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Ethnomathematics in Traditional Culinary Practice: Mathematical Concepts in the Preparation and Sale of Nasi Pecel Tumpang in Kediri, Indonesia

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Abstract
This study explores the presence of mathematical concepts embedded within the traditional culinary process of Nasi Pecel Tumpang, a renowned dish from Kediri, Indonesia. Utilizing an autoethnographic approach combined with semi-structured interviews, the researcher investigates personal childhood experiences and supports them with interviews conducted with local food vendors to uncover mathematical practices inherent in the preparation, processing, and sale of this cultural delicacy. The study involved five traditional food vendors selected through purposive sampling. The findings reveal that daily culinary activities — often seen as routine or informal — contain rich mathematical values, including counting, measurement, comparison, fractions, ratios, sequencing, geometry, and data representation. During the preparation stage, vendors engage in mathematical thinking through the use of standard units (grams, liters), whole number operations (addition, subtraction), and estimation (e.g., handfuls, pinches). The cooking process involves the use of ordinal numbers to sequence tasks, time measurement for boiling or frying ingredients, and length measurement when cutting vegetables. Moreover, elements of geometry are evident in the shapes of utensils and food arrangement, while proportional reasoning is applied in the formulation of spice blends. In the post-production stage, mathematical applications expand to pricing strategies, revenue calculation, and data tabulation using basic statistical tools such as means, frequency tables, and pictograms. The study underscores the value of integrating local cultural practices into mathematics education, offering a contextualized learning experience that is both meaningful and culturally relevant to students. Specific research questions guided the inquiry, focusing on how traditional culinary activities reflect mathematical thinking and how these insights can inform classroom practices. By leveraging familiar cultural artifacts like traditional foods, educators can foster greater student engagement, reduce math anxiety, and build stronger connections between academic content and everyday life. This research contributes to the broader field of ethnomathematics and highlights the importance of culturally responsive pedagogy in elementary education, particularly in areas rich with cultural heritage.

INTRODUCTION

Mathematics as a discipline has an important role in shaping the logical and systematic mindset of students from the elementary education level. However, the mathematics learning process in elementary schools in Indonesia is still dominated by conventional approaches that emphasize memorizing formulas and practicing questions without providing real context in daily life (Mardhotillah & Yazidah, 2023). As a result, mathematics is often perceived as an abstract and difficult subject by students (Wiryanto & Jannah, 2022). In practice, learning that lacks context actually hinders deep conceptual understanding and weakens students' critical thinking skills (Solihin & Rahmawati, 2024). In fact, in the framework of meaningful learning, the integration of the context of daily life is very important to build a relationship between the knowledge taught and the students' experience. This

requires innovation in mathematics learning that is able to connect the material with the local context. One approach that offers a solution to this problem is ethnomathematics. Ethnomathematics allows for the integration of mathematical concepts and local culture as part of contextual learning strategies.

Ethnomathematics is a pedagogical approach that studies how mathematical concepts emerge and develop in various cultural practices around the world (Putra & Prasetyo, 2022). This approach deconstructs the assumption that mathematics is universal and culturally neutral, and encourages the understanding that mathematics grows out of the practical and social needs of a society. In the context of primary education, ethnomathematics is able to provide a more authentic learning experience because students can see the connection between their culture and the math material (Damayanti & Mariana, 2023). A number of previous studies have identified the potential of local cultures such as traditional houses, traditional games, and traditional clothing as sources of mathematics learning (Ramadhani et al., 2024). However, the exploration of mathematical values in culinary traditions is still very limited. In fact, culinary is an important part of a culture that has structures and procedures that are loaded with mathematical concepts such as measurement, proportion, and number operations. Culinary traditions also have an emotional closeness and hands-on experience with students, so there is potential for integration in math learning. Therefore, it is necessary to further study how local culinary traditions can be a source of contextual and meaningful learning.

Kediri Regency is one of the regions in Indonesia that has a diverse local cultural richness, one of which is in the form of traditional culinary. One of the typical foods that is closely associated with the identity of the people of Kediri is Sega Pecel Tumpang, which is a dish based on rice, chili sauce, and tumpang (fermented tempeh) which has been passed down from generation to generation. The process of making and serving Sega Pecel Tumpang involves various mathematical activities, both explicitly and implicitly, such as measuring the weight of ingredients, portion division, and calculating the selling price (Susanti et al., 2025). However, there has been no systematic effort to make this culinary process a source of mathematics learning in elementary schools. In fact, the potential mathematical values contained in it are very relevant to the learning outcomes targeted in the basic education curriculum. By elevating local cuisine as a learning context, students can gain a more applicable mathematical understanding and in accordance with their reality. This approach also supports the preservation of local culture through integration in the formal education system. Therefore, it is important to explore in depth the ethnomathematical values contained in this typical culinary tradition of Kediri.

The researcher's personal experience as a native of Kediri who has never experienced mathematics learning based on local culture is also a reflective foundation in this study. During primary to secondary education, the mathematics learning received focuses more on mechanistic exercises without associating them with daily life. Number material is taught in the form of symbols and procedures that are detached from practical meaning in students' lives, such as the use of fractions in cooking or discounting prices in the market (Wiryanto & Saputra, 2023). This shows that there is a distance between the academic world and the reality of local culture which is actually rich in learning potential. The existence of ethnomathematics can bridge this gap through learning strategies that explore and utilize mathematical values in everyday cultural activities. Thus, students not only learn mathematics as a collection of formulas, but also as part of their social and cultural life (Susiliastini & Sujana, 2022). This critical reflection is the main driver to make local experiences and cultures a starting point for more contextual and meaningful mathematics learning. This research is present as an effort to revive meaning in mathematics learning through authentic cultural experiences.

The transformation of mathematics education through the integration of local cultural contexts is in line with the transformative educational paradigm. Transformative education encourages learners to reflect on their experiences, critique existing knowledge systems, and develop new, more

meaningful understandings (Tugiman et al., 2023). In this context, autoethnography as a research method offers a space for researchers to explore the relationship between personal experience and cultural dynamics in the mathematics learning process (Solihin & Habibie, 2024). Using this approach, researchers can reconstruct past experiences as well as relate them to broader social and cultural realities. The transformative approach also allows for collaboration with local stakeholders, such as traditional food vendors and teachers, to reconstruct a more inclusive learning context. Therefore, the exploration of mathematical values in the culinary tradition of Sega Pecel Tumpang not only contributes to learning innovation, but also strengthens local cultural identity through education. This is in line with the direction of 21st century education that emphasizes cross-disciplinary learning and socio-cultural relevance. In this regard, ethnomathematics-based mathematics education has a strategic position in shaping a generation that is critical, reflective, and rooted in local values.

Based on this description, this study aims to explore ethnomathematical values in the culinary tradition of Sega Pecel Tumpang and reconstruct its potential as a source of mathematics learning in elementary schools. This exploration will not only uncover the various mathematical concepts involved in the production and distribution process of such traditional foods, but also provide a pedagogical framework for integrating them in learning. With this approach, mathematics learning becomes more contextual, engaging, and meaningful for students. In addition, this research is expected to encourage teachers to be more creative and reflective in designing learning based on local potential. This research also contributes to the development of ethnomathematical studies in Indonesia which are still limited to certain cultural aspects. Through a transformative approach and autoethnography, this research presents a narrative that combines personal reflections, cultural practices, and relevant conceptual frameworks. Thus, the results of this study not only enrich the ethnomathematical literature, but also become a reference in the development of mathematics learning curriculum and strategies in elementary schools.

METHODS

This research uses a qualitative approach with a transformative type. This approach was chosen to encourage a paradigm shift in education through the integration of local culture into learning, especially in the context of the Sega Pecel Tumpang Kediri tradition. In a transformative approach, researchers engage actively and reflectively, using personal experiences as a source of data to build new meaning in the learning process. This research also combines three paradigms—interpretive, critical, and postmodern—that complement each other in understanding meaning, building critical awareness, and presenting data creatively and communicatively. The main method used in this study is autoethnography, which is a combination of self-reflection (autoethnography) and direct cultural studies (ethnography). The symbol "|" signifies the simultaneous integration of the two approaches. The researcher reflects on his personal experience while participating in mathematics learning in elementary schools that have not yet associated local culture, as well as conducting observations and interviews with cultural actors of Sega Pecel Tumpang Kediri. This research emphasizes the five dimensions of transformative knowledge developed by Taylor, namely *Cultural Self Knowing*, *Relational Knowing*, *Critical Knowing*, *Visionary and Ethical Knowing*, and *Knowing in Action* to form new awareness and vision in education.

Data collection was carried out through three main methods, namely reflective autoethnography, literature study, and in-depth interviews. Personal reflection is done as a starting point to trace cultural absences in mathematics learning. Literature studies are used to explore ethnomathematical theories and mathematical concepts relevant to the elementary school curriculum. Interviews were conducted with two groups of informants: (1) five Sega Pecel Tumpang vendors (3 women and 2 men, aged 35–60) selected purposively based on experience (minimum 10 years in the culinary business), and (2) three elementary school teachers (2 females, 1 male) familiar with local-based curriculum approaches. These interviews aimed to explore the mathematical elements in the production and presentation process, and to obtain pedagogical perspectives on integrating local

culture into learning. Each interview lasted approximately 45–60 minutes and was conducted in the vendors' homes or stalls, while teacher interviews were held in school offices. All interviews were audio-recorded with participant consent and transcribed verbatim.

The data was analyzed using the Miles and Huberman model which included three stages: data reduction, data presentation, and conclusion drawing. Reduction is carried out by sorting out relevant data from the results of reflections, interviews, and literature studies. The presentation of data is designed in narrative, illustrative, and visual forms, in the spirit of postmodernism. Conclusions are drawn through a process of interpretation and member checking to ensure the accuracy of meaning. To ensure credibility, this study applied triangulation of data sources (autoethnography, interviews, literature), prolonged engagement in the field, and reflexivity through journaling. The results of the research are expected to provide a concrete picture of how local culture can be used as a contextual and meaningful source of mathematics learning.

RESULTS AND DISCUSSION

Research Findings: Mathematical Concepts in the Cultural Practice of Serving Nasi Pecel Tumpang

Historical Background of Nasi Pecel Tumpang from Kediri

Nasi Pecel Tumpang is a traditional dish from Kediri, East Java, known for its harmonious blend of steamed rice, boiled vegetables, spicy peanut sauce (pecel), and a unique fermented tempeh sauce called sambal tumpang. The term "tumpang" refers to the way the sambal is poured over the vegetables and rice, symbolizing abundance and unity. Historically, the origins of pecel as a culinary practice in Kediri date back to the 9th century. This is evidenced by the Siman Inscription dated 865 Saka or 943 CE, which mentions dishes made from boiled leafy greens seasoned with native herbs and spices. The rich taste of Nasi Pecel Tumpang is attributed to its complex layers of spices, fermentation techniques, and traditional cooking methods that represent the cultural identity of the Javanese people. Nusantara cuisine is deeply characterized by the use of local herbs, intricate preparation techniques, and traditional accompaniments such as crackers or rempeyek, which are also found in this dish. The primary ingredients of sambal tumpang include fermented tempeh (tempe bosok), fresh tempeh, shallots, garlic, bird's eye chilies, red chilies, galangal, kencur, kaffir lime leaves, bay leaves, small dried shrimp (udang dawu), coconut milk, palm sugar, and salt. These are complemented with boiled vegetables such as water spinach, long beans, papaya shoots, kenikir leaves, mung bean sprouts, cucumber slices, and basil leaves. The dish is commonly served with fried tempeh or tofu, rempeyek, and krupuk puli.

Ingredients and Their Symbolic Meaning

Beyond their culinary roles, the ingredients of Nasi Pecel Tumpang carry profound symbolic meaning that reflects the agricultural abundance and cultural values of Kediri. Rice, as the staple grain, represents prosperity and sustenance—the foundation of life and community welfare. The assortment of green vegetables, ranging from water spinach to papaya shoots, symbolizes health, vitality, and the freshness of nature. Tempeh and tofu, products of soybean fermentation, stand as emblems of resilience, adaptability, and sustainable agricultural practices. The spices and herbs—including chilies, garlic, shallots, kencur, galangal, and kaffir lime leaves—not only enrich the flavor but also embody traditional medicinal knowledge, illustrating the intertwining of food and health in Javanese culture. Each element of this dish can be viewed as a cultural text, narrating a story of harmony between humans and their environment, and preserving ancestral wisdom through culinary practice.

Mathematical Concepts Embedded in the Cultural Practice

The preparation and sale of Nasi Pecel Tumpang offer rich opportunities for informal mathematical thinking and reasoning. The research applied an autoethnographic lens, weaving together the researcher's personal experiences learning to prepare pecel alongside their grandmother

with observations and interviews of local vendors. These lived experiences unveil a vibrant array of mathematical concepts naturally integrated into everyday activities. For example, measuring ingredients involves not only basic counting but also estimation and comparison, while adjusting recipes necessitates proportional reasoning and fraction calculations. Planning the quantity of food prepared daily requires strategic use of arithmetic to avoid waste and ensure sufficient supply for customers.

Local vendors such as Mrs. Istiana, Mrs. Mariah, and Mrs. Sri corroborated these findings, describing their own habitual use of numbers in routine tasks. They calculate how many bundles of vegetables are needed, weigh tempeh and spices precisely, and adjust the quantity of sambal to maintain consistency in taste. These numerical skills extend into their sales practices, where pricing strategies rely on arithmetic to balance profit margins and customer affordability, and daily earnings are recorded and analyzed to monitor business performance. This symbiosis of cultural tradition and mathematics illustrates how informal learning environments foster practical numeracy skills embedded in cultural practices.

Table 1. Mathematical Concepts in the Production of Nasi Pecel Tumpang

Stage	Mathematical Concepts	Example Activities
Preparation	- Whole numbers - Basic operations - Standard measurement units - Data recording	Counting utensils and ingredients, e.g., 20 chilies minus 15 used = 5 remaining; weighing 200g of tempeh
Cooking Process	- Ordinal numbers - Time measurement - Length measurement - Geometry - Fractions - Proportions	Steps of cooking: first boil rice, second prepare vegetables, etc.; slicing tempeh into 3 cm pieces; measuring ¾ ladle of sambal
Post-production	- Currency - Arithmetic operations - Data representation - Statistical averages	Pricing strategies (Rp 6,000 to Rp 9,000); calculating total earnings; presenting sales data in tables or graphs

The mathematical concepts embedded in the production of Nasi Pecel Tumpang can be organized into three broad stages: preparation, cooking, and post-production.

- Preparation Stage: This initial phase involves counting whole numbers, such as the number of chilies, shallots, or tempeh pieces, and performing simple operations like subtraction to track ingredient usage. Standard units of measurement—grams, liters, and pieces—are applied to ensure correct proportions. Data recording takes place through informal note-keeping or mental calculation, which helps maintain inventory and manage resources effectively.
- Cooking Process: During cooking, ordinal numbers are employed to sequence the steps accurately, such as first boiling rice, then preparing vegetables, and finally mixing sambal. Time measurement plays a crucial role in determining cooking durations, affecting taste and texture. Length measurement occurs when cutting tempeh or vegetables into uniform sizes. Geometric shapes are visible in the arrangement of food on the plate or in the shapes of utensils used. Fractions and proportions guide the balance of ingredients in sauces, essential for consistency in flavor.
- Post-Production: After preparation and cooking, mathematical concepts shift towards economic transactions. Vendors set prices within a certain range, applying arithmetic operations to

calculate total sales and change. Data representation techniques such as tabulating daily sales, calculating averages, and visualizing trends through simple graphs or pictograms support business decisions. These practices enhance the vendor's ability to evaluate performance and plan for future sales.

The findings highlight the potential of culturally rooted practices as meaningful contexts for teaching and learning mathematics. Incorporating familiar cultural elements like Nasi Pecel Tumpang into educational settings can make abstract mathematical concepts tangible and relevant. This approach may help reduce math anxiety and promote engagement by linking mathematical ideas with students' lived experiences and cultural backgrounds. Furthermore, recognizing and valuing indigenous knowledge systems through ethnomathematics reinforces cultural identity and empowers communities to appreciate their heritage as a source of academic and practical knowledge.

In sum, the cultural practice of preparing and selling Nasi Pecel Tumpang serves not only as a culinary tradition but also as a living classroom for mathematical concepts. This intersection between culture and mathematics exemplifies how everyday activities are rich sites for informal learning, demonstrating the seamless integration of academic knowledge in daily life. The study advocates for greater incorporation of local wisdom into formal education to foster holistic and culturally responsive pedagogies.

Discussion

This research aims to identify mathematical concepts contained in the cultural practices of the Kediri people through the traditional food of Nasi Pecel Tumpang. The results of the study show that in each stage of food production—from preparation, processing, to post-production—there are activities that contain mathematical content. These activities include basic calculation operations, time and length measurement, to simple data processing. This is in line with the view that mathematics is not just an abstract science, but also part of daily life practices (Pramudya & Sari, 2022). In other words, local culture can be a rich contextual resource in math learning. This research also shows that the integration of local culture in learning can increase the relevance of the material to students' lives. Therefore, the use of cultural contexts such as Nasi Pecel Tumpang has great potential in strengthening the understanding of mathematical concepts. In this context, culture becomes an authentic and meaningful learning medium (Muzakkir, 2021).

In the preparation stage, the mathematical concepts identified include integers, addition and subtraction operations, and standard units of weight. Sellers use this skill when counting the number of chili peppers, weighing tempeh, or keeping track of the number of rice packets prepared. For example, one of the informants mentioned that he used a digital scale to measure 200 grams of rotten tempeh that would be used in sambal tumpang. This activity indicates the use of the concept of standard units in measurement. These activities reflect contextual and real-experience mathematics learning. This is in line with constructivist learning theory which emphasizes the importance of concrete experiences in building student understanding (Abdiyah, 2021). Therefore, this stage can be used as a real example of the application of mathematics in daily life. Thus, traditional food preparation is a vehicle for strengthening numeracy competence.

The food processing stage shows the application of the concept of sequence (ordinal numbers), measurement of time and length, geometry, and fractions and proportions (Andriliani et al., 2022). For example, cooking activities are carried out in a certain order: first boiling vegetables, then frying tempeh, and finally mixing chili sauce. This sequence involves understanding the sequence number and grouping of work steps. In addition, in cutting materials such as tempeh, a length measure such as "three centimeters" is used. The use of fractions was also found, for example when the seller spooned three quarters (3/4) of a vegetable spoon into each portion of rice. These activities are concrete forms of basic mathematical concepts that are often considered abstract by students. This cultural context allows students to see the real usefulness of learning mathematics. Thus, the cooking stage becomes a holistic and relevant learning medium (Faqih et al., 2021).

The post-production stage also shows the application of mathematical concepts, especially in the financial and data processing aspects. Sellers use numeracy skills to determine competitive selling prices and calculate total daily revenue. One of the informants mentioned that he sells Nasi Pecel Tumpang at a price between Rp6,000 to Rp9,000 depending on the side dishes added. This pricing reflects skills in the concept of numbers and counting operations. In addition, the seller also records the number of portions sold each day, then makes a weekly or monthly recapitulation. This activity demonstrates the ability to represent data and use averages to see sales trends. Thus, the seller becomes not only a cultural actor, but also a practitioner of mathematics in a real context. This phenomenon supports the importance of numeracy literacy in people's lives (Husna et al., 2024).

The results of this study also show that traditional foods such as Nasi Pecel Tumpang have great potential as a contextual medium in mathematics learning. The use of local contexts in mathematics learning is believed to increase student engagement and understanding. This is in line with the opinion of Kyttälä & Björn (2022) who stated that materials based on local culture can reduce students' anxiety about mathematics. This anxiety is often caused by material that feels abstract and irrelevant to students' daily lives. Therefore, a contextual approach based on local culture is an effective and inclusive learning strategy. In this sense, culture is not only an object of anthropological study, but also a rich pedagogical source (Solihin et al., 2025). Culture-based math learning strengthens the relationship between local values and academic competence. Thus, mathematics can be understood not only as a science, but also as a social practice.

The involvement of researchers in this cultural practice through an autoethnographic approach provides added value in exploring the meaning of mathematics in daily life. The researcher's childhood experience with his grandmother (Simbah) in cooking pecel became the starting point for the exploration of existing mathematical concepts unconsciously. Through critical reflection and triangulation of data from interviews with three sellers, researchers were able to reconstruct these cultural activities in a mathematical perspective. This approach is in line with the principle that meaningful learning is built from critically reflected personal experiences (Astriandini et al., 2021). Thus, autoethnography becomes an effective method in uncovering the hidden dimensions of cultural practices. In addition, this approach helps connect personal experiences with a broader theoretical framework (Rahayu et al., 2025). In the context of education, this can encourage students to reflect on daily practice as a source of learning. Therefore, autoethnography is also relevant to be used in teacher education and curriculum development.

The implications of this research are not only limited to the development of teaching materials, but also to the paradigm change of mathematics education. So far, learning mathematics is often detached from the local cultural context, so it feels distant and meaningless for students. Through an ethnomathematical approach, educators can integrate cultural values in the teaching and learning process. (Mailani et al., 2024) states that ethnomathematics is a humanistic approach that respects diverse ways of thinking and solving mathematical problems in various cultures. Therefore, the introduction of mathematics through culture such as Nasi Pecel Tumpang allows students to understand that mathematics is part of the life of their people. This approach is also in line with the Merdeka Learning policy which emphasizes contextual learning and is based on local wisdom. Thus, ethnomathematics can be a bridge between science and cultural identity. This is important to build an inclusive, relevant, and meaningful education.

Based on these findings, it is recommended that primary school teachers start exploring the potential of local culture as a source of mathematics learning. Activities such as cooking, farming, trading, or other traditional activities store various mathematical activities that can be used as a learning context. Teachers can design culturally-based learning projects that allow students to learn while digging into local heritage. In addition, the involvement of parents and the community can also strengthen the meaning of learning. By making culture part of the curriculum, education becomes more integrated with the real lives of students. This effort also supports cultural preservation as well as improving numeracy literacy. In the long run, this strategy can improve the quality of education

and strengthen students' cultural identity. Therefore, culture-based mathematics education needs to be a priority in the development of future curriculum.

CONCLUSION

This study shows that local cultural practices in making Nasi Pecel Tumpang in the Kediri community contain a variety of mathematical concepts that can be used as a source of contextual learning. These concepts include basic calculation operations, unit measurement, geometry, fractions, proportions, and simple data processing found in the food preparation, processing, and post-production stages. The ethnomathematical approach used reveals that people's daily activities turn out to store mathematical knowledge that is authentic and relevant to students' lives. Through autoethnography methods, critical reflection on personal experience and participatory observation enrich the understanding of the importance of cultural context in mathematics education. These results confirm that mathematics learning will become more meaningful when it is associated with the real life and cultural identity of students. Thus, the integration of local cultures such as traditional foods not only preserves cultural heritage, but also strengthens numeracy literacy at the elementary level. The implications of this study provide direction for teachers to design learning that is based on contextual experiences and local values. Therefore, mathematics education should not be separated from the socio-cultural reality of students, but rather used as a bridge between knowledge, skills, and culture. Future research may explore the development of learning modules or teaching materials based on various local traditions in other regions of Indonesia, as well as examine the impact of such culturally contextualized mathematics instruction on students' attitudes, performance, and identity formation.

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