The Inspiration of Geometrical Concepts in *Mengkuang* Weaving Motifs

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ABSTRACT

Every beautiful piece reflects a labour of love and the story of a dying art. Passed from generation to generation, these skills are now possessed by a few master crafts persons. The art of weaving dried leaves of various plants has been a part of many indigenous cultures for centuries. *Mengkuang* leaves are commonly used to make household items such as floor mats, rice holders, food covers, and different kinds of bags and baskets. Some new products that have been introduced in recent times include purses and lamp shades, sometimes innovatively combined with textiles to widen their use and appeal. Weaving is a form of art that involves the interlacing of sets of leaf blades processed according to certain disciplines to create mats and house walls which can be seen almost everywhere. Woven products are made from tropical plants and therefore making them widely available in the country. In the art of *Mengkuang* weaving design, the geometrical shape in weaving is divided into three categories like original geometrical design, natural geometrical design, and arrangement of the geometrical design. The original geometrical designs have existed for many years. The geometrical arrangement design is a combination of the natural geometrical design in producing an abstract. Motifs or *Kelarai* is a design found in the *Mengkuang* weaving motifs. *Kelarai* is a motif that results from a weaving pattern. *Kelarai* is made in a variety of motifs and its role is the same as the floral pattern in weaving. The name will be different if woven in different shapes, sizes and arrangements. The objective of this study is to analyse the geometrical element in the *Mengkuang* weaving motifs or *Kelarai*. A study on geometrical concepts focusing on 8 motifs out of 51 motifs produced by the weavers in Bukit Tanah, Kelantan to analyse mathematical concepts that appear on the *Mengkuang* weaving motifs.

Keywords: *Mengkuang Weaving Motifs, Geometrical Concepts, Kelarai*

INTRODUCTION

Weaving is a traditional form of art inherited from our ancestors without any external foreign influences. Weaving involves the process of crisscrossing raw materials obtained from specially selected plants to be formed into usable products. There are six types of weaving which are *Mengkuang* leaves weaving, pandan leaves weaving, Wild Bornean sago leaves weaving, rattan core weaving, coconut leaves weaving and fern leaves weaving. Mengkuang weaving involves the same process of crisscrossing the dried processed *Mengkuang* leaves in making mats and other handicrafts as a leisure time activity.

Kelarai is a motif design found in the Mengkuang weaving. *Kelarai* is a motif that results from a weaving pattern. *Kelarai* is made in a variety of motifs and its role is the same as the floral pattern in weaving. The *Kelarai* design emphasises more on the use of colour arrangement on a regular weave or *ghadas*. Colours are important in determining the pattern. The patterns are interwoven alternately to leave the original geometric effect. The name will be different if woven in different shapes, sizes and arrangements.

Kelarai in the art of *Mengkuang* weaving is termed as the process of composing shapes that are woven to produce an interesting style or *Ragam hias* as the main motif. *Kelarai* is composed either in a single arrangement or arranged in a specific space to produce a specific style or style. The formation of *Kelarai* is done simultaneously during the weaving process. *Kelarai* weaving is usually planned in advance by using 'eyes' or 'steps' to create various types of *Kelarai*. There are now about 51 types of *Kelarai* that are based on elements of nature such as plant and animal elements. There are also *Kelarai* that are associated with people's names such as *Kelarai Cik Kedah* and *Kelarai Mak Mek* or place names such as *Kelarai Sambas*.

In making *Kelarai*, the main thing to observe is the number of points or steps from the leaf blades used. The number of points determines the size of each pattern. To highlight the *Kelarai*, the blades are dipped in two opposite or contrasting colours. For example, yellow and green, red and purple, or white and brown. Sometimes a third colour is used as the ground or background of the pattern. These coloured blades that are woven over and over and alternately will give the result of *Mengkuang* and pandan weaving. There are 51 *Kelarai* that have been recorded and popularised among local weavers, especially in Kelantan and Terengganu. The types of *Kelarai* that have been identified by previous researchers are categorised into 4 groups, namely *Kelarai* from plants, *Kelarai* from humans, *Kelarai* from animals, and *Kelarai* from abstract forms.

LITERATURE REVIEW

According to Siti Zainun (Traditional Malay Handicraft Design), the geometrical shape in weaving is divided into three categories like original geometrical design, natural geometrical design, and arrangement of the geometrical design. The original geometrical designs have existed for many years. In these motifs, a combination of lines can produce shapes geometrical without a particular shape. The simple shape and geometrical pandanus weaving design were first known as 'gadas'. There are two important features in the decorative style of weaving, namely the creation of *Kelarai* (motifs) and patterns. The term *Kelarai* is devoted to "shaped" motifs (often elements of nature) while pattern refers to an arrangement of colours without referring to the arrangement of colours and shapes of motifs. Weaving without *Kelarai* is referred to as "gadas". There are about 51 types of *Kelarai* based on natural elements such as plant and animal elements.

According to Hajah Minah bt Mohamad, one of the experts in the art of weaving *Mengkuang* in a book entitled *Serian Kelarai* published by Kraftangan Malaysia, before the establishment of RIDA in

February 1957, there were 17 types of *Kelarai* that are very popular among weavers on the east coast, namely:-

1. *Kelarai Berdiri*
2. *Kelarai Sambas*
3. *Kelarai Sambas Di Dalam*
4. *Kelarai Kisar Mengiri*
5. *Kelarai Anak Ikan Sekawan*
6. *Kelarai Berati*
7. *Kelarai Tapak Harimau*
8. *Kelarai Mata Berkait*
9. *Kelarai Bunga Tanjung*
10. *Kelarai Pecah Lapan*
11. *Kelarai Bunga Cina*
12. *Kelarai Gedong*
13. *Kelarai Pucuk Rebung*
14. *Kelarai Mak Mek*
15. *Kelarai Kepala Gajah*
16. *Kelarai Buntut Siput*
17. *Kelarai Bunga Cengkih*

In a book entitled ARTS and CRAFTS, The Pandan Weaving Industry of Terengganu written by E.F. Allen and J.H. Gray, a total of 14 types of *Kelarai* motifs were produced during the establishment of RIDA around 1957 making the total *Kelarai* to 31 types in total, namely:-

18. *Kelarai Tampok Pinang*
19. *Kelarai Berakar*
20. *Kelarai Tampok Manggis*
21. *Kelarai Jari Kedidi*
22. *Kelarai Bunga Cengkih Beranak*
23. *Kelarai Cik Kedah*
24. *Kelarai Anyaman Gila*
25. *Kelarai Bunga Cempaka*
26. *Kelarai Siku Keluang*
27. *Kelarai Pucuk Jala*
28. *Kelarai Sisik Kelah*
29. *Kelarai Cik Kedah Bersila*
30. *Kelarai Tapak Anjing*
31. *Kelarai Bunga Melor*

There are 15 types of *Kelarai* that have been produced after the Handicraft Development Center (MARA) took over with the cooperation of the Manager and Teachers of Weaving Center Kuala Terengganu who have made a study in recording the names of *Kelarai*. A total of 46 types of *Kelarai* that has been identified:

32. *Kelarai Belah Ketupat*
33. *Kelarai Beras Patah*
34. *Kelarai Berati Berkaki*
35. *Kelarai Bunga Ator*
36. *Kelarai Bunga Beremban*
37. *Kelarai Bunga Durian*
38. *Kelarai Bunga Mempelas*
39. *Kelarai Cik Kedah Berakar*

40. *Kelarai Cik Kedah Ketapan*
41. *Kelarai Mata Bilis*
42. *Kelarai Kepala Lalat*
43. *Kelarai Putus Masa*
44. *Kelarai Tampok Jantung*
45. *Kelarai Tampok Pinang Bandai*
46. *Kelarai Mata Punai*

Under the Malaysian Handicraft Development Corporation, in November, 1980 (Serian Kelarai book), a study to collect the names of *Kelarai* designs was conducted and as a result there were the addition of 5 new types of *Kelarai* designs were discovered, namely:-

47. *Kelarai Madu Manis*
48. *Kelarai Bunga Api*
49. *Kelarai Gelung Paku*
50. *Kelarai Tak Bernama*
51. *Kelarai Bunga Kelabutam*

The evolution of ideas that took place in the art of weaving led to a development that is closely related to the way of thinking and deep interest of Malay weavers

Geometry is the concept of two words, 'geo' means the earth and 'metry' means the measurement (Wikipedia, 2010). Geometry is a kind of mathematics focusing on the study of lines, angles, shapes, perimeters, areas, and volumes. In geometry, a line is defined as one dimensional which has length but no width or height. An angle can be defined as having two ray or two line segments that meet at the same endpoint.

In every geometrical shape, there is a difference in a structure that involves two things, they are lines and angles. Every geometrical shape is categorised based on the number of sides on it. The connection of every two points will produce a right angle, acute angle, and obtuse angle.
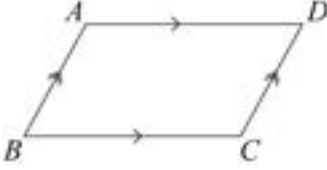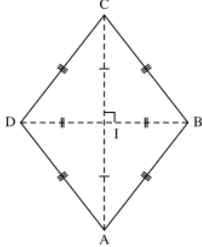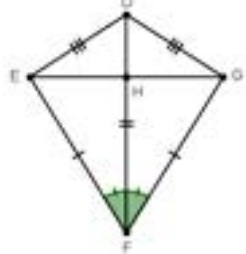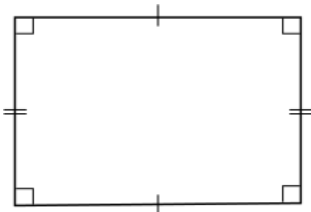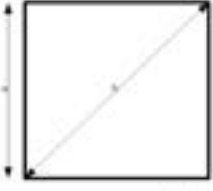
The triangle is the basic shape of the geometry. A triangle is a three-sided polygon. Triangles can be divided into a few types, they are:
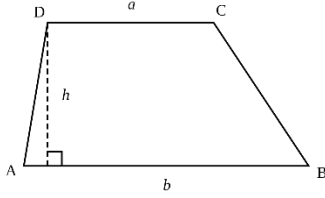
a) acute triangle – a triangle that has all 3 acute angle
b) right triangle – a triangle that has a right angle
c) obtuse triangle – a triangle that has an obtuse angle as one of its angles
d) isosceles triangle – a triangle that has two congruent sides or two congruent angles
e) equilateral triangle – a triangle that has 3 congruent sides or each interior angle measures 60 degree
f) scalene – a triangle that has no 2 congruent sides

Another type of geometrical shape is called a polygon. A polygon is a closed plane object made by joining line segments where each line segment intersects exactly two others. The names of polygons are according to the number of sides They are triangle, quadrilateral, pentagon, hexagon, heptagon, octagon, nonagon, and decagon.

Another attractive feature of polygons is quadrilaterals. Quadrilateral is a four-sided polygon. Quadrilateral are divided into many types (see Table 1).

Table 1. Quadrilaterals

Number of sides	Name	Shape
Parallelogram	2 pairs of parallel sides 2 pairs of equal sides opposite angles are congruent. diagonals are congruent and bisect each other	
Rhombus	2 pairs of parallel sides 4 equal sides Opposite angles are congruent Diagonals are perpendicular bisector	
Kite	2 pairs of parallel sides 2 pairs of adjacent equal sides Opposite angles are congruent	
Rectangle	2 pairs of parallel sides 2 pairs of equal sides 4 right angles	
Square	Diagonals are congruent and bisect each other 2 pairs of parallel sides 4 equal sides Diagonals are congruent Four right angles	

Trapezium	A pair of parallel sides	

Few concepts of geometry that will be applied in this research are symmetry concept, Pythagoras Theorem and tessellation. Symmetry means a symmetrical line which divides a figure into two parts of the same size and measurement. There are three kinds of symmetry that is reflection, rotation and translation. Reflection is a mirror that reflects an object to its image. Rotation is an operation of rotating an object to the centre of its rotation and translation means a vector of movement of an object from one to another.

RESEARCH METHODOLOGY

A study was undertaken to explore the mathematical concepts that appear on the *Mengkuang* weaving motifs or Kelarai The focus was on the arrangement of the motifs that resulted from mathematical elements. Triangulation is a method used to increase the credibility and validity of research findings. Credibility refers to trustworthiness and how believable a study is; validity is concerned with the extent to which a study accurately reflects or evaluates the concept or ideas being investigated. Data were coded and thematically analysed. The observations of the arrangement of the motifs identified the mathematical elements that related to the context. The observations were supplemented by the interviews and focus groups.

Data in this study were obtained from field observations and interviews. The triangulation method is used in order to achieve the research objectives. The triangulation method consists of observations, interviews and analysis of the data. The primary data involved the observations and interviews while the secondary data involved collecting data from books, magazines and websites which supported the primary data. In the collection of primary data observation of geometrical designs, covering the angle, size, arrangement, frequency patterns, distance, and symmetrical lines of Kelarai *Mengkuang* weaving process was analysed to understand the mathematical geometrical concepts used in the art of *Mengkuang* weaving. However, the focus was only on the shapes or characters and symmetrical concepts used in the process of *Mengkuang* weaving.
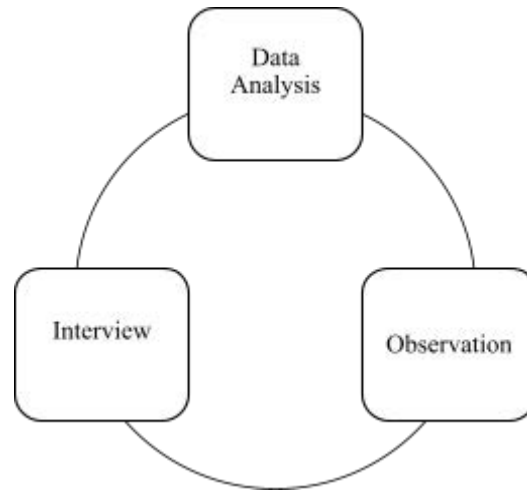
Figure 1. Triangulation Method

An analysis of the 8 motifs out of 51 *Mengkuang* weaving motifs was made. The selected motifs were analysed to identify the geometrical designs in them. Interviews with the *Mengkuang* weavers were carried out to gain information about *Mengkuang* motifs. Finally, conclusions were made based on this analysis.

The Sampling Technique

The sample consisted of 8 different weaving motifs designs from 51 *Mengkuang* weaving motifs categorised into four main areas based on flora, fauna, abstract, and people's names. Eight motifs have been selected from four main areas. Another 16 motifs from each category has been analysed in the other research. 8 motifs are selected is *Kelarai Tampuk Jantung*, *Kelarai Tampok Manggis*, *Kelarai Empat Sebilik*, *Kelarai Pecah Lapan*, *Kelarai Beras Patah*, *Kelarai Mata Bilis*, *Kelarai Bunga Teratai and Kelarai Bunga Cina*.

Table 2. Sample of Mengkuang weaving motifs

Figure 2. *Kelarai Tampuk Jantung*
(Source: Author's personal collection)

Figure 3. *Kelarai Tampok Manggis*
(Source: Author's personal collection)

Figure 4. *Kelarai Empat Sebilik*
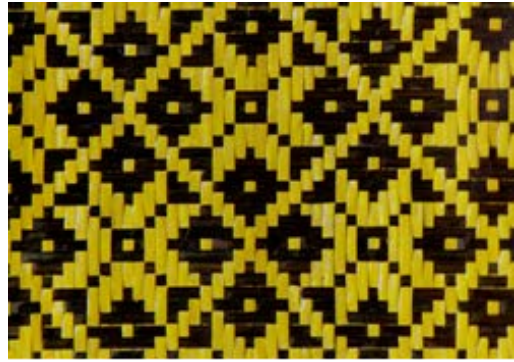*(Source: Author's personal collection)*

Figure 5. *Kelarai Pecah Lapan*
(Source: Author's personal collection)

Figure 6. *Kelarai Beras Patah*
(Source: Author's personal collection)

Figure 7. *Kelarai Mata Bilis*
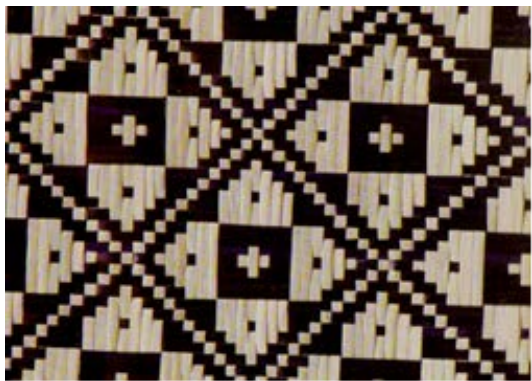*(Source: Author's personal collection)*

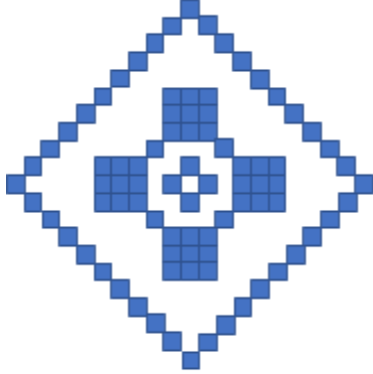**Figure 8.** *Kelarai Bunga Teratai*
(Source: Author's personal collection)

Figure 9. *Kelarai Bunga Cina*
(Source: Author's personal collection)

RESULTS AND DISCUSSION

Data analysis gathered from the triangulation method involved 3 weavers from Bukit Tanah and Kota Bharu, Kelantan. There is an expertise in *Mengkuang* weaving motifs and the interview session was made to get a depth information about the result of selection motifs. Finally conclusions were made based on this analysis.

The Selection of *Mengkuang* Weaving Motifs and The Analysis of Mathematical Concept on Mengkuang Weaving motifs'.

Table 3. Sample of *Mengkuang* weaving motifs

| No	Mengkuang Motif	Geometrical Concepts
1.	**Figure 10.** *Kelarai Tampuk Jantung* *(Source: Author's personal collection)*	**Figure 11.** *Kelarai Tampuk Jantung* *(Source: Author's personal collection)*
	***Kelarai Tampuk Jantung* (Banana Flower)** *Tampuk Jantung* or banana flower is a large dark purple-red blossom that grows from the end of a bunch of bananas. Its sizable bracts or leaves snugly enclose delicate sweetly scented male flowers. The female flowers which do not require fertilisation to become fruit, grow further up from the stem of male flowers. The banana flower so called as banana heart gets its name because of its heart-like shape. *Kelarai Tampuk Jantung* has an octagonal shape fenced by four squares. An octagon shape is an eight sided polygon. The square shape has two pairs of parallel sides and four equal sides. Tampuk Jantung is separated by a rhombus .The rhombus has two pairs of parallel sides, four equal sides, opposite angles are congruent and diagonals are perpendicular bisectors. The symmetrical concept of Kelarai Tampuk Jantung is tessellation, a process of arranging shapes with no laps.	
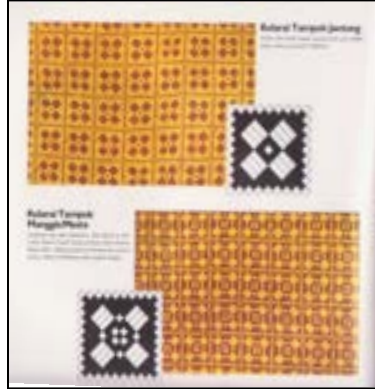
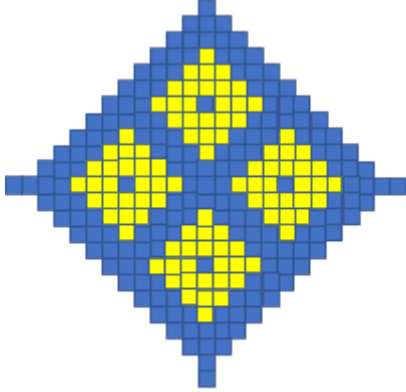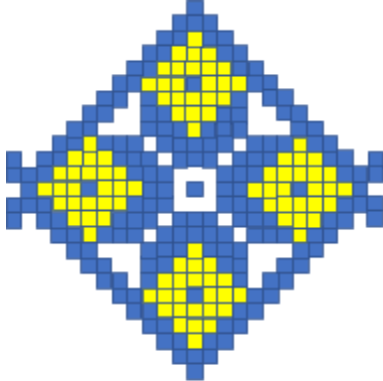| 2.		
	Figure 12. *Kelarai Tampuk Manggis* *(Source: Author's personal collection)*	**Figure 13.** *Kelarai Tampuk Manggi* *(Source: Author's personal collection)s*

***Kelarai Tampuk Manggis* (Mangosteen)**

Manggis, also known as the purple mangosteen, is a tropical evergreen tree with edible fruit native to tropical lands surrounded by the Indian Ocean. The scientific name is Garcinia Mangosteen. The taste of mangosteen is sweet, tangy and juicy. Kelarai Tampuk Manggis is a motif derived from mangosteen fruit, purple in colour and has a hard dark brown flower shaped tuft. Mangosteen stalks are not fixed in number such as five, six, seven and eight petals.
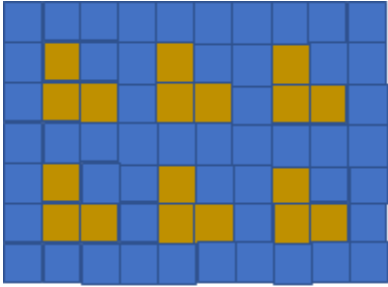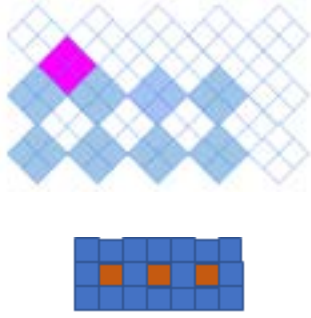
Detailed observation shows that Kelarai Tampuk Manggis has a rhombus shaped motif. The rhombus has four equal sides, two pairs of parallel sides, congruent opposite angles of 90 degrees and four lines of symmetry. The rhombus shape of the mangosteen stem is formed from the arrangement of equal squares and rectangles. The process is known as tessellation ,arranging shapes with no laps.

Table 4. Sample of *Mengkuang* weaving motifs

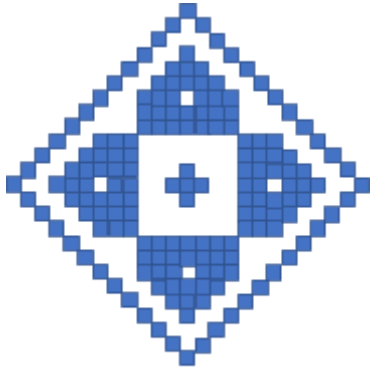| No	*Mengkuang* Motif	Geometrical Concepts
3.	**Figure 14. *Kelarai Empat Sebilik*** *(Source: Author's personal collection)*	**Figure 14. *Kelarai Empat Sebilik*** *(Source: Author's personal collection)*
	***Kelarai Empat Sebilik* (Tetracera)** *Kelarai Empat Sebilik* is originated by *Bunga Mempelas*. *Bunga Mempelas* on tetracera flower is a flower which has 3-5 petals, 3-4 carpels and numerous pink-tipped stamens. *Kelarai Empat Sebilik* is arranged after the arrangement of 4 rhombus shaped in a space or rooms. The rhombus can be identified by the four sides which have the same length, two parallel sides and four equal sides. The rhombus is fenced by rhombus shape too that makes it beautiful.	
4.	**Figure 15. *Kelarai Pecah Lapan*** *(Source: Author's personal collection)*	**Figure 16. *Kelarai Pecah Lapan*** *(Source: Author's personal collection)*
	***Kelarai Pecah Lapan* (Spanish Cherry)** *Bunga Pecah Lapan* or *Bunga Tanjung Peca*h Lapan is known as Spanish Cherry or Mimusops Elengi. It is a medium- sized evergreen flower in tropical forests of South East Asia. The tree is valuable for many purposes such as timber, traditional medicine and the fruit is edible. As the trees give thick shade and flowers emit fragrance, it is a prized collection of gardens.	

	Kelarai Pecah Lapan has the shape of a triangle ,a polygon with three edges and three vertices. A close scrutiny of *Kelarai Pecah Lapan* shows that it is built up by the arrangement of rectangular shapes, which has two pairs of parallel sides, two pairs of equal sides and four right angles. Every *Kelarai Pecah Lapan* is arranged in tessellation, arranging shapes with no laps.

Table 5. Sample of *Mengkuang* weaving motifs

No	*Mengkuang* Motif	Geometrical Concepts
5.	**Figure 17.** *Kelarai Beras Patah* *(Source: Author's personal collection)*	**Figure 18.** *Kelarai Beras Patah* *(Source: Author's personal collection)*
	Kelarai Beras Patah **(Broken Rice)** *Beras Patah* or Broken Rice is a fragment of rice grains, broken in the field during dying or during milling .Mechanical separators are used to separate the broken grains from the whole grains and sort them by size. Broken rice is fragmented, not defective, so there is nothing wrong with it. *Kelarai Beras Patah* has an L shape and is built by the arrangement of three squares. The square shape has two pairs of parallel sides and four equal sides. Diagonals are congruent and also have a perpendicular bisector and four right angles. The symmetrical concept of Kelarai Beras Patah is tessellation, a process of arranging shapes with no laps.	
6.	**Figure 19.** *Kelarai Mata Bilis* *(Source: Author's personal collection)*	**Figure 20.** *Kelarai Mata Bilis* *(Source: Author's personal collection)*

***Kelarai Mata Bilis* (Anchovies)** *Ikan Bilis* or anchovies, a very small saltwater fish of the family of Engraulidae, are used as human food and fish bait. They can be found in the Atlantic, India and pacific oceans. They are small green fish with blue reflections due to a silver longitudinal stripe that runs from the base of the caudal fin. *Kelarai Mata Bilis* has the shape of a rectangle. The rectangles have two pairs of parallel sides, two pairs of equal sides and four right angles. The symmetrical concept is a transition of one object from one position to another with the movement of the x rector.	

Table 6. Sample of *Mengkuang* weaving motifs

No	***Mengkuang* Motif**	**Geometrical Concepts**
7.	**Figure 21. *Kelarai Bunga Teratai*** *(Source: Author's personal collection)*	**Figure 22. *Kelarai Bunga Teratai*** *(Source: Author's personal collection)*
	***Kelarai Bunga Teratai* (Water Lilies)** *Bunga Teratai* or water lilies, the family of Nymphaece are freshwater flowering plants native to the temperate and tropical parts of the world. Water lilies provide food for fish and wildlife but sometimes cause drainage problems because of their rapid growth. Water lilies live as rhizomatous aquatic herbs in temperate and tropical climates around the world. *Kelarai Bunga Teratai* /water lilies ha a shape of trapezium and squares. The trapezium is a 2 dimension shape. The bases of trapezium are parallel to each other. The length of both diagonals is equal. The diagonals of a trapezium always intersect each other. The adjacent interior angles sum up to 180^0. The sum of all the interior angles in a trapezium is always 360^0.	

8.		
	Figure 22. *Kelarai Bunga Cina* *(Source: Author's personal collection)*	**Figure 23.** *Kelarai Bunga Cina* *(Source: Author's personal collection)*

***Kelarai Bunga Cina* (Gardenia Jasminoide)**

Bunga Cina or Gardenia Jasminoide is an evergreen flowering plant of the coffee family Rubiaceae. It originated in Asia and is most commonly growing wild in Vietnam, Taiwan, Japan, Myanmar, India and Bangladesh. *Kelarai Bunga Cina* has a shape of a square and rhombus. The square shape has 2 pairs of parallel sides and 4 equal sides. Diagonals are congruent and also have a perpendicular bisector and it has four right angles. While the rhombus has two pairs of parallel sides, four equal sides, opposite angles are congruent and diagonal are perpendicular bisectors. The symmetrical concept of *Kelarai Bunga Cina* is tessellation, a process of arranging shapes with no laps.

CONCLUSIONS AND RECOMMENDATION

In conclusion*, Mengkuang* weaving is a valuable heritage that should be in the heart of every Malaysian. It should be preserved to ensure that it would not become extinct to the next generation. The evolutions of ideas towards *Mengkuang* weaving were increasing due to the discovery that there are lots of mathematical concepts behind the process of making the *Mengkuang* weaving motifs. The mathematical concepts that can be seen in *Mengkuang* weaving motifs are likely the transformation and geometry shapes. The transformation includes reflection, rotation, and translation. While the geometry shapes include squares, rectangles, rhombus, and others. It shows that there is a connection between the mathematical concepts and *Mengkuang* weaving motifs. Furthermore, this research shows that what exists in the mind of the weavers' shows that they have the knowledge and the intelligence in mathematical thinking and creativity. Finally, yet importantly, to the researcher as a reference to extend this kind of research in the future.

Few suggestions can be given here that a new research can be done to explore new ideas in *Mengkuang* weaving motifs and mathematical concepts to attract new generations, especially generation Z, and to cultivate interest among them in weaving the *Mengkuang* motifs and bringing them to the next level which is international. Also, the *Mengkuang* weavers should develop new motifs which are more urban and trendy to attract more buyers from local or abroad.

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