

## Frieze Pattern on Siak Weaving Motifs and Their Implementation in Mathematics Learning

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### Article Info

#### Article history:

Received Nov 2, 2022  
Revised Des 5, 2022  
Accepted Des 15, 2022

#### Kata Kunci:

Motif,  
Siak Weaving,  
Pola Frieze,  
Pembelajaran  
Matematika.

#### Keywords:

Motifs,  
Siak Weaving,  
Frieze Pattern,  
Mathematics Learning.

### ABSTRAK

Tenun siak merupakan karya seni hasil pembuatan kain songket di Siak Sri Indrapura Provinsi Riau yang memiliki motif menarik dan variatif dengan ciri khas Melayu Riau. Motif tersebut diambil dari lingkungan yaitu flora, fauna dan alam lainnya, kemudian dikembangkan dan disusun secara sistematis membentuk pola geometris tertentu. Penelitian pendahuluan deskriptif dilakukan dengan menggunakan referensi literatur, pengumpulan data dengan wawancara dan observasi ke tempat pengrajin tenun Siak, mengidentifikasi semua motif yang ada untuk mencari jawaban apakah motif tersebut tersusun membentuk pola kelompok frieza, pola yang dibangun dengan pencerjemahan dalam satu arah, selain isometri lainnya berupa pantulan horizontal, pantulan vertikal dan rotasi atau luncuran  $180^\circ$ . Setelah dilakukan observasi dan identifikasi, diperoleh 58 jenis motif pada kain tenun Siak. Dari keseluruhan motif diketahui bahwa semuanya membentuk pola frieze. Ada yang membentuk pola frieze F1, F2, F3 hingga pola frieze F7. Terkadang selembar kain tenun Siak dibuat dari kombinasi beberapa pola dekorasi. Sejauh ini belum ditemukan motif tenun Siak yang tidak membentuk pola frieze. Hal ini menunjukkan bahwa masyarakat Siak, telah lama menggunakan ide-ide matematis dalam pengembangan motif tenun Siak. Selain itu, penggunaan etnomatematika tenun Siak merupakan langkah yang tepat untuk meningkatkan literasi matematis siswa.

### ABSTRACT

Siak weaving is a work of art resulting from the manufacture of songket cloth in Siak Sri Indrapura in Riau Province which has interesting and varies motifs with the characteristics of Riau Malay. Such motifs are taken from the environment, namely flora, fauna and other nature, then developed and arranged systematically forming certain geometric patterns. Descriptive preliminary research was carried out using literature references, data collection with interviews and observations to the Siak weaving craftsman's place, identifying all existing motifs to find the answer whether these motifs were arranged to form a frieze group pattern, a pattern constructed by translation in one direction, in addition to other isometry in the form of horizontal reflection, vertical reflection and  $180^\circ$  rotation or glide. After the observation and identification, it is obtained that there are 58 types of motifs on Siak woven fabric. From the whole motif, it was found that everything formed a frieze pattern. Some form the F<sub>1</sub>, F<sub>2</sub>, F<sub>3</sub> frieze pattern to the F<sub>7</sub> frieze pattern. Sometimes one sheet of Siak woven fabric is built from a combination of several frieze patterns. So far, no Siak weaving motif has been found that does not form a frieze pattern. This shows that the Siak people, have long used mathematical ideas in the development of motifs in Siak weaving. In addition, the use of Siak weaving ethnomathematics is the right step to improve the mathematical literacy of students.

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### How to Cite:

Indriati, M., Turmudi, T., & Dahlan, J.A. (2022). Frieze Pattern on Siak Weaving Motifs and Their Implementation in Mathematics Learning. *JNPM (Jurnal Nasional Pendidikan Matematika)* 6(4), 761-776.

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## **Introduction**

Riau is one of the provinces in Indonesia, which has 12 regencies/cities; among them is Siak county. This area is a former Malay kingdom heritage area with the center of the kingdom being in Siak Sri Indrapura. Siak society is a society that has cultural characteristics like other societies. Among the cultural wealth is a traditional cloth in the form of Siak weaving which has had a long history in the community and depicts a portrait of regional culture. For the Siak Malay community, using woven cloth at parties and other traditional events becomes an identity and pride for the wearer. This weaving is a work of art resulting from the manufacture of songket fabrics that have unique patterns (motifs) and yeast (designs) that are diverse with high values and philosophies characteristic of Riau Malay. Effendy (2013) a Riau Malay culturalist explained that each motif on Siak woven fabric has a certain philosophy that reflects the perspective of human life, the values of Malay beliefs and culture.

Siak woven fabric is traditionally made by craftsmen who have been passed down for generations in the weaver's family environment using the loom "Kek" or some call it gedokan loom. The manufacture of this fabric is carried out through the process of weaving cotton yarn which at the same time is accompanied by inserting gold thread or silver thread as a weft thread to form a variety of woven motifs or patterns (Lestari & Riyanti, 2017), which adorn the fabric surface. To make one sheet of Siak woven fabric takes quite a long time because the work is complicated and requires precision, using a very simple loom. In addition to using kek looms, currently Siak woven fabrics are also widely circulated in the market as a result of production using Non-Machine Looms (ATBM). ATBM is a traditional loom to make woven fabrics with simple webbing and the movements are carried out by the operator himself or driven by human power (Wartiono, et al, 2015) but compared to the Kek loom, this tool is more modern, so it is able to produce fabrics in large quantities with a faster time. According to Mentari & Rosandini (2019), to complete the manufacture of one sheet of Siak woven fabric using a kek loom, the work takes about 3-4 weeks, but currently using ATBM the work can be shortened to only 4-5 days. This woven fabric produced by ATBM is widely circulated in the market which has a much cheaper selling price than woven products that use kek. However, for the Siak Malay community, using Siak (original) woven fabric from home-woven is a matter of pride and adds confidence to the wearer. So that the production of these home craftsmen still has a share and sells well in the market.

The manufacture of Siak woven fabric has gone through a long history and gave birth to many motifs that contain certain meanings and philosophies. The motifs that exist and are in great demand today are traditional motifs of ancestral relics inherited from generation to generation by weaver families. The creativity of Siak

weaving craftsmen is currently in development by combining various basic motifs so that they look like new motifs. The arrangement of motifs on the Siak weave is arranged in a certain pattern, one of the patterns formed by its arrangement is the application of geometric transformations and other mathematical ideas. (Indriati, et al., [2022](#)). Thus, it can be said that the motif of siak woven cloth as a product of local culture is in harmony with mathematics. According to Nur, et al., ([2019](#)), the relationship between mathematics and various cultural activities in society is known as ethnomathematics. Meanwhile, Hasanuddin ([2017](#)) in his research explored ethnomathematics in the Riau Malay community, concluded that there are various applications of mathematics in the activities of the Riau Malay community, ranging from literature, clothing, games, and carving. For this reason, researchers will examine the mathematical patterns constructed by the Siak weaving motif, one of which is how the relationship between the Siak weaving motif and *the frieza group* pattern.

According to the Great Dictionary of Indonesian, a motif is a pattern that goes through a process of iteration to create various forms (patterns) in crafts and works of art. Meanwhile (Kight, [2011](#)), it is revealed that a motif is the smallest unit of a design pattern, to create a pattern or patterns, it is necessary to repeat the motif, and repeated patterns make a design. Furthermore, Suhersono ([2005](#)), stated that a motif is a design consisting of parts of various types of lines and elements that are influenced by natural shapes and objects, and have their own patterns and characteristics. Each region in Indonesia has its own batik motif, this causes certain motifs to be named based on their region of origin (Trixie, [2020](#)). The motifs contained in Indonesian woven fabrics vary greatly depending on the background, beliefs, tribes and customs, as well as the expression of the woven fabric motifs produced in each region are different. Especially for traditional clothing, each region has motifs that describe the tribe, religion, and social class of the wearer in the community. (Gual, [2021](#)).

Siak woven cloth motifs are generally taken from the natural environment, such as plants, animals and other natural. A woven fabric motif can basically be produced using mathematical formulas and digitized using a computer program (Nataliani, [2022](#)). However, motifs that exist and are in great demand by the people today are traditional motifs of ancestral relics inherited from generation to generation by weaver families from generation to generation. The creativity of weavers develop by combining various basic motifs so that they look like new motifs. On the motive indeed there are traits of order that are rhythmic and patterned, neatly arranged, very rarely arranged randomly. The variety of Siak woven fabric motifs can be presented in Figure 1.



Figure 1. Various Siak Woven Fabric Motifs

According to Puguh (2012) and Akkapurlaura (2015), siak woven fabric is generally made in the form of a sealing scabbard, with the composition of the motif arrangement divided into three parts, namely the cloth head, cloth body (sow), and cloth legs. Furthermore, Mentari (2019) stated that the cloth head is located on the front and middle of the fabric, in this part usually almost all types of motifs can be used. As for the fabric legs, they are located on the edges with a motif character that is almost the same as the head of the fabric. In this section, it usually uses motifs that can connect with each other, the difference is only in the laying. Furthermore, the fabric body (sow) is a complementary part and the motifs used are usually units, for example clove flowers, mangosteen tampuk and others. The parts of the adhesive sheath cloth are presented in Figure 2.

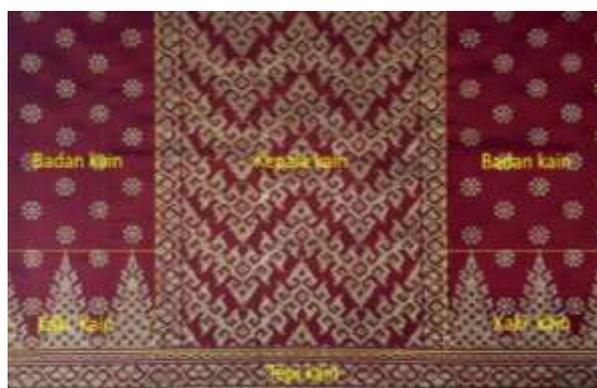


Figure 2. Layout Of Siak Woven Fabric Division

The Siak weaving motif that is in great demand by the public today is the basic motif of bamboo shoots. This motif often adorns the legs of the fabric and has many variations that are developed and combined with other motifs that are intertwined into new forms of motifs, including combined bamboo shoots, cupping shoots, and others. Each of these motives has its own meaning and philosophy. To describe the philosophy of such motive is usually expressed by rhyme. As an example of a fern bamboo shoot motif, such as Figure 3.



Figure 3. Pucuk Rebung Kaluk Pakis Pattern

The philosophy of the name of the fern kaluk bamboo shoot motif is:

Shoots of shoots painted fern	Pucuk rebung berkaluk pakis
Draw evenly right and left	Sama imbang kanan dan kiri
Love continues, disputed over	Kasih bersambung sengketa habis
Live quietly all day long	Hidup tenang sepanjang hari

The frieze Group pattern or commonly called the frieza group is a concept of a subgroup of symmetry groups built by the translation or displacement of an object along a straight line with a certain direction and distance (Cooper, [2013](#)). This frieza pattern is a set of isometry and is expressed with  $\text{Sym}(X)$ . The isometry of the concordance or tranformation (the congruent one) is a transformation that maintains the distance between the metric spaces, Isometry that builds frieze patterns include translation, horizontal reflection, vertical reflection,  $180^\circ$  rotation and glide. (Rahmawati, at al., [2018](#)). furthermore the isometry on the plane is a bijective function  $f: \mathbf{R}^2 \rightarrow \mathbf{R}^2$  that maintains the distance from a plane to the plane itself, this means that for each  $p, q \in \mathbf{R}^2$  applies.

$$|f(P) f(Q)| = |PQ| \text{ or } |f(p) - f(q)| = |p-q|$$

The meaning of  $P$  and  $Q$  is a point while  $p$  and  $q$  are the position vectors from the point  $P$  to  $Q$ . There are several types of isometry in the plane mapped to itself, namely translation, horizontal reflection, vertical reflection,  $180^\circ$  rotation and glide reflection (Andriani & Muchyidin, [2020](#)). Assuming a one-dimensional repeating pattern (Frieze pattern) is placed horizontally, then only seven patterns are possible (Liu & Collin, [1999](#)). Furthermore, Gallian & Joseph ([2010](#)), also suggests that there are seven frieze patterns built by the existing isometric-isometric combination.

## Methods

The research uses a descriptive qualitative method, by collecting data and information related to Siak weaving motifs through literature, observations and interviews with parties at siak woven fabric production centers (weaving houses). Identification was carried out on all Siak woven fabric motifs to answer the research objectives. Which becomes subject on this research itself. The determination of the type of pattern is carried out by observing all existing motifs, then it is determined visually whether the patterns have unidirectional translation and are constructed by other isometry. Because the Isometry that may be present in the frieze pattern

can be horizontal reflection, vertical reflection, and  $180^\circ$  rotation or glide. From the identification results, it can be determined the type of frieze pattern contained in Siak woven fabric. All such frieze patterns are one-way translating and have different provisions that can be classified as cyclic or dihedral groups which are described in detail as follows.

Frieze Pattern  $F_1$  can be annotated with the equation  $F_1 = \{x^n \mid n \in \mathbb{Z}\}$ , which is composed by a one-way isometric circuit forming a horizontal translation. There is no other isometric in this pattern. Each of the elements has the same shape and size, the formation of such elements can be expressed by the following Dagger image.



Figure 4. Illustration of  $F_1$  Frieze Pattern

In addition to loading translations in one direction with a certain distance, in this pattern there is also a *glide reflection* isometry, this pattern can also be annotated with the equation  $F_2 = \{x^n \mid n \in \mathbb{Z}\}$ . The formation shape of each element can be expressed by the following dagger image symbol.



Figure 5. Illustration of The  $F_2$  Frieze Pattern

Frieze Pattern  $F_3$  is annotated by the equation  $F_3 = \{x^n y^m \mid n \in \mathbb{Z}, m = 0 \text{ or } 1\}$ . has a one-way translation and vertical reflection, the formation of each of its elements is shown with the following dagger image.



Figure 6. Illustration of The  $F_3$  Frieze Pattern

Frieze Pattern  $F_4$  can be annotated with  $F_4 = \{x^n y^m \mid n \in \mathbb{Z}, m = 0 \text{ or } m = 1\}$ . has a one-way translation and a rotation of  $180^\circ$ . The formation form of each of its elements can be shown with the following Dagger image.

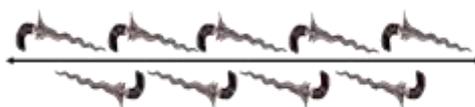


Figure 7. Illustration of The  $F_4$  Frieze Pattern

Frieze Pattern  $F_5$  can be annotated with  $F_5 = \{x^n y^m \mid n \in \mathbb{Z}, m = 0 \text{ or } m = 1\}$ , which has a one-way translation, with a rotation of  $180^\circ$ , and a vertical reflection. The relationship of each element of this group can be symbolized by a combination of the following dagger image.



Figure 8. Illustration of  $F_5$  Frieze Pattern

Frieze Pattern  $F_6$  can be annotated by the equation  $F_6 = \{x^n y^m \mid n \in \mathbb{Z}, m = 0 \text{ or } m = 1\}$ . loading one-way translation and horizontal reflection, the relationship between each of its elements can be shown with the following dagger Image symbol.



Figure 9. Illustration of The  $F_6$  Frieze Pattern

Frieze Pattern  $F_7$  can be annotated with  $F_7 = \{x^n y^m z^k \mid n \in \mathbb{Z}, m = 0 \text{ or } m = 1, k = 0 \text{ or } k = 1\}$ , which contains translation, vertical reflection, and horizontal reflection. The product of  $y$  and  $z$  is a rotation of  $180^\circ$ . The contact of each element of this pattern group can be shown with the following Dagger image symbol.



Figure 10. Illustration Of The  $F_7$  Frieze Pattern

## Result and Discussion

There are quite a lot of traditional motifs that reflect the characteristics of Riau Malay Culture today, with various variations. According to Lestari & Riyanti (2017), there are around 140 traditional typical motifs of Riau. Of these, 58 types of them are motifs on Siak woven fabrics, while the others are other handicraft motifs. According to Zulkifli, et al (2008), broadly speaking, the forms and types of Riau handicrafts are songket crafts, puzzle crafts, batik crafts, embroidery crafts (embroidery), woven crafts and wood carving crafts.

Siak weaving motifs are usually taken from the natural environment, such as plants (flora), animals (fauna) and other natural objects (Mentari & Rosandini, 2019). From the natural objects of the environment are sorted (changed, modeled) into interesting motifs. (Zulkifli et al, 2008), subsequently each motif develops and has diverse variations. The motifs that are often used are those that are sourced from flora. This is because the Malays are generally Muslims so the use of fauna motifs is feared will lead to "idolatry" (Lestari & Riyanti. 2017).

From the results of identification carried out by the researcher, for the basic motifs of flora, for example, shoots of bamboo shoots were found as many as 17 variations, including full shoots of bamboo shoots, shoots of drooping bamboo shoots, shoots of bamboo shoots with elbows, shoots of ranked flower shoots and others. This motif is most widely used to decorate cloth legs and cloth heads combined with other motifs. Furthermore, for the basic pattern of mangosteen tampuk, there are as many as 14 variations in Siak weaving, including crossed mangosteen tampuk, layered mangosteen tampuk, plot mangosteen tampuk, cross-plot mangosteen tampuk and others. This mangosteen tampuk motif is predominantly found on the fabric body (sow) and the edges of the fabric as well as on the cloth head combined with other motifs. As for the basic motifs of elbows and wajik, 11 variations were found including crown wajik, sow plot wajik, perfect wajik, flower wajik, wajik elbow, corner floret elbow and other wajik. This motif is found mostly on the edges of the fabric and the head of the fabric combined with other motifs. Similarly, for the other basic motifs, each has various variations. At this time, the use of color in Siak woven fabric is no longer dominated by one color but has combined several colors, this change is made to follow people's tastes (Guslinda & Kurniawan, [2016](#)).

The manufacture of Siak tenun fabric from time to time has undergone various changes, both looms and materials that are used. This change was caused by several factor, including increasingly expensive raw materials, inefficient tools, and even the situation and conditions of colonial politics also influenced the process of making kain tenun Siak (Bunari, et al., [2021](#)). The production of Siak woven fabrics is currently very small compared to other types of handicrafts, for example malay batik. According to Wan Hamidah, one of the Siak woven fabric craftsmen who still exists and is a resource person in this study said that this happened because the number of craftsmen was very small, the manufacturing process was very complicated and high accuracy was needed, especially in making the selected motifs, and a large capital is needed for its business. Besides that, the price of gold thread and silver thread needed for the manufacture of motifs on woven fabrics is very high in the market. So that the selling price of this woven fabric is very high compared to the price of other types of fabrics. Moreover, this cloth is not used by the community as daily clothes, but is worn only on certain occasions, for example at weddings and other traditional occasions. To anticipate the high price of raw materials, craftsmen are forced to reduce the quality of their production by reducing the thickness of the fabrics produced and using gold threads and class 2 silver threads (imitations).

Motive pattern that exists in the weave of Siak, generally composed of certain patterns, one of the patterns indicated to be formed by the arrangement of these motifs is the application of geometric transformations, and other mathematical

ideas (Indriati, et al. 2022). In this case, the art patterns and variations of motifs on the is a development of basic motifs that undergo a process of geometric transformation, can be from the results of reflection, rotation, translation or dilatation of one basic motif that occurs repeatedly. In addition, it is also a combination of different basic motifs that produce one new motif so as to enrich the variety of existing motifs. The patterns of arranging motifs in the weaving can be classified into seven types of patterns based on the frieze group theory, proposed by Gallian, & Joseph (2010). The Frieze pattern has a special characteristic that it is always built by unidirectional translation, (Rahmawati, et al., 2018). The symmetries formed in the frieze pattern are translational, rotational, vertical/horizontal reflection or glide reflection (Andriani & Muchyidin, 2020). These patterns can be found in various positions on Siak woven fabrics, both on cloth legs, cloth heads, fabric bodies and the edges of the fabric. The following are some of the Siak weaving motifs that have been identified and show the concept of frieze group theory.

One of the Siak weaving motifs identified as forming the  $F_1$  frieze pattern is the keluang elbow. This pattern is formed from one basic motif that undergoes translation (shift) in one direction to the right and there is no other isometric in the pattern. This motif is often found on the edges of the fabric and also on the head of the fabric combined with other motifs. The appearance of the elbow-to-hand motif is as shown in Figure 11.



Figure 11. The Motive Of The Opportunity Elbow

Siak woven motifs with  $F_1$  frieze patterns are fairly rare compared to other patterns, the majority of Siak woven fabrics are arranged with more than one isometric pattern.

Frieze Pattern  $F_2$  is built with one-way translation to the right and there is no branching in the other direction, besides that in the pattern there is also a glide (reflection whose reflection axis is parallel to the translational axis). One of the Siak weaving motifs identified as forming the  $F_2$  frieze pattern is the crown wajik motif. This motif is found in many fabric edges and cloth heads combined with other motifs. For the edges of the fabric, this crown wajik motif is very beautiful to look at and is an uninterrupted series and can give the impression of being a barrier for the fabric. Other uses of this motif are also found in siak's typical scholars including climbs and bags. The appearance of the crown wajik motif is presented in Figure 12.



Figure 12. Crown Diamond

Other motifs that make up the  $F_2$  frieze pattern are full shoots of shoots of shoots, shoots of stratified fern painted shoots and single elbows.

The Siak woven fabric that uses the most  $F_3$  frieze pattern is a bamboo shoot motif. This motif is often found on cloth legs and cloth heads which are usually combined with wajik motifs, elbows, cloud elbows and other motifs. Bamboo shoots are the most widely used motif in Siak weaving. In addition to the sarong cloth, this motif is also found in many clothes, skullcaps and accessories and other typical Siak souvenirs. Shoots of bamboo shoots have many variations including shoots of fern bamboo shoots as shown in Figure 13.



Figure 13. Shoots Of Shoots Of Kaluk Bamboo Shoots

In Figure 13, it can be seen that the motif is formed from an archetype that undergoes translation to the right and glide (horizontal reflection). In addition to the shoots of fern kaluk bamboo shoots, the Siak weaving motifs that form this pattern are the shoots of drooping floret shoots, the shoots of keluang-elbowed bamboo shoots, the shoots of ranked flower bamboo shoots, the shoots of children's hall bamboo shoots, studded bamboo shoots, the shoots of bird-billed bamboo shoots, layered mangosteen tampuks, mangosteen tiles, the cross-plot mangosteen tampuks, the mangosteen tiles of children's plots, the mangosteen splinters of the florets, tampuk mangosteen tampuk split, wajik busty star, wajik sow plot, corner florets, full plot, hollow plot and pasu-pasu split.

Frieze Pattern  $F_4$  is formed from one basic motif that undergoes translation in one direction and also a rotation of  $180^\circ$ . One of the Siak weaving motifs arranged with the  $F_4$  frieze pattern is the ant alongside motif which is commonly found on the edges of the fabric, and the cloth head combined with the keluang elbow motif, cloud elbow and wajik-wajik. The display of the ant motif in tandem is presented in Figure 14.



Figure 14. Ant Motifs Go Hand In Hand

The Original Siak weaving motif that formed the  $F_4$  pattern is rarely found, currently there are several new motifs developed by weavers, but it is not the original Siak alay motif but adopts from a motif taken from the outside including the virsace motif.

One of the Siak weaving motifs that uses this pattern is full bamboo shoots, this pattern is formed from one basic motif that undergoes translation in one direction, in addition to reflection and  $180^\circ$  rotation. This motif is most commonly found on cloth heads which are usually combined with other matching motifs. In addition to woven fabrics, this motif is most commonly found as decoration on various sides of the building in the form of drawings and carvings. The ampilan of the full shoot motif is as shown in Figure 15.



Figure 15. Full Rebung Shoots

In addition to being found in the full bamboo shoot motif, the Frieze  $F_5$  pattern is also found in the cascading fern bamboo shoot motif.

Siak weaving composed of this pattern is found in the basic motifs of bamboo shoots with various variations, which are placed as cloth legs and cloth heads combined with various other matching motifs. One of the Siak woven cloth motifs arranged with the  $F_6$  frieze pattern is the shoots of waving leaf shoots as shown in Figure 16.



Figure 16. Shoots Waving Leaf Bamboo Shoots

In Figure 16, it can be seen that one archetype of the bamboo shoot motif is translational to the right, besides that it also simultaneously undergoes vertical reflection. In addition to the shoots of waving leaf bamboo shoots, Siak weaving that forms this pattern is very much, including the shoots of kaluk paku bamboo shoots, the shoots of drooping branch bamboo shoots, decorated bamboo shoots, full bamboo shoots, flower blooms, middle florets, florets related to florets, telingkai of switched star shoots, wajik-breasted stars, earthquake motion perigi flowers, wajik-wajik, wajik full of cloudy kaluk, wajik-wajik petak sow, wajik kembang, full plots, hollow plots and split plots.

Frieze Pattern  $F_7$  formed from unidirectional translation. In addition, in this pattern there is also vertical reflection and horizontal reflection. One of the Siak weaving motifs that form the  $F_7$  frieze pattern is the cape flower board motif. This motif is found mostly on the edges of the fabric and the head of the fabric combined with other motifs. In addition to the sarong cloth pad, this motif is widely used on clothes, climbs and bags. One of the Siak weaving motifs that form the  $F_7$  pattern is the cape flower board motif as shown in Figure 17.



Figure 17. Bunga Tanjung Board

In addition to the cape flower board motif, the  $F_7$  frieze pattern is also found in the single leaf motif of arrow eyes, layered mangosteen tampuk, split mangosteen tampuk, studded mangosteen tampuk tampuk, herd ducklings, sow plot wajik and perfect wajik.

The Siak woven fabric motifs used as samples for each of the above patterns are the most widely produced by weavers in Siak Sri Indrapura and in Pekanbaru City. The craftsmen have become accustomed to using this pattern so that to make woven fabrics with this pattern is felt to be younger and faster. From the overall siak woven fabric motifs identified, it turns out that all of them form patterns that can be classified using the frieze pattern. There has not been found a Siak woven cloth motif that does not form a frieze pattern. Even on one sheet of Siak woven fabric, sometimes there is a combination of various patterns, for example in Figure 18.



Figure 18. Siak Woven Scabbard Fabric

In Figure 18, it can be seen that on one piece of Siak woven adhesive scabbard cloth there are several frieze patterns at once, namely the elbow motif *keluang* forming the frieze  $F_1$  pattern and the ant motif in tandem forming the  $F_4$  pattern on the cloth head, the crown wajik motif forming the  $F_2$  frieze pattern found on the edges of the fabric, the head of the cloth, and the body of the fabric; while the full bamboo

shoot motif forms an  $F_3$  *frieze* pattern found on the fabric legs and fabric heads. This shows that the Siak people, especially the craftsmen of woven fabrics from ancient times have been very rich in ideas and imagination in developing basic motifs into variations of motifs, the development of basic motifs with new variations sometimes seems like giving birth to new motifs. The craftsmen never realized that the motifs they made formed a unique arrangement of patterns, in the form of geometric patterns mathematically identified as *frieze group patterns*.

Referring to the diversity of Siak as a product of local culture weaving motif patterns that have developed to date, it shows that the Siak people are very close and use mathematical ideas in their daily lives. There are already many variations of woven motifs, but from these motifs there are those that are favorite motifs in the community and are in demand by many people, as for these motifs include Pucuk Rebung, Tampuk Manggis and Wajit with various variations / derivatives.

### ***Implementation in Mathematics Learning***

Based on the explanations of the frieze groups pattern that have been put forward, it can answer the author's guess that the basic motifs and variations of the Siak weaving motifs are related to the frieze groups pattern. Thus it can be said that between the local cultural product in the form of Siak weaving with its various patterns of motifs, has a knot related to mathematics (ethnomathematics) Siak weaving. This fact can enrich teachers and other educational actors to use the Siak woven cloth as the right medium to be a tool for learning mathematics in schools, on geometry transformation material given to junior high school / MTs class IX students, in accordance with the content of the independent curriculum.

If mathematics learning is synchronized with cultural products (ethnomathematics), then the learning process in schools will be more interesting and easier for all parties involved in running their respective roles. By using Siak weaving as a learning medium, students in this area will be helped, because they are familiar with these weaving motifs, and often times encountered it in the environment of everyday life. Students will find it easier to learn the concept of transformation geometry through existing Siak weaving motifs. In line with that, Lestariningsing (2017) stated that the use of the context of batik motifs in classroom learning activities can bring students, in a situation of reinventing the basic concepts of geometric transformations. After achieving the basic concept of transformation, students will be able to solve problems at the formal level by using their knowledge and experience at the situational, referential and general level. Using learning media that is familiar to students, will make it easier for them to build mathematical connections in their lives to solve the problem. This is in line with the opinion of Sirate (2012) who stated that students will more easily understand every topic discussed because it is related to their lives everyday.

There are many components that can influence the success of mathematical literacy, one of which is ethnomathematics, in this case Fajriyah (2018), stated that ethnomathematics has a role in supporting literacy Especially mathematical literacy. By viewing Siak woven fabric as ethnomathematics, creative students can connect the weaving motif with the concept of geometric transformation, they will be able to visualize abstract geometric transformation concepts into tangible forms. In improving mathematical literacy, ethnomathematics is a strategy that teaches students to understand, clarify, process, and apply mathematical ideas, both in concepts and practices that can be used for solving problems related to everyday life. (Barton, 1996). So that ethnomathematics can provide opportunities for culture to be used in mathematics learning (Astriandini & Kristanto, 2021). Ethnomathematics also gives an idea that the implementation of mathematics is very close to everyday life and can be interpreted through various ways or points of view. One pattern of Siak weaving motifs can give different meanings, according to the point of view used to see them. Whether from a socio-cultural, philosophical, or mathematical point of view. With the many concepts of geometric transformation in Siak weaving motifs that can be utilized in mathematics learning, it can be said that the ethnomathematics of Siak weaving can be utilized to improve the mathematical literacy ability of students.

### **Conclusion**

Siak woven fabric is made traditionally with various patterns and motifs taken from the environment, namely flora, fauna and other nature as basic motifs. So far, the author has found as many as 58 types of motifs on Siak woven fabric, most of which are developments/variations of basic motifs. The craftsmen have never realized that what they do/make is a pattern arranged in a geometric format, they don't pay much attention to the symmetry in the motif. Craftsmen only focus on the motifs that will appear they always work with the simple thought of shifting and twisting the basic motifs so as to produce interesting motifs. The uniqueness of this motif shows that the Siak people, especially the weaving craftsmen from the past, have been very rich in ideas and imagine developing basic motifs into variations of motifs. The arrangement of motifs in Siak weaving generally forms a geometric pattern that is mathematically identified as a frieze group pattern or frieze pattern. From all these motifs, it was found that all of them formed a frieze pattern, some formed the  $F_1$  frieze pattern, some formed the  $F_2$  frieze pattern, up to the  $F_7$  frieze pattern. So far the author has not found a motive that does not form a frieze pattern. This shows that the Siak people have long used mathematical ideas in the development of motifs in Siak weaving. Between cultural product in the form of Siak weaving motifs has a connection with mathematics (ethnomathematics). This can be used by every educational actor (teacher and student) to use it as an appropriate medium to be used as a mathematics learning aid on the topic of transformation geometry. Thus

it can be said that ethnomathematics of Siak weaving can improve the mathematical literacy of students in schools.

## References

- Akkapurlaura, A. (2015) *Pengembangan Motif Rantai, Tampuk Manggis, Pucuk Rebung, Siku Awan, dan Lebah Bergayut pada kain Songket Melayu Riau*. Seminar Nasional Cendekiawan. Universitas Trisakti. Jakarta. <https://doi.org/10.25105/semnas.v0i0.121>
- Andriani, L, & Muchyidin, A. (2020). Frieze Group Pattern on Buyung Kuningan Dance Movement. *Journal of Mathematics Education and Science (JES-MAT)*, 6(2), 81-100. <https://doi.org/10.25134/jes-mat.v6i2.2997>
- Astriandini, M.G., & Kristanto, Y.D. (2021). Kajian Etnomatematika Pola Batik Keraton Surakarta Melalui Analisis Simetri. *Mosharafa: Jurnal Pendidikan Matematika*, 10(1), 13-24. DOI: <https://doi.org/10.31980/mosharafa.v10i1.831>
- Barton, W. (1996). *Ethnomathematics: Exploring Cultural Diversity in Mathematics*. New Zealand University of Auckland.
- Bunari., Fikri,A., Pernantah, P.S, & Fiqri,Y.A. (2021). Perkembangan Pembuatan Tenun Melayu Siak: Suatu Tinjauan Historis. *Diakronika* 21(1). 1-10. <https://doi.org/10.24036/diakronika/vol21-iss1/170>.
- Effendy,T. (2013). *Lambang dan Falsafah dalam Seni Bina Melayu*. Pekanbaru: Yayasan Tenas Effendy.
- Fajriyah, E. (2018). Peran Etnomatematika Terkait Konsep Matematika dalam Mendukung Literasi. *PRISMA, Prosiding Seminar Nasional Matematika*, 1(1), 114-119.
- Cooper, C.D.H. (2013). *Techniques of Algebra*. Australia: Macquarie University.
- Gallian, & Joseph, A. (2010). *Contemporary Abstract Algebra*. USA: Sevent Edition, Brooks/Cole Cengage Learning, Belmont, CA 94002-3098
- Gual, Y.A. (2021). Pergeseran Penggunaan Tenun Ikat pada Masyarakat Desa Tanah Putih. *Jurnal Ilmu Komunikasi*, 2(1), 85–110.
- Guslinda, & Kurniawan, O. (2016). Perubahan Bentuk, Fungsi dan Makna Tenun Songket Siak pada Masyarakat Melayu Riau. *Jurnal Primary Program Studi PGSD Universitas Riau*, 5(1), 2303-1514. <http://dx.doi.org/10.33578/jpkip.v5i1.3676>
- Hasanuddin, H. (2017). Etnomatematika Melayu: Pertautan Antara Matematika dan Budaya pada Masyarakat Melayu Riau. *Sosial Budaya*, 14(2), 136–149.
- Indriati M, Turmudi, Dahlan JA. (2022). Aplikasi Transformasi Geometri pada Etnomatematika Tenun Siak. *Math Educa Journal*, 6(2), 105-119. <https://doi.org/10.15548/mej.v6i2.4543>
- Kight, K. (2011). *A Field Guide to Fabric Design, Print & Sell Your Own Fabric, Traditional & Digital Techniques for Quilting, Home Dec & Apparel.* , New York: C&T Publishing
- Lestari, S., & Riyanti, M.T. (2017). Kajian Motif Tenun Songket Melayu Siak Tradisional Khas Riau. *Dimensi DKV*, 2(1), 33-48. <https://doi.org/10.25105/jdd.v2i1.1876>
- Lestariningsih, L. (2017). Desain Pembelajaran Transformasi Menggunakan Motif Batik Tulis Sidoarjo. *Jurnal Edukasi*, 3(1), 83-98.
- Liu, Y., & Collins, R.T. (1999) *Frieze and Wallpaper Symmetry Groups Classification under Affine and Perspective Distortion*. Pittsburg: The Robotics Institute, Carnegie Mellon University.
- Mentari, M., & Rosandini, M. (2019) Pengembangan Motif Kain Tenun Songket Siak Khas Riau pada Produk Fesyen. *E-Proceeding of Art & Design*, 6(3), 4216-4221. <https://doi.org/10.25124/eoe.v6i3.11282>
- Nataliani,Y. (2022). Frieze Group in Generating Traditional Cloth Motifs of the East Nusa Tenggara Province. *Jurnal Teori dan Aplikasi Matematika*, 6(3), 651-664. <https://doi.org/10.31764/jtam.v6i3.8568>

- Nur, A. S., Sukestiyarno, Y. L., & Junaedi, I. (2019). Etnomatematika dalam Perspektif Problematika Pembelajaran Matematika, *Tantangan pada Siswa Indigenous. Prosiding Seminar Nasional Pascasarjana UNNES*, 2(1), 910-914.
- Puguh, S. (2012). *Seluk Beluk Tenunan Siak*. Pekanbaru: UR Press
- Rahmawati, A., Helmi, H., & Fran, F. (2018). Frieze Group pada Seni Dekoratif Masjid. *Buletin Ilmiah Math, Stat, dan Terapannya (Bimaster)*, 7(1), 23-32.
- Sirate, F. S. (2012). Implementasi Etnomatematika dalam Pembelajaran Matematika pada Jenjang Pendidikan Sekolah Dasar. *Lentera Pendidikan: Jurnal Ilmu Tarbiyah dan Keguruan*, 15(1), 41-54. <https://doi.org/10.24252/lp.2012v15n1a4>
- Suhersono, H. (2005). *Desain Bordir Motif Geometris*. Jakarta: Gramedia Pustaka Utama.
- Trixie, A. A. (2020). Filosofi Motif Batik Sebagai Identitas Bangsa Indonesia. *Folio*, 1(1), 1-9.
- Wartiono, T., Wiyono, W., & Nusantara, A. E. B. (2015). *Rancang Bangun Alat Tenun Bukan Mesin (ATBM) Dengan Pengendali PLC Sebagai Alat Tenun Mekatronika*. Surakarta: The 2nd University Research Coloquium.
- Zulkifli, Z. A., Syahrizal, S., Rahman, H., Koyap, S., Junaidi, J., Abbas, A., Dahroni, D., & Riki, M. (2008). *Khazanah Kerajinan Melayu Riau*. Pekanbaru: Dewan Kerajinan Nasional Daerah Provinsi Riau.