



# Ethnomathematics Exploration in the Process of Manufacturing Sidikalang Coffee Powder as a Source of Mathematics Learning

Nurkeke Fitriani Kudadiri<sup>a,\*</sup>, Ella Andhany<sup>a</sup>

<sup>a</sup> *Departement of Mathematics, UIN Sumatera Utara, Medan, 20235, Indonesia*

\* *E-mail address: nurkeke0305202106@uinsu.ac.id*

## ARTICLE INFO

### Article history:

Received 25 July 2024

Received in revised form 5

August 2024

Accepted 6 August 2024

### Keywords:

Ethnomathematics; Coffee; Sidikalang.

## Abstract

Mathematics plays an important role in various areas of daily life and helps develop logical, critical, and systematic thinking patterns, and problem-solving abilities. However, the mathematics learning process often experiences obstacles both from internal factors such as students' negative attitudes, low interest in learning, and weak motivation, as well as external factors such as lack of teacher focus and minimal family support. Ethnomathematics, namely mathematics integrated with local culture, has emerged as an effective method to help students understand mathematical concepts more easily and interestingly. This research was conducted on the process of making Sidikalang coffee at UD (trading business) Kopi Keke, Dairi, North Sumatra, which combines ethnomathematics with mathematics learning. Through qualitative methods with an ethnographic approach, this research identifies mathematical concepts contained in the six stages of coffee making, namely drying, pounding, roasting, grinding, packaging, and marketing. The research results show that this process includes the concepts of social arithmetic, calculation, time comparison, plane geometry, space geometry, and measurement so that it can support mathematics learning that is easy for students to understand.

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## 1. Introduction

Life is an important learning process to understand self-potential. One important example of learning is mathematics in everyday life. Mathematics plays an important role in a variety of fields and can develop a mindset as well as an understanding of the basics of modern technology. Therefore, a mathematical understanding is essential to develop the ability to think logically, critically, systematically, and solve problems in daily life (Mashuri, 2019).

The process of learning mathematics encounters constraints arising from internal and external factors (Ayu et al., 2021). Internal factors include negative attitudes of students, low interest in learning, weak motivation, and less perceptive abilities. External factors include a lack of teacher focus, minimal learning equipment, poor family support, crowded surroundings, and low average public education.

According to Widdiharto (Raharyu in Rahmah & Abadi, 2020), difficulty learning mathematics occurs when students are unable to master concepts, principles, or algorithms of problem solving, even though they have learned them. This difficulty is exacerbated by the student's inability to abstract, generalize, think deductively, and remember concepts and principles of math. It causes students to feel that math lessons are difficult.

Mathematics plays an important role in everyday life, but not everyone understands it (Muslihah, 2021). Mathematics is studied from elementary to higher education. As technology develops, the curriculum needs to incorporate culture in learning to form a generation with a unique character and capable of preserving

### To cite this article:

Kudadiri, N. F. & Andhany, E. (2024). Ethnomathematics Exploration in the Process of Manufacturing Sidikalang Coffee Powder as a Source of Mathematics Learning. *Unnes Journal of Mathematics Education*, 13(2), 143-151. <https://doi.org/10.15294/r43wt284>

the culture of the nation. Ethnomathematics utilizes activities and surrounding cultures to help students understand mathematical concepts more easily and interestingly (Putri et al., 2022).

Without realizing that mathematics can be learned from the cultures around us, many of the mathematical concepts are present in everyday life. It shows that mathematics is a useful and understandable science. The relationship between mathematics and culture is called ethnomatematics, which not only studies mathematical but also the cultural values contained in it (Aprilia et al., 2019). Ethnomathematics is an effective learning method to help learners understand mathematical concepts more easily and interestingly, because it uses cultures and activities that are close to their lives. And according to Damayanti et al. (2022) ideal mathematical learning includes four aspects of core competence: spiritual, social attitude, knowledge, and skill.

Some observations have been carried out, such as the articles by Safitri and Siregar (2023) entitled *Etnomatematics in the Knowledge Making Process as a Source of Mathematical Learning*. The articles by Wicaksono and Warli (2022) with the title *Ethnomatomatics in The Black Thread Taping Process*. And the article by Pratiwi and Pujiastuti (2020). with the titles *Explorations of Ethnomatmatics in Traditional Slow Games*. In these studies, discussing the existence of ethnomatematics, there is a mathematical concept in it. So it makes it easier for us to understand the concept in everyday life.

Dairi district, North Sumatra, is famous for its culture that is closely associated with coffee. Sidikalang's robusta coffee is one of the region's top products (Yulsafrida & Mourisa, 2023), contributing 43.47% to the local economy. The preservation of coffee culture in Sidikalang is carried out through various efforts, such as seminars, training, and the Njuah-Njuah Cultural Festival. In this cultural festival, there are dance performances depicting the activities of coffee farmers, from planting to harvesting. The Sidikalang coffee is not just a plant, but also an identity and a source of life for the communities there. Its existence demonstrates the rich cultural and economic potential of Sidikalang and Indonesia.

This research was carried out on Sidikalang coffee which could be used as a source of mathematical learning. This research describes that the process of making coffee powder is part of ethnomathematics. The mathematical concepts that are present in the coffee powders process as an inter-cultural activity. So with the presence of ethnomathematics in the process of making coffee powder can support the learning of mathematics that can be understood students at school.

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## 2. Methods

The study used qualitative methods with an ethnographic approach to studying the relationship between the process of making coffee powder and ethnomatematics. Data collection methods used are participatory observations, structured interviews, and documentation. The research was carried out at the Keke Coffee Department, located at Medan-Sidikalang No. 12, Sitinjo Prefecture, Dairi District, North Sumatra Province, which is one of the leading coffee-producing areas.

The researchers are directly involved in the daily activities at the UD (trading business) Coffee Keke to observe the process of making coffee powder, i.e. participatory observations, interviewing the workers about the mathematical knowledge they have applied in their work of structured interviews. Photo and video documentation is also used to record the activities and processes of making coffee powder.

Data analysis techniques used according to the type of data collected. The collection and analysis of qualitative research data is interactive, taking place in overlapping circles. Such measures are commonly referred to as data collection and analysis strategies, techniques that are used flexibly, depending on the strategy used previously, the data obtained. Qualitative data analysis is done interactively and continues until completion, so that the data is saturated. The researchers use data analysis of the Miles and Huberman models.

The data validity verification process is basically used to assure all parties concerned of the validity of the findings. To test the validity of data in qualitative research, researchers used triangulation techniques. According to Moleong in his book entitled *Qualitative Research Methodology* (2005) states that triangulation can be understood as a technique of verifying the validity of data that utilizes outside the data as a data comparison. In this data verification, researchers use two types of triangulations by comparing information obtained from informants with different sources. This technique aims to verify the degree of confidence of information from the same data source and various sources. As for the data collection techniques used, there are two types, namely, triangulation of techniques and triangulation of sources.

### 3. Results & Discussions

Based on the results of research and interviews with the owner of UD (trading business) Keke Coffee conducted by the researchers, obtained a short history of making coffee in UD (trading business) Coke Coffee located in Sitinjo Village, Sitinjo Subdistrict, Dairi District named Surung Kudadiri and Roni Dawaty Matanari who have been producing for 8 years. The market is not just coffee powder, but there are coffee seeds that are still green beans, grained seeds, and raw coffee that are grained or known to be broken. As for the kinds of coffee that Keke sells, robusta coffee and arabica coffee. Each type has its variants: ordinary robusta, single seed robusta, ordinary arabica, single-seed arabica and wine-aromatic arabica.

Based on the results of the observations, interviews and documentation obtained, the results are six stages: melting (drying coffee), knocking (separating coffee peel), irrigation, grinding, packaging and marketing. Different from the common coffee processing that was initially coiled to separate the red skin and then sunbathed. The six phases are the mathematical concepts found in the process of making coffee powder.

#### 3.1 Drying process

This process is the initial process of making coffee powder. Coffee with the condition of red skin is sunbathed until the coffee skin changes colour into brown, which is done for more than ten days according to the climate. The ethnomathematics found in this process are:

1. The concept of comparing the volume of coffee, after the melting of the coffee volume will decrease (reducing) the original 100 kg to 50 kg.
2. The concept of space geometry, which is the shape of an ellipsoid and round coffee seed.
3. A concept of flat geometry, that is, the shape of the sunrise that shapes a square.



**Figure 1.** Coffee bean drying process

#### 3.2 Grinding Process (Separating Coffee Beans from the Skin)



**Figure 2.** Grinding process

In this process, the coffee is put into a bowl first and then crushed with wood/coffee bean. The ethnomathematics found in this process are:

1. The concept of space geometry, namely the shape of a mortar that resembles a cylinder shape and long wooden shapes that have a cylinder shape.
2. The concept of volume comparison, namely the volume of coffee after separating it from the skin, which was initially 50 kg to 45 kg to become green bean coffee.
3. The concept of flat geometry, namely the shape of a *tampi* that is square.

### 3.3 Roasting process

In this process, the weight of the green bean seeds will be measured first before being put into the roasting container. The ethnomathematics discovered in this process are:

1. The concept of measuring weight, namely using a measuring scale .
2. The concept of calculating time, namely the time to roast coffee for one roasting, takes 1 hour per 14 kg. However, if the firewood is used while it is still damp, the roasting time will be longer, increasing by 15-25 minutes.
3. The concept of volume comparison, namely that each kg will decrease by 200 grams, which was originally 45 kg will become 36 kg.
4. The concept of space geometry, namely a cylinder-shaped roasting tool.
5. The concept of flat geometry, namely a square base.
6. Arithmetic concept, namely roasting coffee using firewood. In one production, the entrepreneur consumes 1/2 cubic meter of firewood from a pick-up car at a price of Rp. 60,000.



**Figure 3.** Roasting process

### 3.4 Grinding process

The coffee is finely ground to make coffee powder using a coffee grinder. The ethnomathematics that occur in this process are:

1. Time calculation concept, namely 2 hours grinding time per 14 kg, and 2 hours cooling time for all coffee grounds.
2. The concept of space geometry, namely the shape of the container used in coffee grinding machines which is in the form of a cylinder without a lid.
3. The arithmetic concept, namely that each grinding is charged per kg at Rp. 5,000.
4. The concept of measurement, namely using measuring instruments as a form of weight measurement..



Figure 4. Grinding process

### 3.5 Packaging process



Figure 5. Packaging process

Coffee that has become powder will be packaged according to the size of the packaging, namely paper pouches and coffee boxes. The ethnomathematics obtained in this process are:

1. The concept of measuring volume, namely that each package will be measured according to a predetermined weight, for example, there are 100 gr, 250 gr, 500 gr and 1 kg.
2. The concept of space geometry, namely a coffee box with a block shape and a grid of blocks before being glued together using wax glue.

### 3.6 Marketing process

After the coffee powder is packaged according to size, some use plastic, boxes and paper pouches. The ethnomathematics obtained in this process are:

1. Arithmetic concept, namely coffee is sold according to its respective type and variant. Regular robusta coffee is priced at Rp. 35,000/250 gr. Single robusta coffee priced at Rp. 40,000/100 gr. Regular Arabica coffee priced at Rp. 30,000/100 gr. Single Arabica coffee priced at Rp. 50,000/100 gr. Grape aroma Arabica coffee priced at Rp. 60,000/100 gr.
2. The measurement concept is that in 1 box the size is 250 grams, so in one kg there are 4 boxes. If the size of coffee is 100 grams, there are 10 packets in one kg.
3. Sharing concept, 1 kg of green bean robusta coffee is purchased for IDR. 65,000. In one production, the minimum amount of coffee required is 45 kg of green bean robusta coffee for IDR. 2,925,000, after roasting it becomes 36 kg. The cost of ½ cubic firewood from a pick-up car costs IDR. 60,000, roasting wages Rp. 1,000/kg then 45 kg becomes Rp. 45,000, milling costs Rp. 5,000/kg then 36 kg for Rp. 180,000, packaging costs Rp. 5,000/kg then 36 kg costs Rp. 180,000. So the total capital cost is Rp. 2,925,000 + Rp. 60,000 + Rp. 45,000 + Rp. 180,000 + Rp. 180,000 = Rp. 3,390,000. For sales of 36 kg of regular robusta coffee for Rp. 5,040,000. So the profit obtained in one production is Rp. 5,040,000 – Rp. 3,390,000 = Rp. 1,650,000.

Based on the above research, it can be found that the process of making Sidikalang coffee powder contains mathematical concepts. Learning mathematics using a cultural context provides many benefits to students, namely, improving intellectual, social, and intellectual intelligence as well as emotional and cultural awareness (Busrah & Pathuddin, 2021). In this way, students can learn the mathematical concepts of the coffee powder making process: social arithmetic, comparison, geometry, and measurement.

Based on the results above, it can be seen that mathematical concepts can be associated with culture so that students can learn mathematics concepts and learn that the Sidikalang coffee is typical of the Dairi district. At every stage of the creation process there are some mathematical concepts. As for the mathematical concepts on the process of making coffee powder as follows.

#### 1. Concept of social arithmetic

In the marketing process, this concept will be implemented in society, for example, the activity of the process of buying coffee from green coffee bean sellers, selling coffee powder to customers and calculating the profit capital from the manufacture of coffee powders. Profits are obtained through the difference from the sales price minus cost and taxes. The formula for profit is as follows:

$$\text{Profit} = \text{Selling Price} - \text{Buying Price}$$

The ethnomathematics found in this concept are very clearly influenced by the Sidikalang region that Dairi district also has no less promising potential, namely the Sidikalang coffee. The Dairi district is identical to its coffee. The Sidikalang robusta coffee has a production of about 3,736 tons and is the largest coffee production in Sumut or 40% of the total Sumut coffee production. "The development of this 3F and coffee program is very important in order to be the attention and focus of the Dairi District Government. It is the agricultural sector that makes the largest contribution to the economy with 43.47%," he said. Meanwhile, Dr. Eddy Keleng Ate Berutu said that the Njuah-Njuah cultural festival is a people's party as a form of actualization of the development of a culture-based region whose purpose is to preserve culture.

In addition to being a grove that can grow everywhere, coffee also has a high selling value that can be used as a drink. With its sales value and its high fans, coffee has become something that has an influence in the Indo-India even in the economic sphere.

## 2. Concept of ratio

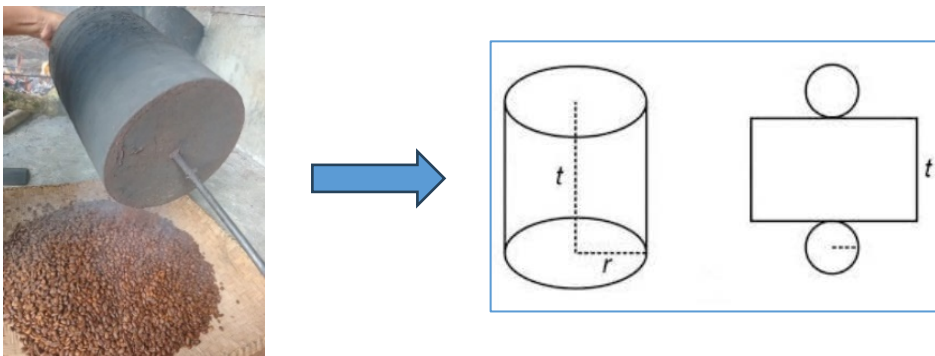
This concept was found at the time of the coffee melting process, so you can see the difference in the weight of coffee volumes before and after the melt. There is also a process of clamping the coffee skin to separate the coffee seeds from the skin. At the time of the process, the concept of comparison obtained gives an explanation of the nature of the comparison itself, which is a comparison of the values of two values.

## 3. Concept of geometry

The concept of flat geometry and space is very clearly present in its stages. It has several shapes, such as squares, cylinders, beams, circles and ellipses. With the presence of some examples, it is a learning that can be found from elementary school to upper secondary school and is found in everyday environments.

### 1) Cylinder

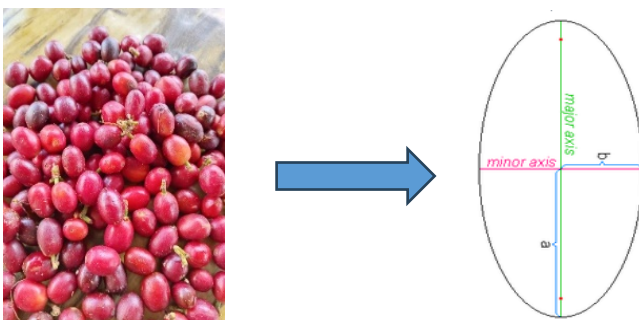
A cylinder is a building of a space that has a curved side. The cylinders has three main side fields: the base side field called cylinders base, the curved field called the pipe blanket and the upper field called a cylinders cap. The base side and the top side of the cylinder are in the shape of a circle that is congruent and parallel. The thumbs of the cylinders were of the thumb's thumb, and of its diameter, and its height; and its thumb was half of the center of the circle on the side, and the diameter was twice the length of its fingers; and the height of its width was of the curved side of its cover.



**Figure 6.** Concept of Cylinder

### 2) Ellipse

Ellipse is part of a nodular incision and has properties similar to circles. Unlike circles, the ellipse has an oval shape. The position of the points is represented by an ellipse with an eccentricity less than one, and the sum of the distance between the two foci of the elliptic is a constant value.



**Figure 7.** Concept of Ellipse

### 3) Square

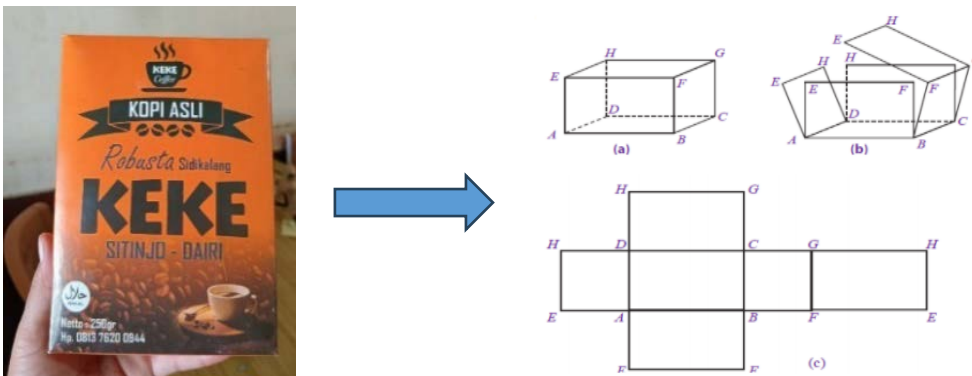
A square is a combination of four lines connecting four points, with three non-fresh points, and has the properties of: 1) No line squares intersecting, except at the end points. 2) Each point is the exact end of two line streaks. For example, the fourth side is the square and the longest. The square is a fourth-sided polygon. All the angles are equal, therefore the quadrant is considered to be the equal

fourth angle. Square length: The square length is a two-dimensional build with four sides, four corners of an elbow on the inside, and four angles.



**Figure 8.** Concept of square

There are three pairs of sides of the same shape and size, each of which is square in length; and there are three of them, the same length, and the same height, and their length and their breadth.



**Figure 9.** Concept of block

4. Concept measurement

This concept explains the existence of the process of measuring the weight of the volume of coffee and the use of a measuring instrument. With this concept of measurement, an understanding of the usage of the measuring instruments of everyday life becomes an example of ethnomathematics found for mathematical learning examples.

**4. Conclusion**

Based on the results of research conducted by the researchers, it can be concluded that the ethnomathematics that exists in the process of making sandwich coffee powder of six stages. The six processes include social arithmetic concepts, concepts of calculation, time comparisons, flat geometry, space geometries, and measurements. The relationship between culture and mathematics will make it easier for students to understand mathematical concepts in everyday life. Not only can cultural elements be found in the process of making coffee powder, the mathematic concepts are also very easy to understand for the source of mathematically learning in students according to the material of their respective levels. In addition to the previous concepts, there is also the concept of counting, which is used as a calculation of the phase-time use of some of the processes of making this coffee powder. The inter-cultural relationship of mathematics makes it easy for teachers to take examples of everyday life using mathematical concepts..



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