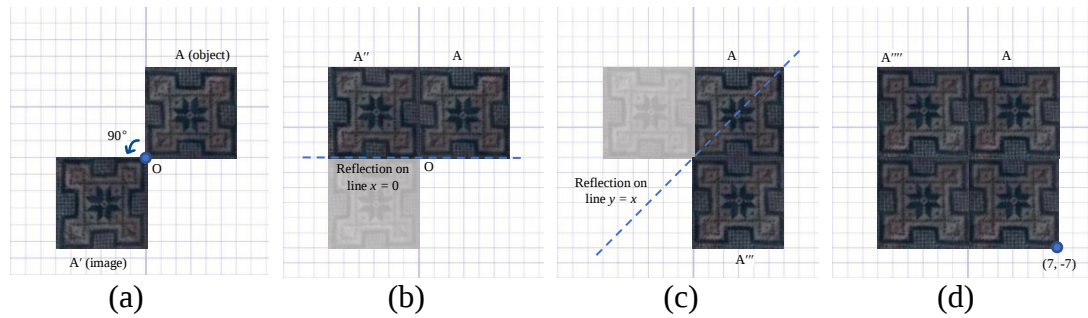


Figure 3. Image of object A under combined transformation $WXYZ$

Figure 2 shows the image of object A under single transformation. The enlargement with scale factor 2 at center $(7, 7)$ in a single transformation shows the same results as the final image under combined transformation $WXYZ$. The uniqueness of Kelarai Kepala Gajah pattern can be shown when the final image remains the same for both combined and single transformation were applied.

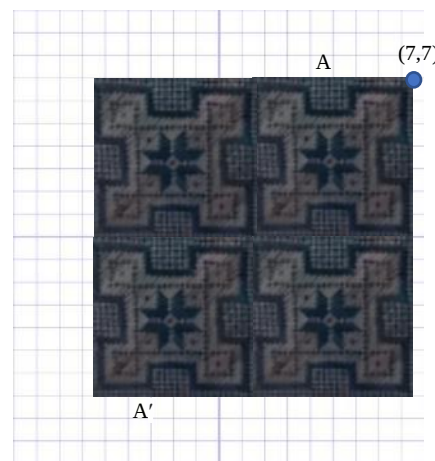


Figure 2. Image of object A under single transformation

INTEGRATION OF NAQLI AND AQLI

Stated in the Holy Quran, from Surah Al-Baqarah verse 143, which means:

“Thus, We have made of you an Ummah justly balanced, that ye might be witnesses over the nations, and the Messenger a witness over yourselves...”

The balanced community mentioned in the verse refer to us being the witnesses over the nation’s act. Allah has put us in balance so that no one will left behind and together helping each other. So, the balance is a very great thing. Islam teaches us to be moderate and balanced in all aspect of life whether it is about religion, daily activities, ideas and more. There is no such thing as overweight or else.

Balance is actually making us feel calm. In aspect of a design pattern, it is very true that if the pattern is not equally balanced, we will find it boring and not attractive. That’s why the ancient people created this pandan mat design pattern repeatedly and constantly same. The balance in the pattern arouses our interest through the eye.

CONCLUSION

In Mathematics, rotation, reflection and enlargement are types of transformation concept to make some changes in any given geometric shape. In this research, the concept of transformation on pandan mat weaving art at Kolej GENIUS Insan was analysed. The main objective is to determine the pattern of Kelarai Kepala

Gajah between the combined transformation WXYZ and was compared to the final image of Kelarai Kepala Gajah under single transformation. Under the combined transformation, Z is defined as an anticlockwise rotation of 90° about the center origin. After rotation, the image formed was reflected using Y and X transformation, which are reflection on line $x = 0$ and on line $y = x$, respectively. The transformation W described the final image of Kelarai Kepala Gajah pattern, where the concept of enlargement with scale factor 2 at center of (7, -7) was applied. However, the enlargement with scale factor 2 at center (7, 7) in a single transformation shows the same results as the final image under combined transformation WXYZ. The uniqueness of Kelarai Kepala Gajah pattern can be shown when the final image remains the same for both combined and single transformation were applied.

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