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EXPLORING ETHNOMATHEMATICS IN THE PROCESS OF MAKING TOFU IN DESA PENAMPAAN, ACEH TENGGARA REGENCY, AS A SOURCE OF MATHEMATICS LEARNING

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ABSTRACT

This study explores the mathematical concepts involved in tofu-making through an ethnomathematics approach, linking cultural practices with mathematics education. Using qualitative methods, including interviews, observations, and documentation, the research identifies seven stages in tofu production where mathematical concepts such as arithmetic, geometry, time comparison, and ratios are applied. Findings suggest that these concepts, which are relevant to school mathematics, can serve as a contextual learning resource. The study emphasizes the importance of integrating local culture into mathematics teaching, demonstrating that everyday activities like tofu-making offer valuable real-world applications for learning mathematical principles. This approach enhances students' understanding by connecting theory with practical, cultural contexts.

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1. INTRODUCTION

Ethnomathematics is an interdisciplinary field that explores the connection between cultural practices and mathematical concepts. This approach seeks to bridge the gap between formal mathematical education and real-world applications by integrating local cultural knowledge into mathematics teaching. Ethnomathematics is widely recognized as a way to contextualize mathematics learning, making it more relevant and engaging for students by drawing upon familiar, everyday activities [1]. Previous research has explored ethnomathematics in various contexts, including food production, traditional architecture, and musical instruments. For example, studies have examined the mathematical concepts involved in tempeh-making, Kupang lontong production, and the patterns found in musical instruments. However, one key area that has been overlooked is the application of ethnomathematics in the process of tofu-making, despite tofu being a staple food in many cultures [2].

Tofu production involves several stages, such as soaking, grinding, cooking, filtering, curdling, and cutting, each of which integrates various mathematical concepts, including arithmetic, geometry, time comparison, and ratios. These concepts, though integral to the tofu-making process, have not been thoroughly explored from an ethnomathematical perspective. The gap in the literature regarding ethnomathematics in tofu production presents a significant opportunity for research, especially considering the educational potential it holds. Tofu-making provides a real-world example of how mathematics is applied in everyday life, making it an ideal context for teaching various mathematical principles [3].

The urgency of this study lies in the need to bridge the gap between abstract mathematical theory and its practical applications. By integrating local cultural practices, such as tofu-making, into mathematics instruction, students can gain a deeper understanding of mathematical concepts that are directly applicable to their daily lives. This research not only contributes to the growing body of ethnomathematics literature but also offers a novel way to engage students in mathematics learning. It demonstrates that mathematics is not confined to the classroom but is embedded in the cultural practices and everyday activities of the community [4]. Therefore, this study aims to explore the ethnomathematical concepts involved in tofu production in Penampaan Village, Southeast Aceh Regency, and to highlight its potential as a contextual learning resource for mathematics education [5].

2. RESEARCH METHODS

This research is an exploratory qualitative study using an ethnographic approach to obtain detailed explanations and analyses based on field research. Qualitative research aims to understand the phenomena that occur, making it suitable for solving research problems that need to be explored [6] and described descriptively using words and images rather than numbers [7]. The ethnographic approach in this study aligns with the goals of ethnomathematics, which is to examine ideas, methods, and techniques within a specific culture based on the perspectives of its members [8]. This research has a main instrument, which is the human instrument or the researcher as the main instrument, whose role cannot be replaced or represented. This research has a main instrument, which is the human instrument or the researcher as the main instrument, whose role cannot be replaced or represented [9]. This research aims to uncover the exploration of ethnomathematics in the tofu-making activities among the people of Penampaan Village. The research location is Penampaan Village, Deleng Pokhkisen District, Southeast Aceh Regency. The research object is Tofu. Data collection techniques were carried out through observation, interviews, and documentation.

The observation was conducted by observing the process of making tofu. The objects observed are the materials, tools, and stages of tofu making, from soaking soybeans to cutting the tofu. This research also conducted interviews with informants who have expertise in making tofu, asking them as many questions as possible about the tofu-making process. The information from the informants was then recorded in a field notebook and documented in the form of images. This research also includes photographs of the process as part of the documentation. Data obtained from observations, interviews, and documentation were analyzed using triangulation [10]. The triangulation technique involves comparing data from interviews, observations, and documentation. Finally, the data is presented and described to obtain the findings. Then, conclusions were drawn regarding the exploration of ethnomathematics in the process of making tofu and its contribution to mathematics learning.

3. RESULT AND ANALYSIS

Based on the research findings and interviews with one of the tofu craftsmen conducted by the researcher, a brief history of tofu making in Penampaan Village, Babussalam District, Southeast Aceh Regency, was obtained. The owner of the tofu, named Mr. Saripudin, has been producing tofu for approximately 8 years. Mr. Saripudin himself has been producing tofu since 2018 [11].

Based on the results of observations, interviews, and documentation, it was found that the process of making tofu generally consists of seven stages: soaking, grinding, cooking, filtering, curdling, molding, and cutting. Each stage contains mathematical elements that are naturally carried out by the community. Additionally, there are cultural values and life philosophies integrated into every stage. From those seven stages, it was found that there are mathematical concepts present in the process of tofu manufacturing. Those seven stages take only one day for the process of making tofu.

Soaking process

This soaking process is the initial step in making tofu. The soybeans are placed in several large vats and soaked in water for 4-5 hours until they increase in volume. The ethnomathematics found in this process is:

a. The mathematical operation concept is division, which determines the amount of soybeans soaked for production. Mr. Saripudin usually produces 80 kg of soybeans in one day. One bag contains 50 kg of soybeans, so for each batch, 8/4 bags of soybeans are used, which is equivalent to 80 kg.
b. Calculation concept: The soybeans are soaked for 4-5 hours.
c. Time, soybean volume, and water volume ratio concept: After soaking, the soybeans will significantly increase in volume. Initially 80 kg, after 4 hours of soaking, they will weigh 112 kg. As the soybean volume increases, the water volume also decreases.
d. Spatial geometry concept: based on figure 1, small soybeans are those that are not yet soaked in water and are large after the soaking process, taking on an ellipsoid shape.
e. Three-dimensional space concept: The place or container used to soak the soybeans is hemispherical.

Figure 1. Soybean soaking process

Washing and grinding process

In this process, the beans are first soaked, then drained and washed. The soybeans are then finely ground using a special soybean grinder. Next, grinding is done with the addition of water to facilitate the process. The ethnomathematics found in this process is:

a. The concept of water flow and volume used in washing and grinding. In the washing process for one grinding cycle, 40 liters of water are used. Then, in the grinding process, 1.8 liters of water per minute are used for 30 minutes, which is equivalent to 54 liters of water. Therefore, for one washing and grinding cycle of 7 kg of dry soybeans, 94 liters of water are used.

b. Counting concept, which is the duration of the soybean washing process for one grinding, which is approximately 5 minutes, and the grinding process takes 30 minutes.

c. Three-dimensional space concept, which is the container used in the grinding process is cylindrical without a lid.

Figure 2. Grinding process

Cooking process

The soybeans are finely ground to make soybean porridge, then water is added and boiled until it boils. The ethnomathematics that occurs in this process is:

a. Time calculation concept, which is the time it takes to cook soybean porridge, typically 15 minutes per batch.

b. Three-dimensional space concept, where the barrel used to cook soybean porridge is cylindrical without a lid, and the cooking surface is hemispherical.

Figure 3. The process of cooking soybean porridge

Filtering and coagulation process

Filter the cooked soybeans through a sieve to make soy milk using a barrel. The ethnomathematics present in this process are:

a. Counting concepts, namely that filtering the cooked soybean pulp once takes 5-10 minutes, and the curdling process itself takes 15-20 minutes.

b. Water flow rate concepts, meaning that a single filtering and curdling process requires 70 liters of water.
c. Three-dimensional space concepts, namely the holding tank for the filtered product and the place for the soybean curdling process, which is cylindrical without a lid, and the filter is hemispherical.
d. The concept of two-dimensional flat shapes, specifically the sieve used for half-sphere filtration.
e. The concept of buying and selling, where the remaining filtered material, called dregs, is collected daily. 2-3 sacks were sold for Rp. 20,000 per sack. You can also mix and use the purchased feed to make snacks like crackers, nuggets, etc.

Figure 4. Filtration and coagulation process

Printing and cutting process

In this process, printing and cutting the tofu are the final stages of tofu production. The curdled soy milk is then molded into tofu. Before the tofu is pressed, the mold is lined with thin cloth. Then, the tofu curd is poured into the mold, covered again with thin cloth, and topped with a wooden lid. It is then pressed to remove the water quickly. Wait until it solidifies into tofu, which is then cut. The tofu is placed on a cutting board and cut into the desired shapes. The ethnomathematics found in this process are:

a. Counting concepts, specifically the waiting time for the soybean curd to become tofu, which is approximately 15 minutes.
b. Two-dimensional flat shape concepts, as the cloth used for pressing is rectangular.
c. Three-dimensional space concepts, as the mold used for making tofu is a rectangular prism without a lid, 50 cm long, 50 cm wide, and 50 cm high. The resulting tofu is also rectangular. The size of one tofu piece is 3 cm × 3.5 cm × 2 cm.
d. The concept of numerical operations is multiplication, where one rectangular mold is cut into 16 × 19304 pieces. Therefore, there are 304 tofu pieces in one mold.
e. The concept of two-dimensional flat shapes, which is the tool used for cutting the tofu.
f. It is made of rectangular wood.

Figure 5. Tofu printing and cutting process

Division concept

From the tofu mold in figure 5, if tofu is molded in the size of 40 cm × 55 cm × 2 cm, the volume of the resulting tofu is 40 cm × 55 cm × 2 cm = 4400 cm³. By using a tool to straighten the cut edges made of wood, which is sized 5 cm wide, so each block of tofu cut will be a rectangular prism with a volume of 5 cm × 5 cm × 2 cm = 50 cm³, meaning each tofu mold will produce $\frac{4400\ cm^3}{50\ cm^3}$ = 88 blocks of tofu.

Concept of equivalent ratios

From the tofu mold in image 5, block-shaped tofu with the dimensions shown can be formed 5 cm × 5 cm × 2 cm as many as 88 pieces of tofu. If a tofu maker can produce 60 blocks of tofu in a day, then in a day, the tofu maker can make $\frac{1}{88} = \frac{60}{x}$ ↔ x = 88.60 = 5280 pieces block-shaped tofu measuring 5 cm × 5 cm × 2 cm.

The concept of congruence

In figure 5, it can be seen that the number of tofu pieces cut from a tofu mold is 88, each measuring 5 cm × 5 cm × 2 cm. These pieces have square and rectangular sides measuring 5 cm × 5 cm and 5 cm × 2 cm. The squares formed are congruent. Furthermore, the rectangles formed are also congruent.

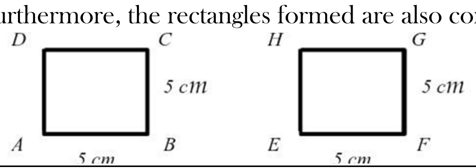

Figure 6. The concept of congruence in squares

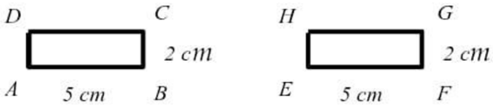

Figure 7. The concept of congruence in rectangles

Corresponding angles are equal.

$\angle A = \angle E$ $\angle D = \angle H$

$\angle B = \angle F$ $\angle C = \angle G$

Corresponding sides are equal in length.

$AB = EF$ $AD = EH$

$CD = GH$ $BC = FG$

The philosophical meaning of the tofu-making process and its connection to mathematics learning

The tofu-making process is not just a production activity, but also reflects philosophical values that can be integrated into mathematics learning. For example, soaking soybeans for 4–5 hours reflect the values of patience and perseverance important values that students also need to gradually understand mathematical concepts. The coagulation process, where soy milk transforms from liquid to solid, mirrors the shift from abstract to concrete thinking, just as the thought process does in solving mathematical problems [12].

During the tofu printing and cutting stage, there is a symbolism about the importance of structure, order, and precision. Tofu pressing using block molds and consistent measurements provides a tangible illustration of geometric concepts, volume, and congruence, while also instilling the values of precision and systematic thinking, which are part of the scientific approach to learning mathematics [13].

Comparison of raw material proportions and the concept of ratios in mathematics

In an interview with a tofu craftsman (Mr. Saripudin), it was learned that the proportions of soybean and water are very important in determining the quality of tofu. The ratio used in practice is 1:3, which means: 1 kg of soybeans is mixed with 3 liters of water to produce tofu that is firm, does not crumble easily, and is not too soft [14].

This comparison is a form of equivalent ratio that can be directly integrated into the comparison and proportion material in mathematics learning. Examples of learning integration:

a. If 2.5 kg of soybeans are used, then 7.5 liters of water are needed.
b. If 15 liters of water are available, then 5 kg of soybeans can be used.

This material is relevant for 5th–7th grade elementary/middle school students in the topics of proportional reasoning, scale, and operations with fractions/decimals.

The process of making tofu in penampaan village, southeast Aceh regency, in mathematics learning

The process of making tofu in Southeast Aceh Regency can be developed for students in mathematics learning [15]. An example of local culture-based learning, specifically the tofu-making process in penampaan village, Southeast Aceh Regency, that can be used in mathematics learning is as follows.

Geometric concept

Based on the research findings, it is known that a cylindrical barrel without a lid can be used in the soybean soaking process. Educators can explain the initial process of making tofu, which involves soaking soybeans overnight [16]. Subsequently, educators can discuss the ingredients used in the soybean soaking process. Educators can ask students the following questions.

a. Mr. Saripudin is a tofu maker from Penampaan Village who will make tofu from 100 kg of soybeans in a day. If he soaks soybeans in a used paint bucket with a diameter of 30 cm and a height of 40 cm, and each bucket is only filled with soybeans to ¾ of its capacity, how many buckets of the same size does Mr. Saripudin need to soak 100 kg of soybeans?
b. If Mr. Saripudin is going to boil soybeans in a half-spherical pan made of iron with a diameter of 80 cm, and the pan is only filled to 3/4 of its capacity, what is the volume of soybean porridge that Mr. Saripudin boils in one cooking session?

Division concept

Based on the research findings, it is known that in the process of making tofu, image 5 from the village of Penampaan, Southeast Aceh Regency, is the molding process. This involves molding in a block-shaped mold without a base or lid before the tofu is cut in the 5th process [17]. Educators can ask students the following questions.

a. It is known that Mr. Saripudin prints tofu with dimensions of approximately 40 × 55 cm × 3 cm using a mold. How many pieces of tofu did Mr. Saripudin get from that one mold if the tofu will be cut into blocks measuring 2 cm × 5 cm × 3 cm?

b. How many pyramid-shaped tofu pieces can be obtained if the tofu with dimensions 2 cm × 5 cm × 3 cm in point a is divided equally along one of its diagonals?

The concept of direct proportion

Educators can explain that the more soybeans used to make tofu, the more soybean pulp will be molded using the molds, resulting in a greater final yield of tofu, and vice versa. Educators can ask students the following questions.

a. One boil of soybean porridge in a semi-spherical pan with a diameter of 80 cm takes one hour. What is the total time Puk Saripudin needs to boil soybean porridge if he does it 10 times?
b. Mr. Saripudin cut the pressed tofu, which was 40 cm × 55 cm × 2 cm in size, into block-shaped tofu measuring 5 cm × 5 cm × 2 cm, resulting in 88 pieces of tofu. If Mr. Saripudin prints 60 times using that mold, how many pieces of tofu will Mr. Saripudin get?

The concept of congruence

Educators can explain to students that the surface sides of tofu that have been cut into pieces are congruent if the tofu is cut to the exact same size, both in terms of angles and side lengths. Educators can assign tasks to students as follows.

a. Besides what has been explained, mention the application of the congruence concept found in the process of making Kalisari-style tofu in Southeast Aceh Regency!
b. Explain the congruence conditions from your answer in point a!

The results of this study show that there are mathematical concepts contained in the process of making tofu in Penampaan Village, Southeast Aceh Regency [18]. This aligns with the goals of Ethnomathematics to bring mathematics closer to the reality and perceptions of society. Ethnomathematics increases students' interest and motivation in participating in mathematics learning. By incorporating the culture surrounding the students, the perception that mathematics is a difficult subject can change, ultimately leading to increased student interest and learning outcomes [19] [20].

Mathematics learning that only takes place in the classroom makes students inactive, overstimulated, and unable to gain real benefits or experience from their learnin. According to, mathematical characteristics are often used in daily life [21]. Therefore, environmentally friendly learning resources are needed for students, such as the ability to understand ethnomathematics by observing the process of making tofu. It turns out that the process of making tofu involves many mathematical concepts [22]. This is intended to connect math lessons to real-world situations, making math lessons more enjoyable and less boring.

This research provides novelty in the study of ethnomathematics by integrating local philosophical values into the practice of tofu making and incorporating them into mathematical learning concepts. Additionally, this research reveals the raw material ratio (1:3) in the tofu production process as a representation of the direct application of mathematical ratio and proportion concepts in local culture, which has not been widely explored in ethnomathematics studies of food in Southeast Aceh [23].

This approach enriches mathematics teaching methods through real and familiar cultural contexts for students, and demonstrates that learning mathematics doesn't have to be limited to the classroom and textbooks, but can be sourced from the social and economic activities of the local community. As for the advantages of this research, they include the strategic location as a research site and the distance from the researcher's residence being relatively short [24]. Then, the owners or tofu craftsmen who were the subjects of the research also warmly welcomed the researchers, making the observation, interview, and documentation process carried out by the researchers easy and comfortable.

The advantage of this research compared to relevant studies is that this research explains the step-by-step stages in the process of making tofu in more detail [25]. The results of this research can also be used as a learning material for mathematics in schools, as there are mathematical concepts within this tofu-making process.

4. CONCLUSION

The conclusion of this study indicates that the process of making tofu in Penampaan Village contains various mathematical concepts, such as arithmetic operations, geometry, volume, time comparison, and ratios. These concepts can be used as a relevant and engaging source of mathematical learning for students. This research fills a gap in the ethnomathematics literature by integrating local culture, namely tofu making, into mathematics instruction. In this way, students can understand mathematical concepts practically, connecting them to everyday life. This research suggests that schools adopt this approach, for example, by organizing visits to tofu factories, to make math learning more practical and engaging.

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