

How to make “Sumedang” tofu: An ethnomathematics context from West Java

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Abstract

Mathematics is one of the subjects that involves abstract concepts, which often poses difficulties for students in understanding the material. One solution to address these challenges is to connect mathematical concepts to students' everyday lives. Sumedang Tofu is a traditional food that is already familiar to students. The abstract mathematical concepts can be understood contextually through the production of Sumedang Tofu. This study aims to explore the mathematical concepts involved in the production of Sumedang Tofu that can be utilized in contextual learning. The research method employed is qualitative descriptive with an ethnographic approach. The research instruments consist of observation sheets, interview guidelines, and documentation sheets. Data collection techniques include direct observation at the Sumedang Tofu production site, interviews with Sumedang Tofu craftsmen, and photographs of the tools used in the production process. The collected data were analyzed using triangulation. The results indicate that in the production of Sumedang Tofu, there are concepts of flat shapes, such as squares and rectangles, as well as three-dimensional shapes, including cubes, rectangular prisms, and open-top cylinders. Additionally, concepts of division, proportionality, and congruence are also present. Sumedang Tofu can serve as a medium for contextual learning in teaching these mathematical concepts.

Keywords: ethnomathematics, contextual learning, mathematical concepts, Sumedang tofu, traditional food from West Java

Introduction

The ability to understand concepts is crucial for students in solving mathematical problems. However, the understanding and motivation of students towards mathematical concepts remain low (Putra, Setiawan, et al., 2018; Damayanti & Rufiana, 2021; Gusmira & Nasution, 2022).

Many students face difficulties in applying mathematical concepts in their daily lives, as their problem-solving skills are also inadequate (Putra, et al., 2018; Fauziah et al., 2022; Ramadhani et al., 2023).

The low ability of students to understand and solve problems is partly due to the delivery of abstract mathematical material that is not relevant to students' real-life experiences. Contextual learning connects mathematical concepts to students' everyday lives. The use of visual media in contextual learning can enhance students' understanding of mathematical concepts and increase their learning activities (Brinus et al., 2019; Mutia & Safrina, 2022; Nababan & Sipayung, 2023). Students' critical thinking skills also improve through the connection of mathematical concepts with their foundational knowledge in everyday life (Pandia & Sitepu, 2022; Rahmadani et al., 2023).

Mathematical concepts are also found in elements of culture, such as the concepts of addition, subtraction, multiplication, fractions, and profit and loss in the traditional Javanese game of Ganjilan (Astuti et al., 2023), Geometric concepts in the culture of ceramic pottery craftsmanship (Gunawan et al., 2024). Ethnomathematics emerges as an alternative that integrates mathematical material with culture. This approach not only makes learning more engaging but also helps students understand and apply mathematical concepts in a more relevant context. The integration of local culture in mathematics education can enhance students' motivation and understanding of the material being taught (Soebagyo et al., 2021; Bimantara, 2024)

Other local cultures that utilize mathematical concepts include the production of Sumedang Tofu, a traditional food from West Java. The tools used in the tofu-making process incorporate mathematical concepts, such as pots. Ethnomathematics research on Sumedang Tofu production has been conducted previously (Safitri & Siregar, 2023), the production of tofu in Sayurmatinggi Village (Febriyanti & Afri, 2023), the production of Kalisari Banyumas tofu (Kumala, 2022), and the production of Pekalongan tofu (Ilmiyah et al., 2022). Previous research (Irawati et al., 2023) also discusses the production of Sumedang Tofu and Bongsang. The research only focused on the concept of tofu resembling a cube. However, many other mathematical concepts can be explored in the production of Sumedang Tofu.

This research complements the mathematical concepts from each stage of Sumedang Tofu production that have not been addressed in previous studies. The novelty of this research lies in the integration of the stages of Sumedang Tofu production as a medium in contextual learning to teach mathematical concepts such as cylinders, rectangles, prisms, cubes, the concept of proportional comparison, and the concept of congruence. In addition to understanding concepts, students also become familiar with the process of making Sumedang Tofu as part of Indonesian culture. Students not only learn mathematics but also understand the importance of their culture in everyday life.

The purpose of this research is to explore the mathematical concepts present in the process of making Sumedang Tofu. Additionally, this study designs contextual learning to teach mathematical concepts through the production of Sumedang Tofu. Through this research, students can more easily understand mathematical concepts and become acquainted with one

of the cultural practices of traditional food production in West Java. This is important for creating a generation that is academically intelligent and has a strong love for their culture.

Methods

This study employed a qualitative approach aimed at obtaining in-depth and contextually rich information regarding the production processes of Sumedang Tofu. Data were gathered through systematic observation, semi-structured interviews, and comprehensive documentation. The use of qualitative data facilitated a detailed exploration and holistic description of the mathematical concepts embedded within the traditional tofu-making practices. An ethnographic research method was adopted to examine the cultural dimensions inherent in the Sumedang Tofu production process. This approach enabled the researchers to engage directly within the natural setting of the tofu craftsmen's environment, allowing for immersion and active participation to capture authentic cultural and mathematical practices. The procedural stages of the research are illustrated in [Figure 1](#).

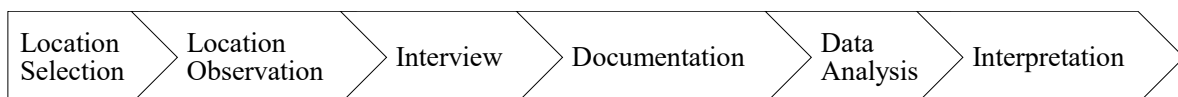


Figure 1. Stages of the Research Process

The study was conducted at the Jembar Manah Tofu Factory, located in the Samoja area, Pasanggrahan Baru, Sumedang Regency, West Java, Indonesia. This location was purposively selected based on its strong cultural relevance to the traditional Sumedang Tofu craftsmanship and its accessibility, which supported comprehensive data collection. Research instruments comprised interview protocols, structured observation checklists, and documentation templates. Data collection procedures included direct field observations of the tofu production process, interviews with experienced tofu artisans recognized for their expertise and cultural knowledge, and visual documentation of equipment, raw materials, production stages, and final products. These multiple data sources contributed to the triangulation of findings, ensuring the credibility and depth of the study.

The data collected through interviews, observations, and documentation were analyzed using a triangulation method to ensure validity and provide a comprehensive understanding of the mathematical concepts embedded in the Sumedang Tofu production process. Triangulation enabled the researchers to compare and corroborate information across multiple data sources, thereby strengthening the credibility and interpretative depth of the findings. The stages of data triangulation followed the framework proposed by Miles et al. (2014), as outlined in [Table 1](#).

Table 1. Stages Of Data Triangulation

Stages	Interview Sheets	Observation Sheets	Documentation Sheets
Data Collection	Eliciting explanations from craftsmen	Systematically recording the sequence of	Capturing visual documentation of tools,

Stages	Interview Sheets	Observation Sheets	Documentation Sheets
	regarding the processes and rationale behind tofu production.	production activities, tools, materials, and observable geometric patterns or regularities.	raw materials, production processes, and final tofu products.
Data Analysis	Transcribing interview recordings to extract meaning and explanations related to cultural and mathematical practices.	Identifying observable patterns, procedural logic, spatial configurations, and measurements emerging during the production process.	Analyzing visual content to extract contextual descriptions and infer mathematical ideas embedded in the artifacts.
Cross-Data Comparison	Comparing craftsmen's narratives with field observations and supporting visual evidence.	Cross-validating observational insights with interview transcriptions.	Using photographic documentation to confirm the consistency of observational and interview-based findings.
Interpretation and Synthesis	Interpreting the motivations and cultural rationale behind production practices and identifying the associated local knowledge systems.	Contextualizing observed practices within relevant mathematical frameworks.	Providing tangible and objective visual evidence to substantiate the triangulated findings.
Reporting Results	Incorporating direct quotations from craftsmen to present their perspectives authentically.	Including detailed observational accounts as empirical data.	Utilizing photographs to visually demonstrate the authenticity and validity of the results.

Instruments used during data collection included interview sheets, observation protocols, and documentation checklists. Each instrument was designed to identify and record mathematical aspects relevant to the tofu production process. The interview sheet was structured to extract contextual information about tofu production from experienced craftsmen, including the ingredients used and the procedural stages involved. A sample format is presented in [Table 2](#).

Table 2. Sample Items from the Interview Sheet

Questions	Answers
What ingredients are used to make tofu?	Information 1
What are the stages of tofu production?	Information 2
And others.	And so on.

The observation sheet focused on capturing specific production activities and linking them to relevant mathematical concepts. This facilitated the identification of embedded mathematical ideas within the tofu-making practices. An excerpt from the observation sheet is shown in [Table 3](#).

Table 3. Observation Sheet for Tofu Production Activities and Mathematical Concepts

Activities Observed	Involved Mathematical Concepts
Soaking the soybeans	Concept 1
Making tofu slurry	Concept 2
Straining the tofu slurry	Concept 3
Pressing the tofu	Concept 4
Molding the tofu	Concept 5
Frying the tofu	Concept 6

The documentation sheet included photographs taken at each critical stage of the tofu production process using a smartphone camera. These images served as visual evidence to support the observational and interview data. A sample layout is presented in [Table 4](#).

Table 4. Documentation sheet for tofu production

Description	Photographic Evidence
Tools for soaking soybeans	Image 1
Strainer for tofu slurry	Image 2
Tofu pressing tool	Image 3
Tofu molding tool	Image 4
Resulting tofu	Image 5

Through triangulated analysis of the interview transcripts, observational field notes, and photographic documentation, the study systematically identified the mathematical concepts embedded in the traditional tofu production practices. This approach provided a rigorous framework for interpreting the interplay between cultural practices and mathematical thinking in an ethnomathematical context.

Results and Discussion

This study investigates the mathematical concepts embedded within the traditional process of Sumedang Tofu production, with the aim of utilizing them as a contextual medium for mathematics learning. Data collection was conducted through semi-structured interviews with an expert Sumedang Tofu artisan, complemented by direct observation of the tofu production stages and documentation of the final products. The findings derived from the interview with the artisan are presented through an excerpt of the following transcribed conversation.

Researcher : What are the ingredients for making tofu?

Craftsman : The main ingredient is soybeans.

Researcher : What is the initial step in tofu production?

Craftsman : Soak the soybeans for about 3-5 hours, then wash the soybeans until clean. After that, grind the soybeans with water until they become a soybean slurry, then place it in a bucket to be boiled for 1 hour on a stove (the stove is cylindrical and open-topped).

Researcher : Why is it boiled after becoming a slurry and not while still whole?

Craftsman : To avoid the smell of raw soybeans.

Researcher : What is the next process?

Craftsman : Strain with a cloth (rectangular) to separate the soy milk from the pulp, then perform the coagulation.

Researcher : What is coagulation?

Craftsman : Coagulation is separating the tofu protein from the water (the coagulant water has a sour taste). The coagulant is added gradually because if too much is added, the tofu will become hard. The first step is to add 8 ladles and stir gently while observing the texture. Stir slowly in a vertical direction, then for the second coagulation, add 7 ladles and stir as in the first step until the tofu protein clumps together. It is very important to observe the changes in tofu texture to avoid adding too little or too much coagulant. Once the water is clear, it is separated, and the water is lifted and stored to become a new coagulant. The coagulant lasts a maximum of 5 days; if it exceeds 5 days, it will no longer taste sour and cannot coagulate the tofu protein.

Researcher : Next, what else is done?

Craftsman : Let it sit first until the tofu protein settles (separating the tofu protein from the coagulant). The tofu protein is placed in a mold, and then it is pressed to reduce the water content (while showing the tofu mold made of wood, measuring 54 cm long, 54 cm wide, and 8 cm high).

Researcher : After the tofu slurry is molded, what happens next?

Craftsman : The tofu is cut using a specially designed cutting tool, then soaked in saltwater for about 5 minutes and fried in hot oil.

Researcher : What is the size of the tofu after frying?

Craftsman : The size of the tofu is about 4 cm.

According to the interview data, the primary materials required for the production of Sumedang Tofu include soybeans, water, and salt. The production process follows a series of steps: soaking the soybeans, boiling them, coagulating the tofu, molding the tofu, soaking the tofu in a saltwater solution, and finally frying the tofu. Observational data and product documentation further reveal several mathematical concepts inherent to the production process, which can be utilized as a contextual framework for learning. These concepts are outlined as follow.

Concept of a Cylinder

During the soaking of the soybeans and the making of the tofu slurry, the craftsman uses a large pot that resembles an open-topped cylinder. The pot has a height of 75 cm and a diameter of 70 cm, as shown in Figure 2.



Figure 2. The soaking and tofu slurry-making tools are in the shape of a cylinder

Contextual learning can be designed by the teacher by explaining to students the elements of a cylinder using the pot used for soaking soybeans. The teacher displays an image of the pot and then presents the elements of the cylinder. The height of the pot is the height of the cylinder $t = 75$ cm. The diameter of the pot is the diameter of the cylinder $d = 70$ cm. The radius of the pot is the radius of the cylinder $r = \frac{1}{2} \times d = \frac{1}{2} \times 70 \text{ cm} = 35$ cm. The area of the base of the pot is the area of the base of the cylinder, which is the area of the circle $\pi r^2 = \frac{22}{7} \times (35 \text{ cm})^2 = 3850 \text{ cm}^2$. The lateral surface area of the pot is the lateral surface area of the cylinder $2\pi r t = 2 \times \frac{22}{7} \times 35 \text{ cm} \times 75 \text{ cm} = 16500 \text{ cm}^2$. The surface area of the pot with a lid is the surface area of the cylinder $2\pi r^2 + 2\pi r t = 2(3850) \text{ cm}^2 + 16500 \text{ cm}^2 = 24.200 \text{ cm}^2$. The volume of the pot is the volume of the cylinder $\pi r^2 t = 3850 \text{ cm}^2 \times 75 \text{ cm} = 288750 \text{ cm}^3$.

Concept of a Rectangle

During the making of the tofu slurry, filtering is done using a cloth that is in the shape of a rectangle with dimensions 180 cm $\times$ 170 cm, as shown in Figure 3.

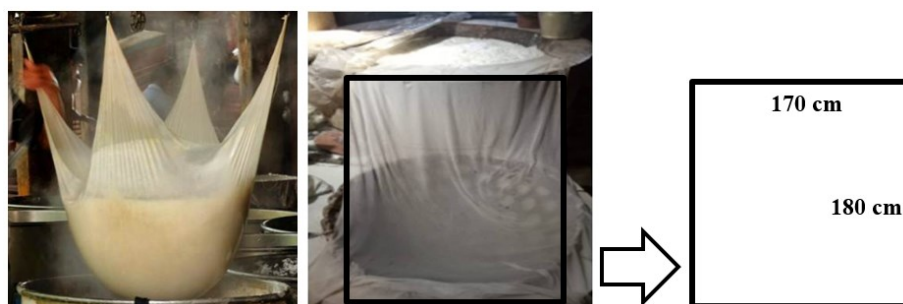


Figure 3. The tofu slurry filter cloth is in the shape of a rectangle

Contextual learning can be designed by the teacher using the tofu filter cloth to explain the elements of a rectangle. The longest side of the cloth is taken as the length of the rectangle, which is $p = 180$ cm. The shorter side of the cloth is taken as the width of the rectangle, which is $l = 170$ cm. The perimeter of the tofu filter cloth is the perimeter of the rectangle $K = p + p + l + l = p + p + l + l = 2p + 2l = 2(p + l) = 2(180 \text{ cm} + 170 \text{ cm}) = 2(350 \text{ cm}) = 700 \text{ cm}$. The area of the cloth is the area of the rectangle $L = p \times l = 180 \text{ cm} \times 170 \text{ cm} = 30600 \text{ cm}^2$.

Concept of Cuboid

The filtering process results in tofu protein and curds. The tofu protein is placed in a mold to be pressed to reduce its water content. The pressing tool and tofu mold are in the shape of a cuboid with dimensions $54 \text{ cm} \times 54 \text{ cm} \times 8 \text{ cm}$, as shown in Figure 4.



Figure 4. The pressing tool and tofu mold are in the shape of a cuboid

Contextual learning can be designed by the teacher by explaining the elements of a cuboid using the tofu mold. The length, width, and height of the tofu mold correspond to the length, width, and height of the cuboid. The dimensions of the tofu mold are length $p = 54$ cm, width $l = 54$ cm, and height $t = 8$ cm. The surface area of the tofu mold is calculated as $L = 2(p \times l) + 2(p \times t) + 2(l \times t) = 2(54 \text{ cm} \times 54 \text{ cm}) + 2(54 \text{ cm} \times 8 \text{ cm}) + 2(54 \text{ cm} \times 8 \text{ cm}) = 2(2916 \text{ cm}^2) + 2(432 \text{ cm}^2) + 2(432 \text{ cm}^2) = 5832 \text{ cm}^2 + 864 \text{ cm}^2 + 864 \text{ cm}^2 = 7560 \text{ cm}^2$.

Concept of Cube

The tofu in the mold is cut into cubes with each edge measuring 4 cm. Finally, the tofu is fried so it can be eaten directly and packaged. The appearance of the fried tofu is shown in Figure 5.

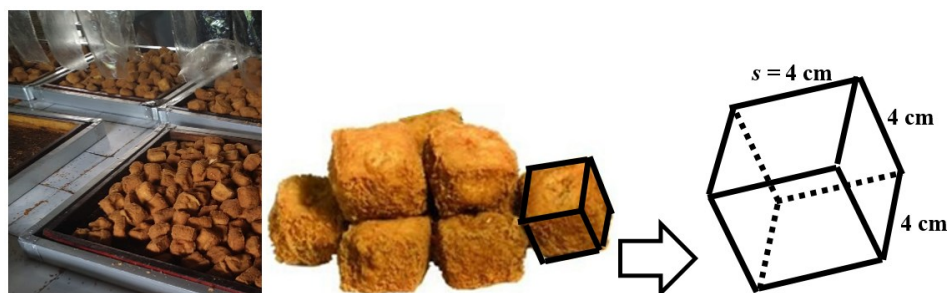


Figure 5. The fried tofu pieces are in the shape of a cube

Contextual learning can be designed by the teacher by explaining the elements of a cube using pieces of Sumedang Tofu. The tofu, which resembles a cube, has equal edge lengths (s) of 4 cm each. The surface area of the tofu is the surface area of the cube $L = 6 \times s \times s = 6 \times 4\text{cm} \times 4\text{cm} = 96\text{cm}^2$. The volume of the tofu is the volume of the cube, which is $V = s \times s \times s = 4\text{cm} \times 4\text{cm} \times 4\text{cm} = 64\text{cm}^3$.

Concept of Division

The size of the tofu in the mold is $54\text{ cm} \times 54\text{ cm} \times 8\text{ cm}$. After being pressed, the size of the tofu in the mold shrinks to $48\text{ cm} \times 48\text{ cm} \times 4\text{ cm}$. To straighten the cut tofu pieces, a tool made of wood is used. Each cut piece of tofu will be in the shape of a cube with dimensions $4\text{ cm} \times 4\text{ cm} \times 4\text{ cm}$. Contextual learning can be designed by the teacher by teaching the concept of division through the number of tofu pieces produced in the mold. The number of tofu pieces is the volume of the tofu in the mold divided by the volume of each cut tofu piece, which equals

$$\frac{48\text{ cm} \times 48\text{ cm} \times 4\text{ cm}}{4\text{ cm} \times 4\text{ cm} \times 4\text{ cm}} = \frac{9216\text{ cm}^3}{64\text{ cm}^3} = 144\text{ pieces of tofu.}$$

Concept of Proportional Comparison

Each mold produces 144 pieces of tofu. In one day, the craftsman can make tofu pieces from 50 molds. Contextual learning about the concept of proportional comparison can be designed by the teacher through the number of tofu pieces produced by the craftsman in a day. If 1 mold produces 144 pieces of tofu, then in one day, using 50 molds, the number of tofu pieces x can be calculated as follows $\frac{1}{144} = \frac{50}{x} \Leftrightarrow 1x = 50 \times 144 \Leftrightarrow x = 7200$ pieces of tofu. The more tofu the craftsman molds, the more pieces of tofu are produced.

Concept of Congruence

The pieces of tofu are in the same shape and size, which is a cube with each edge measuring 4 cm. Contextual learning can be designed by the teacher by demonstrating congruent three-dimensional shapes using 2 pieces of tofu, as shown in Figure 6.

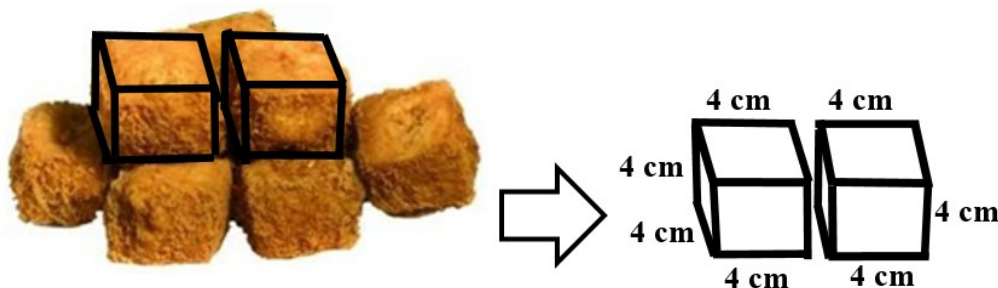


Figure 6. The concept of congruence in cubical tofu pieces

In Figure 5, there are two pieces of tofu in the shape of cubes with the same dimensions of $4\text{ cm} \times 4\text{ cm} \times 4\text{ cm}$. The teacher can explain to the students that these two pieces of tofu are congruent cubes. Both cubes have the same edge length (s) of 4 cm. The surface area of

the two cubes is the same because they have the same s value, calculated as $L = 6s^2 = 6(4 \text{ cm})^2 = 6(16 \text{ cm}^2) = 96 \text{ cm}^2$. Similarly, the volume of the two cubes is also the same, calculated as $V = s^3 = (4 \text{ cm})^3 = 64 \text{ cm}^3$.

Contextual Learning

Contextual learning emphasizes the significance of linking instructional content to real-world contexts relevant to students. The primary objective of contextual learning is to enhance students' understanding and application of acquired knowledge in practical, everyday situations. By engaging in contextual learning, students actively participate in the learning process (Pehe, 2021; Wuryani, 2022; Wirati, 2023), which facilitates the development of critical thinking and problem-solving skills (Masrura et al., 2022; Sa'diah & Nahdi, 2023). The core elements of contextual learning include real-life experiences, collaboration, reflection, and relevance. In this approach, students gain insights through direct experiences, such as grasping mathematical concepts within the context of Sumedang Tofu production. The learning environment fosters collaboration, where students work in groups to engage in knowledge-sharing and deepen their understanding. Additionally, students reflect on the mathematical concepts they have encountered and apply them to their everyday lives.

Mathematical concepts, including the properties of cylinders, rectangular prisms, cubes, rectangles, division, proportional reasoning, and similarity, hold significant relevance and utility in students' lives, serving as motivating factors for further exploration. Within the context of Sumedang Tofu production, various tools and products can function as effective media for contextual learning. Through the study of Sumedang Tofu a traditional food from West Java students not only gain insight into the production process but also learn the underlying mathematical principles involved. This research extends prior studies that have primarily focused on explaining two-dimensional and three-dimensional shapes within tofu production across different regions. However, it identifies additional mathematical concepts that can be contextualized through the process of tofu production. This study delves into a broader range of mathematical concepts present in Sumedang Tofu production, such as two-dimensional shapes (e.g., squares and rectangles) and three-dimensional shapes (e.g., cubes, rectangular prisms, and open-top cylinders), as well as concepts of division, proportionality, and congruence.

Conclusion

The integration of ethnomathematics with cultural identity provides a rich and meaningful context for teaching mathematical concepts, as demonstrated through the example of Sumedang Tofu production from West Java. This study explores how everyday practices, such as tofu production, can be utilized to introduce fundamental mathematical concepts to students. The various stages of tofu production, from soaking soybeans to frying the tofu, offer opportunities to relate geometric shapes and mathematical principles to real-world objects. For example, the cylindrical shape of the soaking pot introduces the concept of volume, while the rectangular cloth used for straining can be used to explain surface area. The rectangular prism-shaped

pressing and molding tools, along with the cubical fried tofu, provide concrete representations of geometric figures and their properties. Furthermore, the production process naturally incorporates concepts such as division, proportional comparison, and congruence, thereby fostering an understanding of these concepts in a tangible and culturally relevant context. This approach enhances students' comprehension of mathematics by grounding it in their daily experiences and cultural heritage.

However, several limitations should be acknowledged in this study. The research was conducted with a specific focus on the Sumedang Tofu production process, which may not be universally applicable to all cultural contexts or mathematical topics. Additionally, the study was limited to a specific geographical region, which may affect the generalizability of the findings to other regions or cultural contexts. The study also relied on a limited sample of students, which may not fully represent the diversity of learners in different educational settings. Future research in this area should expand the scope to include a broader range of cultural practices and mathematical concepts, thereby providing a more comprehensive understanding of the potential of ethnomathematics in diverse educational contexts. Furthermore, studies could investigate the long-term impact of contextual learning on students' mathematical achievement and their ability to apply mathematical concepts in real-life situations.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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