



BATIK JLAMPRANG WITH KOCH SNOWFLAKE AND KOCH ANTI-SNOWFLAKE FRACTAL GEOMETRY USING DESMOS

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ABSTRACT

Batik Jlamprang is a cultural heritage from Pekalongan. This batik motif has a round shape and floral ornaments. The motif of batik Jlamprang is similar to the Koch snowflake. Mathematically, batik Jlamprang can be categorized as one of the shapes of fractal geometry. There are many known shapes of fractals, some of which are Koch snowflake and Koch anti-snowflake. The difference between Koch snowflake and Koch anti-snowflake lies in the fractal generation process. Koch anti-snowflake is the opponent of Koch snowflake. The main step of the generation process is done to develop the Koch snowflake and Koch anti-snowflake function formulas, followed by iterations. The making of the batik motif is originally carried out traditionally, which has disadvantages in terms of time and cost. However, this study proposes that the motif of batik Jlamprang can be designed mathematically with the help of Desmos software. This will definitely shorten the production time and reduce production costs. The Desmos software was chosen because it has several advantages, including easy to operate via a mobile phone or a computer. This paper examines the function formulas, iterations, and application of Koch snowflake and Koch anti-snowflake fractal geometry in designing batik Jlamprang assisted by Desmos. The method used was literature review by collecting several relevant sources. The fractal generation process produced the function formulas of P_n (perimeter) and A_n or S_n (area) which are necessary for designing the batik Jlamprang motif. The visualization process was carried out on Desmos, followed by geometric transformation and cloning to produce the batik Jlamprang motif as desired.

Keywords: Desmos, fractal, Jlamprang, Koch snowflake

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INTRODUCTION

Ethnomathematics consists of two words, namely “ethno” and “mathematics” which can be defined as a study which integrates culture and mathematics. This term was first introduced in the 1930’s. The ethnomathematics movement began with the establishment of International Study Group on Ethnomathematics in 1985 in the meeting of National Council of Teachers of Mathematics (NCTM) in San Antonio, Texas by the leader, a mathematician and philosopher named Dr. Ubiratan D’Ambroiso. D’Ambroiso conveyed his view on ethnomathematics as follows:

The ethnomathematics program is a theoretical framework that establishes the foundation for organizing practices and systems of explanations developed by the species throughout its evolution in order to survive and to transcend. It is a system of knowledge that offers the possibility of a harmonious relation among humans and between humans and nature. It

contributes to restoring cultural dignity and offers the intellectual tools for the exercise of citizenship. It enhances creativity, reinforces cultural self-respect and mutual respect, and offers abroad view of humanity. (D'Ambrosio & Rosa, 2017).

According to D'Ambrosio's writings, it is understood that ethnomathematics may serve as an alternative in the implicit philosophy of mathematics practices in school, as it belongs to contextual approach. Ethnomathematics serves as a bridge between math and culture. As explained above, ethnomathematics recognizes the existence of different ways in using math in the activities of the society. The application of ethnomathematics as a learning approach will greatly allow a learning material to be easier to understand for students as it is directly related to their culture and daily activities in society. One of the ways that math can be linked to culture is by associating geometric shapes with batik patterns or motifs. By using geometric pattern generating formulas, we can develop or even create new batik patterns that serve as the identity of the Indonesian culture.

Fractal geometry is a new type of geometry discovered by Mandelbrot in 1975. This geometry explains various irregular forms of a geometric figure that cannot be identified in the regular geometric figure patterns (Anggraini, 2019). There are many types of fractals, including the Mandelbrot set, Sierpienki triangle, Koch snowflake, Koch anti-snowflake, etc. (Hasang & Supardjo, 2012). Fractals are often found among objects in real life, such as clouds, mountains, turbulence, and coastlines that have complex geometric shapes. In general, fractals are irregular in shape and are not objects that can be defined by traditional geometry or Euclidean geometry. They have infinite details and can have self-similarity structures at different magnification levels. In many cases, a fractal can be generated by repeating a pattern, usually in a recursive or iterative process. Fractals can help explain many situations that are difficult to describe using Euclidean geometry.

The difference between fractal and Euclidean geometry is the dimension approach. Fractal geometry uses a more abstract approach on the concept of dimensions than Euclidean geometry. The dimension of an object in the Euclidean geometry can be stated in integers, such as a one-dimensional line and a two-dimensional plane. On the other hand, the fractal geometry is stated in fractions. For example, a fractal image may have boundaries that can be infinitely detailed to the point that the object is present in one dimension or two dimensions. Conceptually, this presents fractal geometry with the ability to formulate natural objects as well as non-linear dynamic system. In conclusion, fractals are part of geometry that explains the irregularity of figures in nature that cannot be described using the dimensions of conventional geometry (Euclidean geometry).

At present, many fractal shapes have been applied in various fields of science, technology, and computer-based arts. In computer graphics, fractals are commonly used to create natural, and even magnificent figures. The existence of fractal geometry shows that math is not a dry, flat, and monotonous science, but a beautiful science that can produce art works with high intellectual and artistic values. Fractals tend to have significant details which can be observed on any scale. The self-similarity characteristic of fractals means that the magnifications of a fractal on a certain scale will reveal an image that resembles the original pattern. These sets are typically defined with recursion. One example of fractal geometry, namely the Mandelbrot Set, is presented in different magnification scales in Figure 1.



Figure 1. The Mandelbrot Set Fractal

Batik is a traditional craft with a high artistic value that is a part of the Indonesian culture. There are many cities in Java that produce batik, including Yogyakarta, Surakarta, Cirebon, Pekalongan, etc. The city of Pekalongan is even known as the City of Batik and presented with a title of “World City of Batik” which signifies its strong batik culture. One of the many traditional batik motifs of Pekalongan is the batik Jlamprang motif which is illustrated by round and floral ornaments. Many residents of Pekalongan work in the batik business sector which includes the hand-drawn batik, stamp batik and printed batik. In general, batik is produced in a great amount of time due to the use of wax as the drawing method. Because of this, the batik making process is less efficient in terms of time and cost. One of the strategies to overcome this issue is to make the batik making process easier by changing the producing method into a digital one. As time goes, batik undergoes transformations in terms of the motifs, meaning, making process, as well as how it is used in daily life. Batik motifs can be developed in various ways, one of which is by using fractals.

Fractal batik is batik with designs (motifs and ornaments) that are made by developing fractal formulas that are applied using computer technology. One of the mathematical graphic calculator software that can be used to design fractal geometry-based batik is the Desmos software which is free and accessible by a mobile device or a computer. It is also easy to operate and demonstrate to people who may not be familiar with computer programming language. The required input is a function with a graph that will be illustrated to run or iterate the variables of the function.

Based on the background, this study aims to develop batik Jlamprang motif with Koch snowflake and Koch anti-snowflake fractal geometry. The formulation of the problems are as follows: (1) How does the function formulas and iterations are developed to generate batik Jlamprang motif with Koch snowflake and Koch anti-snowflake fractal geometry?; (2) What is the application of the function formulas and iterations of Koch snowflake and Koch Anti-Snowflake fractal geometry on the Desmos software to design the batik Jlamprang motif?

The research objectives are: (1) to describe the function formula development method and iterations to generate the Jlamprang batik motif using the Koch snowflake and Koch anti-snowflake fractal geometry, and (2) to describe the application of the function formulas and iterations of Koch snowflake and Koch anti-snowflake fractal geometry on the Desmos software to create the design of the Jlamprang batik motif.

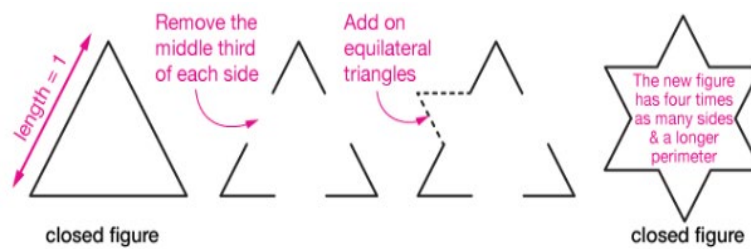
METHOD

The study uses the literature review approach, which is done by collecting books and journals on fractal batik, as well as the development and application of algorithm of the Koch snowflake and Koch anti-snowflake fractal geometry for Jlamprang batik. The research procedure was carried out as follows: (1) Analyzing problems related to fractal batik; (2) Collecting data in the form of studies related to fractal batik, including Digital Processing Technological Advancements ([Pratiwi et al., 2016](#)) which describes the exploration process in the making of batik motif using computational technology in a basic description on the work system of the jBatik program; The influence of fractal batik in the development of Indonesian Batik and the creative industry ([Cahyo, 2018](#)) which studies the background of the fractal batik trend due to the development of the jBatik software; fractal batik: development of a fractal geometry application ([Romadiastri, 2013](#)) which summarizes the fractal batik patterns developed using the jBatik software; prototype development of Batik Lampung with fractal motif using the GeoGebra application ([Femmy, 2020](#)) which results in a prototype of Lampung-style fractal batik generated using the GeoGebra application; and batik motif design using the fractal and L-System algorithm method to build the Batik Wali literature ([Saefurrohman & Ningsih, 2016](#)) which results in a batik motif design developed using the L-System algorithm; (3) Selecting the type of fractal batik to be studied, namely batik Jlamprang with Koch snowflake and Koch anti-snowflake fractals; (4) Identifying the characteristics of Koch snowflake and Koch anti-snowflake fractals based on the Koch snowflake and Koch anti-snowflake generation with the L-System method ([Sholeha et al., 2020](#)), Koch anti-snowflake generation with the Affine Transformation method ([Alkhori et al., 2019](#)), and Koch snowflake generation with the L-System method assisted by GUI Matlab ([Riwansia, 2016](#)); (5) Developing the function generating formulas for Koch snowflake and Koch anti-snowflake fractal geometry based on the method for finding the Koch snowflake fractal area ([Kamil et al., 2017](#)) and the generation process of Koch snowflake and Koch anti-snowflake

curves (Purnomo et al., 2020); (6) Developing the formulas for generating the functions and iterations for Koch snowflake and Koch anti-snowflake fractal geometry on the Desmos software; (7) Applying the generation formulas of the functions and iterations for Koch snowflake and Koch anti-snowflake fractal geometry on the Desmos software into fractal batik by referring to the original batik Jlamprang motif using geometric transformation; and (8) Drawing conclusions which serve as the answers to the problems described.

RESULTS AND DISCUSSION

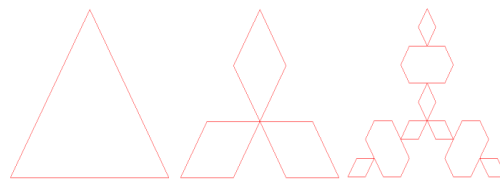
The Koch Snowflake fractal generation process starts with an equilateral triangle with a side length of 1 unit, followed by the removal of the middle third of each side, and an addition of an equilateral triangle on the hollow space in each side. The length of each side of the newly formed triangle is of the length of the original side. After this process is done, the newly created object is a closed equilateral twelve-sided polygon. The first iteration results in a shape with sides that are four times of the original shape, a shorter side length, namely of $\frac{1}{4}$ of the original, and a bigger perimeter. The Koch snowflake generation process can be seen in [Figure 2](#).



[Figure 2](#). The Koch Snowflake Generation Process

This process can be repeated to as many iterations as possible. The more iterations, the better the shape obtained which resembles Koch snowflake. This is why the fractal is named Koch snowflake. In this study, the shape used for the batik ornament is the second to fourth iterations of Koch snowflake.

Essentially, the generation processes of Koch anti-snowflake and Koch snowflake are nearly similar, but with opposite directions. Whereas Koch Snowflake is formed by adding a triangle outward, Koch anti-snowflake is formed by adding a triangle inward as seen in [Figure 3](#).



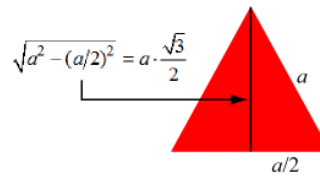
[Figure 3](#). The Koch Anti-Snowflake Generation Process

To create a fractal motif, first, it is necessary to define the boundaries of the object, which are represented by the perimeter and area formulas. The process for developing a formula manually is done before the formula is applied in the Desmos software. Iterative manual calculation process allows us to define the formulas of Koch snowflake and Koch anti-snowflake with n indicating the number of iterations conducted, N_n indicating the number of iteration sides at the n -iteration, L_n representing each side length at the n -iteration, and P_n representing the perimeter at the n -iteration. The manual generation processes of Koch Snowflake and Anti-Snowflake fractals are described in [Table 1](#).

Table 1. The Manual Generation Processes of Koch Snowflake and Anti-Snowflake

Koch snowflake Generation Process	Koch anti-snowflake Generation Process
Calculation of the Perimeter Formula of Koch Snowflake and Koch Anti-Snowflake Fractals	
$Nn = 3 \cdot 4^n$ $Ln = \left(\frac{1}{3}\right)^n$ $Pn = Nn \cdot Ln$ $= 3 \cdot 4^n \cdot \left(\frac{1}{3}\right)^n$ $= 3 \cdot 4^n \cdot 3^{-n}$ $= 3 \cdot \left(\frac{4}{3}\right)^n$	$Nn = 3 \cdot 4^n$ $Ln = \left(\frac{1}{3}\right)^n$ $Pn = Nn \cdot Ln$ $= 3 \cdot 4^n \cdot \left(\frac{1}{3}\right)^n$ $= 3 \cdot 4^n \cdot 3^{-n}$ $= 3 \cdot \left(\frac{4}{3}\right)^n$

Calculation of the Area Formula of Koch Snowflake and Koch Anti-Snowflake Fractals



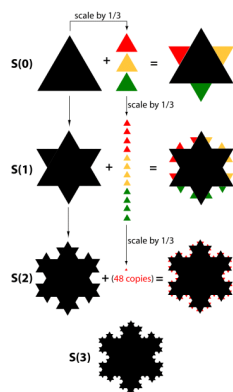
The next step is to identify the area of the fractal at the n-iteration. The first thing to do is to examine the area of the equilateral triangle with the side length of a unit.

$$A\Delta = \frac{1}{2} \cdot a \cdot \frac{a\sqrt{3}}{2} = \frac{a^2\sqrt{3}}{4} = \frac{\sqrt{3}}{4} a^2$$

Based on the result of calculation above, if a=s and S(0) describes the original area of the equilateral triangle, the following is obtained:

$$S(0) = \frac{\sqrt{3}}{4} s^2$$

After finishing the calculation for iteration zero, the next step is to find the area using iterative calculation to iteration n.



Area at n=1

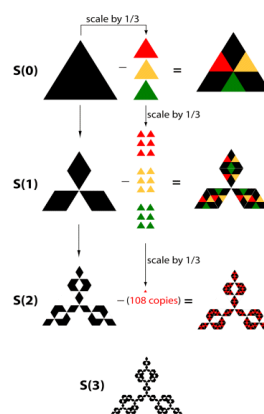
$S(1) = S(0) +$ area of the additional triangle
Each of the additional triangle side length is $\frac{s}{3}$.

Therefore:

$$S(1): \frac{\sqrt{3}}{4} s^2 + 3 \cdot \frac{\sqrt{3}}{4} \left(\frac{s}{3}\right)^2 = \frac{\sqrt{3}}{4} s^2 \left(1 + \frac{3}{9}\right)$$

Area at n=2

$S(2) = S(1) +$ area of the additional triangle
Each of the additional triangle side length is $\frac{s}{9}$.



To form the Koch Anti-Snowflake curve, we start with an equilateral triangle and begin the iteration step to make copies of the Koch curve along all three sides. The copies are made to point inward of the original equilateral triangle (before iteration).

Because the newly formed triangle is made inward, the equilateral triangle area must be reduced. The illustration is as follows.

Koch snowflake Generation Process	Koch anti-snowflake Generation Process
<p>Therefore:</p> $S(2): \frac{\sqrt{3}}{4} s^2 \left(1 + \frac{3}{9}\right) + 3 \cdot 4 \cdot \frac{\sqrt{3}}{4} \left(\frac{s}{9}\right)^2$ $= \frac{\sqrt{3}}{4} s^2 \left(1 + \frac{3}{9} + \frac{3 \cdot 4}{9^2}\right)$ <p>Area at n=3</p> $S(3): \frac{\sqrt{3}}{4} s^2 \left(1 + \frac{3}{9} + \frac{3 \cdot 4}{9^2}\right) + 3 \cdot 4 \cdot 4 \cdot \frac{\sqrt{3}}{4} \left(\frac{s}{9^3}\right)^2$ $= \frac{\sqrt{3}}{4} s^2 \left(1 + \frac{3}{9} + \frac{3 \cdot 4}{9^2} + \frac{3 \cdot 4^2}{9^3}\right)$ <p>In the iterative calculation, it can be concluded that at the k-iteration, we add $3 \times 4^{k-1}$ triangle with the area of the additional triangle $\frac{\sqrt{3}}{4} \left(\frac{s}{3^k}\right)^2$. This means that we add the total area from</p> $3 \cdot 4^{k-1} \cdot \frac{\sqrt{3}}{4} \left(\frac{s}{3^k}\right)^2 = \frac{\sqrt{3}}{4} s^2 \left(\frac{3 \cdot 4^{k-1}}{9^k}\right)$ <p>to the area of the original shape S(k-1) in order to obtain the k area S(k). Therefore, area at the n-iteration is</p> $S(n) = \frac{\sqrt{3}}{4} s^2 \left(1 + \sum_{k=1}^n \frac{3 \cdot 4^{k-1}}{9^k}\right)$	<p>In iteration 0 or S(0), there are 3 sides of the triangle. To obtain S(1), each side of the triangle is removed into $\frac{s}{3}$. Therefore, the area equation is</p> $S(1): \frac{\sqrt{3}}{4} s^2 - 3 \cdot \frac{\sqrt{3}}{4} \left(\frac{s}{3}\right)^2 = \frac{\sqrt{3}}{4} s^2 \left(1 - \frac{3}{9}\right)$ <p>We have 4 new sides from each of the 3 original triangle sides, resulting in a total of 12 sides. In the next iteration, each side of the previous 12 sides is removed and replaced with a side length of $\frac{s}{9}$. Therefore, in iteration S(2), the area equation is</p> $S(2): \frac{\sqrt{3}}{4} s^2 \left(1 - \frac{3}{9}\right) + 3 \cdot 4 \cdot \frac{\sqrt{3}}{4} \left(\frac{s}{9}\right)^2$ $= \frac{\sqrt{3}}{4} s^2 \left(1 - \frac{3}{9} + \frac{3 \cdot 4}{9^2}\right)$ <p>If the iteration goes on to k, we eliminate the $3 \times 4^{k-1}$ triangle with the additional triangle area of $\frac{\sqrt{3}}{4} \left(\frac{s}{3^k}\right)^2$. This means that a total area has been added from</p> $3 \cdot 4^{k-1} \cdot \frac{\sqrt{3}}{4} \left(\frac{s}{3^k}\right)^2 = \frac{\sqrt{3}}{4} s^2 \left(\frac{3 \cdot 4^{k-1}}{9^k}\right)$ <p>to the area of the original shape S(k-1) in order to obtain the k area S(k). Therefore, area at the n-iteration is</p> $S(n) = \frac{\sqrt{3}}{4} s^2 \left(1 - \sum_{k=1}^n \frac{3 \cdot 4^{k-1}}{9^k}\right)$

Generation Process of Koch Snowflake and Koch Anti-Snowflake on Desmos

The Desmos software helps in the visualization process of mathematical objects. The software does not require special programming codes, as the user can simply input the function formula of the object to be visualized. The generation process of Koch snowflake and Koch anti-snowflake is performed by first inputting the formulas of Pn (Perimeter of n-variable) and An (Area of n-variable). The Input scheme on Desmos can be seen in [Figure 4](#) and [Figure 5](#).

Koch Snowflake

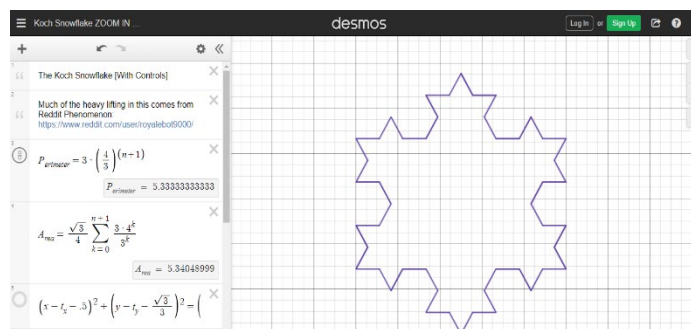


Figure 4. Koch Snowflake Generation on Desmos

Inputting the Koch Snowflake function formulas (P_n and A_n). P_n is the perimeter formula and A_n is the area formula of Koch snowflake.

$$A(n) = \frac{\sqrt{3}}{4} s^2 \left(1 + \sum_{k=1}^n \frac{3 \cdot 4^{k-1}}{9^k} \right) \quad (1)$$

$$P_n = 3 \cdot \left(\frac{4}{3} \right)^n \quad (2)$$

The modification is applied on n starting from -1 . Therefore, the function formulas for Desmos are as follows:

$$P_n = 3 \cdot \left(\frac{4}{3} \right)^{(n+1)} \quad (3)$$

$$A(n) = \frac{\sqrt{3}}{4} \sum_{k=0}^{n+1} \frac{3 \cdot 4^k}{3^{2k}} \quad (4)$$

The designed circle equation will be adjusted to the Koch snowflake curve as a frame or boundary of the Koch snowflake curve. The Koch snowflake Curve is built from point to point which has parameters that can move in the x-axis and y-axis which is done by: (1) Inputting the set of pairs in order based on the formulated coordinates; (2) Inputting parameter t_x which states the curve's coordinate on x-axis; and (3) Inputting parameter t_y which states the curve's coordinate on y-axis.

Koch Anti-Snowflake

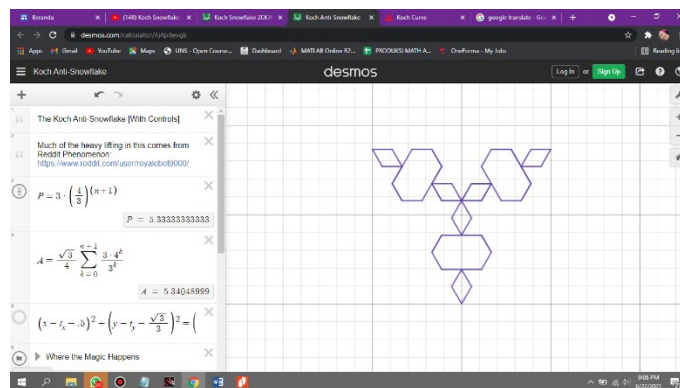


Figure 5. Generation of Koch Anti-Snowflake on Desmos

Inputting the Koch anti-snowflake function formulas (P_n and A_n). P_n is the perimeter formula and A_n is the area formula of Koch anti-snowflake.

$$P_n = 3 \cdot \left(\frac{4}{3} \right)^n \quad (5)$$

$$A(n) = \frac{\sqrt{3}}{4} s^2 \left(1 + \sum_{k=1}^n \frac{3 \cdot 4^{k-1}}{9^k} \right) \quad (6)$$

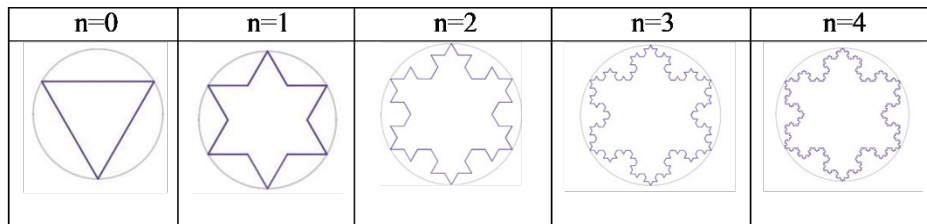
The modification is applied on n starting from -1 . Therefore, the function formulas for Desmos are as follows:

$$P_n = 3 \cdot \left(\frac{4}{3} \right)^{n+1} \quad (7)$$

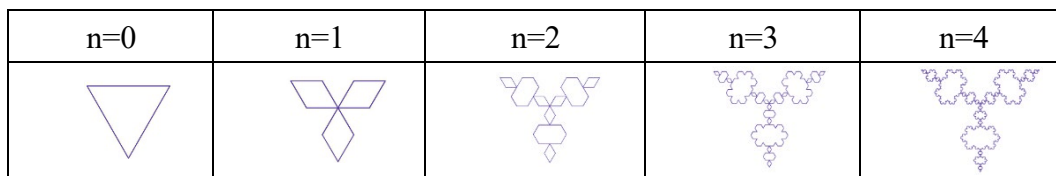
$$A(n) = \frac{\sqrt{3}}{4} \sum_{k=0}^{n+1} \frac{3 \cdot 4^k}{3^{2k}} \quad (8)$$

The Koch anti-snowflake curve is built from point to point which has parameters that can move in the x-axis and y-axis which can be done by: (1) Inputting the set of pairs in order based on the formulated coordinates; (2) Inputting parameter t_x which states the curve's coordinate on

x-axis; (3) Inputting parameter ty which states the curve's coordinate on y-axis. The results of the generation of Koch snowflake and Koch anti-snowflake fractals on Desmos are illustrated in [Figure 6](#) and [Figure 7](#).



[Figure 6](#). Result of Koch Snowflake Generation on Desmos

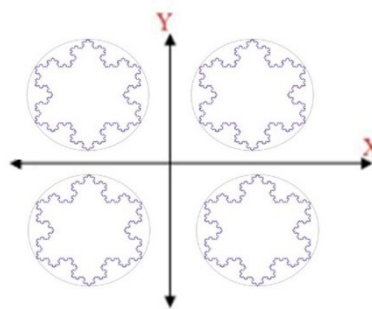


[Figure 7](#). Result of Koch Anti-Snowflake Generation on Desmos

The results of generation of fractal patterns on the Desmos software are then combined using the geometric transformation principles in order to create a whole new design of batik Jlamprang motif with Koch snowflake and Koch anti-snowflake fractal geometry.

Basic Ornament

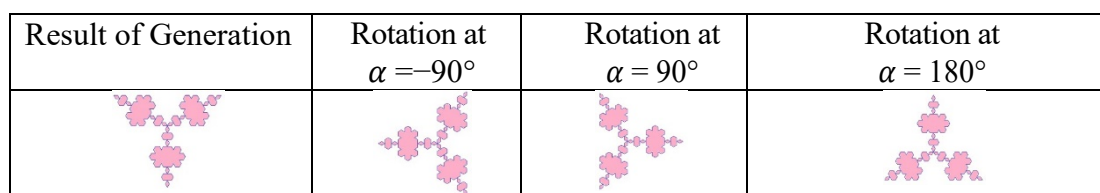
The permanent ornament, namely the Koch snowflake fractal is added with a circle around the perimeter as a boundary which is then mirrored. The basic ornament of fractal batik consisting of geometric figures in the form of circles and the Koch snowflake fractals as a result of the Desmos generation at the fourth iteration can be seen in [Figure 8](#).



[Figure 8](#). Basic Ornament of Fractal Batik

Additional Ornaments

The additional ornaments are Koch anti-snowflake fractals that are colored and modified using geometric transformation. The additional ornaments of fractal batik consisting of Koch anti-snowflake fractals as a result of generation on Desmos at the third iteration are illustrated in [Figure 9](#).



[Figure 9](#). Additional Ornaments of Fractal Batik

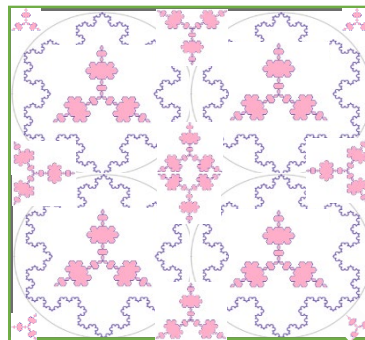
Batik Jlamprang with Koch Snowflake and Koch Anti-Snowflake Fractal Geometry

The Batik Jlamprang motif has round and floral ornaments known as the ceplok motif by the Pekalongan people. It consists of squares and rectangles that are arranged and designed to resemble a weaving motif on patola woven fabric. The batik Jlamprang motif can be seen in [Figure 10](#).



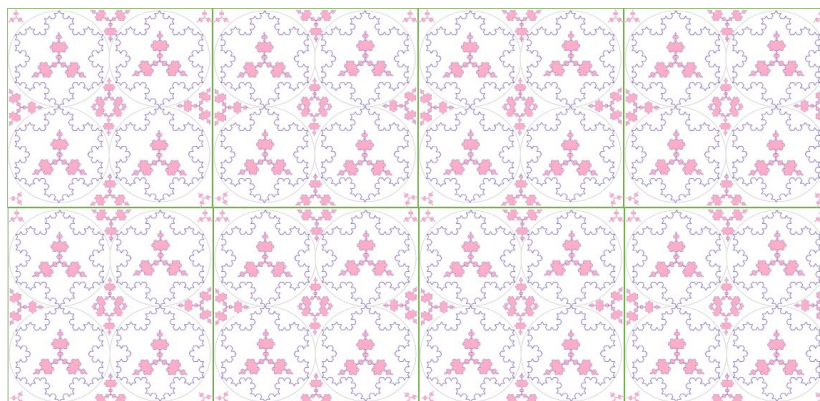
[Figure 10](#). Batik Jlamprang motif

The innovation on Jlamprang here is evident in the floral motif that is designed with the Koch snowflake and Koch anti-snowflake fractal geometry. The innovation is designed by modifying the fourth iteration of the Koch snowflake and the third iteration of the Koch anti-snowflake as a result of the fractal generation process performed on Desmos. One of the created batik motif innovations can be seen in [Figure 11](#).



[Figure 11](#). Batik Jlamprang Motif with Koch Snowflake and Koch Anti-Snowflake Fractal Geometry

After the individual fractal batik pattern is designed, the last step is cloning the batik motif in [Figure 11](#) by duplicating the motif into a more identical and interconnected pattern to create a whole motif design that can be represented on a regular size fabric (40 cm x 110 cm). [Figure 12](#) below shows the illustration of fractal batik on the fabric. The image size is 632 x 702 pixels assuming the fabric size of 40cm x 110cm with a scale of 1: 0.0000003748 cm.



[Figure 12](#). The Fractal Batik Final Product

The presence of a digital printing machine can solve problems related to inefficiency and ineffectiveness in the manual batik making process. A digital printer can also enhance the batik motif creations. In this case, mathematics can serve as one of the disciplines that can enhance batik motif through geometry. Batik Jlamprang with Koch snowflake and Koch anti-snowflake fractal geometry is one of the forms of innovation that can be done. Technically, there are two methods for printing the batik motif, namely by direct printing on the fabric and indirect printing using a medium of transfer, usually in the form of a transfer paper. The indirect printing process begins by printing the image on the transfer paper using either offset or inkjet technology. The paper usually has a special coating to receive the sublimation ink. The image is then transferred from the paper onto the fabric.

This process is suitable for the application on clothing and accessories such as bed sheets, pillow sheets, and other fabric-based products that have direct contact with human skin. On the contrary, in the direct printing process, it is the fabric that is coated. After the coating, the fabric can be immediately printed on using the commonly available inkjet printer. To finish, the fabric is processed in a heating machine. This can be done offline (heating machine separated from the printer) and online (integrated heating machine and printer). The latter is suitable for the application of advertising purposes, such as banners, flags, and pennants.

From the education perspective, linking the lessons at school with culture in Indonesia is certainly a very good idea as students become aware of the utilization of the science while simultaneously learning and preserving the culture of Indonesia. From the development process of the Koch snowflake and Koch anti-snowflake fractal geometry, students will learn a lot about math, including the basic concepts, the development of area and perimeter formulas, the making of programming algorithm for object visualization, the use of geometric transformation, and measuring the scale of the actual batik size.

CONCLUSION

Based on the illustrated results, conclusions can be drawn as follows: (1) The development of function formulas and iterations to generate batik Jlamprang motif with Koch snowflake and Koch anti-snowflake fractal geometry is first by understanding the characteristics of the Koch snowflake and Koch anti-snowflake fractals, followed by performing the fractal generation and iterative calculation of the object perimeter and area, and finally defining the perimeter and area formulas of the object using mathematics symbols to identify the formulas for the P_n (perimeter) and A_n or S_n (area) which become the basis to generate the Koch snowflake and Koch anti-snowflake fractals on the Desmos software; (2) The application of function formulas and iterations of the Koch snowflake and Koch anti-snowflake fractal geometry on the Desmos software to make the batik Jlamprang motif design is done by applying the formulas developed on the Desmos software by adjusting the formulas with the software algorithm, namely by finding the coordinates of fractals to be visualized, followed by a geometric transformation process and cloning to produce the desired result, namely an innovation on the batik Jlamprang motif with Koch snowflake and Koch anti-snowflake fractal geometry.

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