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Mathematics in the *Nyadran* Tradition and How Students Solve Permutation Problems Based on It

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ABSTRACT

This qualitative research aims to reveal the relationship between local culture and the concept of cyclic permutation through an ethnomathematical approach to food arrangement in the *Nyadran* tradition in Banyon Village, Klaten, Central Java, Indonesia. The *Nyadran* tradition in Banyon is an activity of paying respect to ancestors, and the important thing is the arrangement of food in *Tenong*, which is done alternately every year. Data were collected through tests, documentation, observations, in-depth interviews, and literature reviews, and analyzed using the stages of data reduction, data presentation, and conclusion. Interviews were conducted with several traditional authorities and citizens who participated in the *Nyadran* tradition in Banyon. The test subject was one of the students who participated in the *Nyadran* tradition in Banyon. The results of the study show that the arrangement of food in *Tenong* follows an annual rotation pattern that reflects cyclical permutations. This finding proves that the concept of cyclic permutation has been implicitly applied in people's lives through the *Nyadran* tradition. Test results indicate that students can solve cyclic permutation problems in the context of the *Nyadran* tradition. This research is expected to be a reference in developing culturally relevant mathematics learning for students.

Keyword : Ethnomathematics, Cyclic Permutations, *Nyadran* Tradition, *Tenong*.

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1. INTRODUCTION

Indonesia is known as a country rich in diverse cultures and local traditions. Each region possesses its own local wisdom that has been passed down through generations and is continuously preserved by the local community (Brondízio et al., 2021). These traditions not only carry spiritual and social values but also contain patterns of thought that reflect certain order and systematization (Muliadi, 2019; Yanich et al., 2019). One way to understand the relationship between cultural patterns and scientific knowledge is through the ethnomathematical approach (Rodríguez-Nieto et al., 2023), which explores how mathematical concepts naturally emerge within the cultural practices of a society (Prahmana & D'Ambrosio, 2020; Yogasmara Binsar Putra Wimansyah et al., 2025). Through ethnomathematics, mathematics is not merely seen as a collection of formulas and numbers (Abasi, 2025), but as an integral part of real life, embedded in traditions, symbols, and everyday activities.

One example of the application of ethnomathematical concepts in community life can be found in Banyon Village, Klaten Regency, Central Java, Indonesia. The people in this village continue to preserve the *Nyadran* tradition, a communal prayer ritual and feast held as a form of respect for their ancestors (Annisa Ul Aliyah, 2022; Arumugam, 2022). In its practice, they use *Tenong,* a traditional round container made from woven bamboo, to carry and arrange food (Chen et al., 2023; Dzarna et al., 2022). Interestingly, the arrangement of food within the *Tenong*, as well as the circular seating formation of the participants around it, reveals a regular pattern that can be examined from a mathematical perspective, specifically through the concept of cyclic permutations (Borga, 2021; Mauleto, 2025). This pattern is not merely a hereditary custom but reflects an arrangement that carries cultural significance while also embodying

fundamental mathematical principles naturally embedded in community practices.

The *Tenong* used in the *Nyadran* tradition is not merely a practical container for carrying food, but also holds rich symbolism and geometric structure embedded with cultural and mathematical values. Made from lightweight yet sturdy woven bamboo, its round shape reflects equality and togetherness (Handoko, 2019). In real-life practice, community members sit in a circle regardless of social status, forming a symmetrical pattern that not only symbolizes social harmony but can also be analyzed as a representation of a circle in geometry (Gropp et al., 2020; Mubarok, 2024). This circular formation creates a space for equal social interaction and strengthens bonds among community members (Sunarno & Rahmawati Zakiyah, 2024). Philosophically, the shape of the *Tenong* symbolizes the continuity of life, intergenerational connections, and the life cycle values aligned with the spirit of honoring ancestors within the *Nyadran* tradition (S. D. Putri et al., 2025). Thus, this cultural practice embodies not only social and spiritual meaning but also a tangible manifestation of how mathematical principles and cultural values are interwoven in community life.

In addition, from a functional perspective, the circular shape of the *Tenong* facilitates arrangement in open spaces, allowing it to be accessed from all sides and creating a neat and orderly layout. This circular arrangement reflects the concept of circular patterns in mathematics learning, specifically the regular positioning and grouping of objects around a central point (Jainuri et al., 2025; Payadnya et al., 2023). This concept can be taught to students through simple activities such as arranging objects in a circle, determining adjacent or opposite positions, and recognizing the regularity of repeating arrangements (Triyono et al., 2025). These activities can strengthen students' understanding of order, spatial relationships, and the connection between shape and arrangement (Muhammad Yusuf et al., 2023). Although the community does not explicitly refer to these arrangements as mathematical concepts, their practice demonstrates a contextual and natural application of mathematical ideas (Meliasari & Wardana, 2023). This makes the *Tenong* a concrete example of ethnomathematics, a fusion of local culture and mathematical concepts that can be effectively utilized in more meaningful learning experiences.

Interestingly, the arrangement of food in this tradition is not done randomly. Community members arrange the *Tenong* and the food around it in a circular pattern, both during the communal prayer and when the food is opened and shared together (Apisari et al., 2024). This circular arrangement is not coincidental but is a conscious choice that follows the round physical shape of the *Tenong*, creating visual harmony between the container and the layout (Iswandi et al., 2025). This circular formation also reflects the social philosophy of Javanese society, which highly values equality, togetherness, and harmony (Atu et al., 2023; Lu, 2022). In a circle, there is no highest or lowest position; everyone sits on the same level, sharing space and roles equally (L. C. Silalahi et al., 2020). This structure subtly mirrors a social system in which relationships among community members are built on the principles of mutual cooperation and unity.

Mathematically, the patterns found in the *Nyadran* tradition can be further analyzed to reveal elements such as circular shapes, arrangement patterns, and methods of organizing space in an orderly manner. For example, the round shape of the *Tenong* can be introduced as a type of two-dimensional figure, and the circular arrangement of food can be explained as a form of repeating pattern or grouping (Astuti & Madawistama, 2025). With such an approach, cultural traditions can be utilized as concrete and relatable teaching materials in mathematics, making it easier for students to grasp abstract concepts (Annanda Shofi Sulthoni & Ucik Fitri Handayani, 2025). Thus, this tradition not only reflects local wisdom within a cultural framework (Ibnu Fitrianto & Muhammad Farisi, 2025). This tradition can have a deeper impact, as it holds great potential to serve as a rich and meaningful source for contextual mathematics learning (Untara, 2025). Examining the *Nyadran* tradition through an ethnomathematical approach can broaden students' perspectives on mathematics as a discipline deeply connected to social and cultural life (Rudhito et al., 2024).

However, despite this potential for cultural integration, there is a gap between the current trend in ethnomathematics studies and the reality of low conceptual understanding and student learning outcomes in Indonesia. So far, the focus of material in ethnomathematics studies in Indonesia has been dominated by the exploration of geometric concepts, number patterns, and arithmetic in static physical objects such as

building architecture, traditional tools, crafts, or batik motifs (Afriansyah & Sugiarti, 2025; Dewi et al., 2025; Putra et al., 2023). Conversely, ethnomathematics research exploring advanced combinatorics concepts, particularly cyclical permutations through dynamic cultural activities and social formations, remains limited and under-recognized. The limited scope of this material has a direct impact on classroom teaching practices, where cyclical permutations are often a topic with low learning outcomes because students experience misconceptions, difficulty distinguishing circular position orientations, and are accustomed to memorizing abstract formulas without understanding their contextual meaning (Nopriana et al., 2023). This low spatial reasoning and visualization ability is also reflected in the results of the 2022 PISA, which reported that Indonesian students' mathematics scores dropped sharply to 366, placing Indonesia in 70th place out of 81 countries due to students' inability to solve non-routine problems that require problem-solving based on real contexts (OECD, 2023). This is reinforced by previous research, which shows that the main error of Indonesian students in solving context-based problems is the failure to interpret real situations and formulate them into appropriate mathematical concepts (Lamanna et al., 2022; Nopriana et al., 2023; Nursisto & Ismaimuza, 2022). In fact, several studies have shown that utilizing local cultural contexts has been effective in minimizing learning barriers and significantly improving students' mathematical learning outcomes (Hidayati & Prahmana, 2022; Prahmana et al., 2023). Therefore, this research, which examines ethnomathematics in the Tenong arrangement in the Nyadran tradition in Banyon Village, is urgently needed to fill the gap in cultural combinatorics literature while providing alternative concrete solutions to improve students' conceptual understanding and learning outcomes in the cyclical permutation material.

This study aims to describe and analyze the ethnomathematical elements embedded in the use of *Tenong* and the circular arrangement of food during the *Nyadran* tradition in Banyon Village, Klaten Regency, Central Java, Indonesia (Fauzi & Lu'luilmaknun, 2019). This study is not limited to exploring mathematics within the *Nyadran* tradition but also explores it through tests on students directly involved in the tradition. These tests aim to identify the extent to which the *Nyadran* tradition can develop students' problem-solving skills in cyclical permutation discussions. This study is expected to contribute to the development of culturally-based mathematics education (Masamah, 2019). It not only fosters conceptual understanding but also builds a meaningful connection between students and their own cultural heritage.

2. RESEARCH METHOD

The subjects in this study were selected using purposive sampling, taking into account individuals or groups with knowledge, involvement, and direct experience in the implementation of the *Nyadran* tradition in Banyon Village, Klaten Regency, Central Java, Indonesia. The main focus of the research subjects is the community members who actively participate in the *Nyadran* tradition, particularly cultural practitioners and local figures directly involved in the procession (Li et al., 2021). They are considered authentic and reliable sources of information, as they understand the philosophical meanings and the structure of food arrangement within the *Tenong* used during *Nyadran* (Wulanjari et al., 2024). The *Tenong* unique to this village not only embodies rich cultural values but also contains mathematical concepts, particularly cyclic permutations, which can be analyzed through an ethnomathematical approach.

In addition to the community as the primary source of data, this study also integrates ethnomathematical concepts directly into mathematics learning. Therefore, the researcher involved one 11th-grade high school student as an additional subject, tasked with solving contextual problems based on the *Nyadran* tradition (Utmeemang & Buaraphan, 2024). The student was selected based on criteria such as being cheerful, intelligent, and demonstrating a good understanding of mathematical concepts, although occasionally showing a lack of precision in writing numbers or solution steps. (Windasari et al., 2020). However, these minor errors did not affect the accuracy of the final answers, as the student was able to complete the problems using correct logical reasoning (Cresswell & Speelman, 2020). The inclusion of the student in this research aimed to explore the extent to which the concept of cyclic permutations, derived from cultural practices, could be understood and applied concretely in a mathematics learning context (Lathiifah et al., 2019). Thus, this study not only uncovers mathematical values within local culture but also

highlights the potential for their application in context-based education rooted in local wisdom.

The data in this study were collected using several techniques aligned with the ethnographic approach and ethnomathematical inquiry.

1. Indirect observation was conducted due to the missed opportunity to observe the *Nyadran* tradition directly. Therefore, the observation technique was replaced with video recordings and photographic documentation obtained from reliable sources, such as YouTube, local cultural figures, or village residents who documented the event (Yolan et al., 2024). This indirect observation aimed to study the patterns of *Tenong* usage and the community's interaction with the object within the context of the *Nyadran* ritual.
2. Interviews were conducted with informants involved in the implementation of *Nyadran*, such as cultural practitioners who understand its meaning and a community member who has previously used a *Tenong*. The purpose of these interviews was to gather information related to the philosophical meanings and mathematical concepts, particularly cyclic permutations, embedded in the patterns and arrangements of the *Tenong* (Sutra et al., 2025).
3. Documentation
    - Photos and videos obtained from local sources were also used to support the analysis of cyclic permutation patterns in the *Tenong*. This documentation served as a means of verifying data obtained from interviews and indirect observation.
    - Photos of the students' written responses, collected directly, were also used as part of the documentation.

With this combination of data collection techniques, the study is expected to produce comprehensive and valid data for analyzing the relationship between cultural traditions and the concept of cyclic permutations in the *Tenong* unique to Banyon Village, Klaten Regency, Central Java, Indonesia.

The data collected in this study were analyzed through several systematic stages. The first stage was data reduction, which involved sorting and selecting data relevant to cultural practices and the mathematical forms that emerge in the *Nyadran* tradition, particularly those related to the pattern of cyclic permutations in the *Tenong* (Sari et al., 2021). This process aimed to filter out the most important information aligned with the research focus. The second stage was data presentation, where the reduced data were presented in the form of descriptive narratives that depict the cultural context and the meaning of *Tenong* usage (Selmi et al., 2024). Additionally, the presentation was supported by visual documentation, including photos and diagrams of the *Tenong* arrangement patterns that illustrate the circular positions used in the tradition. This presentation helped clarify and reinforce the visualization of cyclic permutation patterns within the cultural practice. The final stage was concluding, conducted by connecting the identified cultural patterns with the concept of cyclic permutations in mathematics (Ahmad Arisman Nasution & Suparni, 2024). The analysis was performed contextually to demonstrate how such cultural practices implicitly contain mathematical principles (Abang Thamren et al., 2025). Thus, this study not only reveals cultural aspects but also highlights the connection between local traditions and mathematical concepts within the domain of ethnomathematics.

3. RESULTS AND DISCUSSION

Result

The selection of research subjects was based on a purposive sampling approach, in which data were collected through interviews with cultural leaders and practitioners in Banyon Village who were considered to have in-depth knowledge of the *Nyadran* tradition and the arrangement of food in the *Tenong*. In addition, visual documentation in the form of photos and videos of the tradition was also used as an important data source for analyzing cyclic permutation patterns (Senoprabowo et al., 2021). Subjects were chosen based on their active involvement in the tradition and their relevant understanding of the cultural patterns under study (Sheppard & Broughton, 2020). The findings revealed that the arrangement of food in the *Tenong,* unique to Banyon Village, follows a repeating circular pattern and exhibits characteristics of cyclic permutations. The food is not arranged randomly, but rather follows a rotation of positions from one type

of food to another in a sequential manner with each occurrence of the tradition (Tamutu & Hasmah, 2024). This pattern reflects the principle of cyclic permutations in mathematics, where elements shift positions systematically without altering their overall relative order (Aini & Budiarto, 2022). For example, if there are five types of food in one *Tenong*, the food in the first position will move to the second position in the next ritual, and so on, until it returns to its original position.

These findings are supported by an analysis of visual documentation that clearly and consistently shows the rotational pattern of food positions, thereby reinforcing the idea that the *Nyadran* tradition implicitly adopts mathematical concepts within everyday cultural practices. Thus, both cultural figures and visual documentation provide in-depth and relevant information for understanding how the principles of cyclic permutations are applied in a local cultural context (Faris & Hidajat, 2025). This study opens new insights into the close relationship between cultural practices and mathematical concepts, particularly within the field of ethnomathematics (Rosa & Clark Orey, 2019). The results enrich our understanding of the mathematical values embedded in local traditions, while also emphasizing the importance of preserving these traditions as authentic and contextual sources of knowledge.

*Observation Results***.** The results of this observation indicate that the arrangement of food inside the *Tenong* is not done randomly, but instead follows a repeating and systematic circular pattern. Through the observed visualizations, the food is arranged in a circular formation within the *Tenong*. The number of food types served varies, usually between 4 to 7 types (Dosinaeng et al., 2020). Each type of food is placed in a specific position according to the existing layout. In the next *Nyadran* ceremony, the positions of these food items shift one step to the next position in a sequential manner, forming a continuous rotational pattern.
This pattern indicates the presence of a cyclic rotation of food positions, where each type of food shifts sequentially in a circular motion without altering the relative order among them. Observations also reveal a parallel rotation pattern for larger groups of food items, which can be interpreted as multiple simultaneous permutation cycles (disjoint cycles) (Nuryadi & Kholifa, 2020). By analyzing food positions through photographic documentation, this cyclic rotation pattern appears clear and consistent in each *Nyadran* ceremony (Fajriyeh & Zayyadi, 2023). This strengthens the assumption that the arrangement of food in the *Tenong* represents a natural application of the cyclic permutation concept within the *Nyadran* tradition in Banyon Village. Beyond the mathematical aspect, this observation also highlights the symbolic meaning of food positions as a representation of the life cycle and social harmony, preserved and passed down through generations in the *Nyadran* tradition.

Interview Results. Interviews were conducted with a cultural practitioner and a community member from Banyon Village. The purpose of the interviews was to gather information regarding the use of the *Tenong* in the *Nyadran* tradition procession within the context of ethnomathematics.

Interview with cultural leader

Researcher : "How is the food arranged in the *Tenong* during the *Nyadran* tradition in Banyon Village?"
Cultural Leader : "During *Nyadran*, each family brings a *Tenong* filled with food as an offering to the ancestors. The food isn't placed randomly; we arrange it in a circular and orderly way. There's a certain sequence that has become customary, and every year, the position of the food is rotated."
Researcher : "So, there is a specific pattern to the food arrangement in the *Tenong*, right?"
Cultural Leader : "Yes, exactly. For example, if the chicken is in the front this year, next year it might move to the side or the back. All kinds of food like vegetables, side dishes, and snacks take turns. This is done for balance and fairness. It's been practiced since our ancestors' time, every *Nyadran*."
Researcher : "Is there a particular meaning behind the rotation of food positions in *Nyadran*?"
Cultural Leader : "Yes, there is. For us, it symbolizes the cycle of life like a wheel. Everything takes turns, and nothing should remain in the same place forever. *Nyadran* is not only about praying for our ancestors, but also about teaching deep values of life."

Interview with resident

Researcher : "Do you usually take part in bringing a *Tenong* during the *Nyadran* ceremony in Banyon Village?"
Resident : "Yes, we join *Nyadran* every year. Our family prepares a *Tenong* filled with food to bring to the ancestors' graves. It usually contains rice, vegetables, side dishes, and traditional snacks."
Researcher : "Who arranges the food in the *Tenong*?"
Resident : "We arrange it together at home. There's a particular way to do it; it can't be done carelessly. The placement must be balanced. For example, main dishes like chicken or eggs are usually placed in the center or at the front, and the other food surrounds them. That's been a custom passed down from our elders."
Researcher : "Is the food arrangement always the same every year?"
Resident : "No. We usually rotate the food positions in the *Tenong* each year. For instance, if the chicken was in the front last year, this year it might be placed to the side. Every dish gets a turn to occupy what's considered the main position."
Researcher : "What's the meaning behind this rotation of food positions in *Nyadran*?"
Resident : "So that it's fair and every dish gets an important spot. It also symbolizes that life goes in cycles; everything has its turn. During *Nyadran*, it's not just about praying, but also about remembering togetherness and sharing with one another."
Researcher : "Have you ever realized that it's like a rotating pattern or a cycle?"
Resident : "Now that you mention it, yes, it's like it keeps turning every year. But that's just how it's always been, so we follow it as part of the tradition."

Discussion

Tenong in Cultural Tradition. The *Nyadran* tradition is a form of local wisdom that continues to be preserved and passed down through generations by the people of Banyon Village, Klaten Regency, Central Java, Indonesia. This practice is carried out as an expression of respect for ancestors and as a means to strengthen social bonds among community members (Anggreini et al., 2024). *Nyadran* is generally held prior to the month of Ramadan or during certain sacred times, such as before the harvest season or on major religious holidays (Rohman et al., 2024). All community members participate by bringing various dishes from home, neatly arranged in a special container called a *Tenong*. A *Tenong* is a traditional round container made of woven bamboo or metal, often covered with a batik cloth as a lid (Mahayanti et al., 2024). Functionally, the *Tenong* is used to carry food, but it also holds deep symbolic meaning. Its circular shape reflects the philosophy of unity, harmony, and the absence of hierarchy; every point on a circle occupies an equal position (Ishak, 2020). This aligns with the Javanese worldview that life is a shared space without caste or status distinctions (Yulianto et al., 2022). The *Tenong* also symbolizes determination, sincerity in giving, and the spirit of mutual cooperation in community life.

Based on the results of observations and interviews, there is an unwritten rule, orally passed down from generation to generation, that the arrangement of food in the *Tenong* is not done arbitrarily. The types of food commonly *served* include rice, *apem* cakes, free-range chicken, boiled eggs, and *rengginang* (crispy rice crackers). Each type of food is believed to carry its own symbolic meaning (Sekar Kirana Wulandari et al., 2024), For instance, *apem* symbolizes a plea for forgiveness (A. H. Putri et al., 2024); chicken as a source of protein, represents health for the community (Sembiring et al., 2022), Rice, as a staple food, symbolizes prosperity for all (Mu'min, 2020); *eggs* represent the unity of life that is inseparable from nature (Malo et al., 2022); and *rengginang* made from rejoined rice grains, symbolizes brotherhood (Vina Tri Agustinningrum & Sukarman Sukarman, 2024). This tradition illustrates that the *Tenong* is not merely a serving container but a vessel of noble values (Diana, 2023). Within every dish and its arrangement lie deep moral and spiritual messages. The value of sincerity is reflected in how each family brings food without expecting anything in return (Lamawuran et al., 2023). The value of equality is evident in how every type of food is treated with respect. And the value of togetherness is embodied in the moment when all residents sit in a circle, offer prayers, and share a meal from the same container, strengthening a sense of solidarity

and brotherhood.

The *Nyadran* tradition, which uses the *Tenong* as the main container for offerings, not only represents a collective ritual but also embodies profound philosophical values deeply rooted in the Javanese worldview (F. H. M. Silalahi & Purwanto, 2025). Two key philosophies reflected in this practice are *urip iku mung mampir ngombe* (life is temporary and always rotating) and *sangkan paraning dumadi* (everything will return to its origin)*;* both are not only upheld as life principles, but are also symbolically reflected in every aspect of the tradition, including the arrangement of food within the *Tenong*. (Hannan & Khotibum Umam, 2023).

The Javanese proverb *urip iku mung mampir ngombe*, which literally means life is just a stopover to drink, carries the message that life in this world is temporary. In the context of *Tenong* culture, this philosophy is reflected in the community's attitude of not competing for position or status, but rather accepting with sincerity that each type of food in the *Tenong* will have its own turn to be placed at the front (Ambarwati et al., 2019). This demonstrates a life perspective of humility, contentment, and awareness that everything changes and rotates in due time. Just like in human life, no one remains in the same position forever; everyone experiences a cycle of fate, happiness, sorrow, roles, and responsibilities (Safitri et al., 2022). Therefore, the rotation of food within the *Tenong* symbolically reflects the cycle of life: what is below will rise, and what is above will shift, in accordance with the natural order and the passage of time.

Meanwhile, the philosophy of *sangkan paraning dumadi,* which means that all things emanate from and ultimately revert to their source, adds spiritual depth to the arrangement and rotation of food within the *Tenong*. The annual rotation of food from one position to another is not merely a hereditary custom but also symbolizes the journey of living beings from the Creator and back to Him (Amanda Anyza & Listyo Yuwanto, 2023). When the food in the *Tenong* returns to its original position after several cycles, it reflects the eternal cycle of life's destiny (Herawati, 2023). The circular arrangement inside the *Tenong* also represents the unity of life's origin and purpose, emphasizing that in togetherness and equality, humans will always return to their essence and source.

Thus, the *Tenong* tradition is not merely a part of customary rituals but a philosophical expression of Javanese views on life, time, and existence. The *Tenong* serves as a symbol that imparts wisdom about accepting the cycles of life, understanding the origin and purpose of existence, and fostering social harmony rooted in equality, sincerity, and profound spiritual awareness.

Cyclic Permutation Simulation. In everyday life, we often encounter arrangements of objects or people in a circular formation such as sitting around a round table, arranging food in a circle, or implementing a rotating shift system. The mathematical concept that describes such arrangements is known as cyclic permutation (Engen & Vatter, 2021). Unlike regular permutations, which count the number of arrangements in a straight line, cyclic permutations only count arrangements that are truly distinct in a circular form (Ball & Serra, 2024). This is because in a circle, there is no absolute beginning or end, so arrangements that differ only by their starting point are considered the same.
General Formula:

$$P_n = (n-1)!$$

Explanation:
P_n : the number of ways to arrange *n* objects in a circle.
n : the number of known objects
! : factorial symbol (product of all positive integers up to *n*)
For example, if 4 people are sitting in a circle, the number of unique arrangements is: $P_4 = (4-1)! = 3! = 3 \times 2 \times 1 P_4 = 6$. So, the answer is 6 distinct circular arrangements, because rotations of the same arrangement are not counted as new ones.
For example, in one *Tenong*, there are six types of food, namely: A as Rice; B as Chicken; C as Eggs; D as Vegetable; E as *Apem*; F as *Rengginang*.
In the first year, the arrangement in clockwise order is as follows:

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1. Position 1 (very front): A
2. Position 2 (front right): B
3. Position 3 (back right): C
4. Position 4 (back): D
5. Position 5 (back left): E
6. Position 6 (front left): F

In the **second year**, there is a one-position shift in the clockwise direction:

1. Position 1: F
2. Position 2: A
3. Position 3: B
4. Position 4: C
5. Position 5: D
6. Position 6: E

And so on, until after 6 years, the arrangement returns to its original position. This demonstrates a single cyclic permutation of 6 elements; see the following illustration in Figure 1.

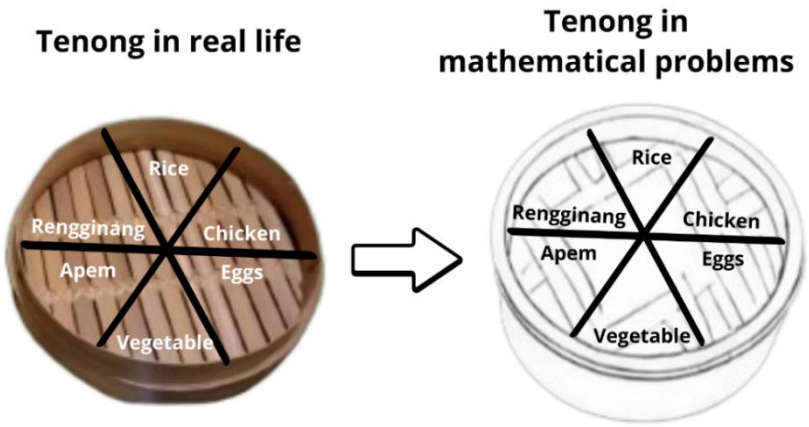


Fig 1. Illustration of *Tenong* in *Nyadran* Tradition in Banyon Village

The context in Figure 1 can be used as a cyclic permutation problem under different conditions as follows. In the *Nyadran* tradition of Banyon Village, the community arranges food in a circular *Tenong* containing 5 types of food: fruit, *apem, rengginang*, chicken, and eggs, placed in clockwise order. Each year, the food positions are rotated one step clockwise so that each food item takes turns occupying the front position (the side facing the prayer direction).

1. How many different circular arrangements can be formed from the arrangement of the food items?
2. If this year (2025) the front position is occupied by fruit, in what year will chicken be in the front position?
3. After how many years will the arrangement return to its original order?

To solve the first question, Grade XI students need to first understand the concept of cyclic permutations, which involve arranging objects in a circle where one arrangement is considered the same as another if they differ only by rotation. In the problem, it is stated that there are 5 types of food: fruit, *apem, rengginang*, chicken, and egg, arranged in a circle inside a *Tenong*. Since this is a circular arrangement, the number of distinct arrangements can be calculated using the formula $(n - 1)!$, where n is the number of objects being arranged. So, $(5 - 1)! = 4! = 4 \times 3 \times 2 \times 1 = 24$ distinct circular arrangements can be formed. Next, for the second question, it is stated that in the year 2025 the front position is occupied by fruit, and the food positions are rotated one step clockwise each year. Since chicken is in the fourth position after fruit, it will move to the front in the fourth year after 2025, which is in the year 2028.

For the third question, since the rotation is done one step each year in a five-element arrangement, it

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takes 5 years for all positions to rotate back to their original places. Therefore, the arrangement will return to its initial state in the year 2030. This explanation demonstrates how mathematics, particularly cyclic permutations, can be applied to logically and systematically understand patterns within cultural traditions. This problem is designed for 11th-grade high school students, as the concept of cyclic permutations is part of the advanced mathematics curriculum introduced at that level. By incorporating local cultural context through the *Nyadran* tradition, students are encouraged to understand mathematical concepts in a contextual and applicable manner (Sulistyowati et al., 2024). Through the arrangement of food in the *Tenong* that rotates each year, students not only learn to calculate cyclic permutations using the formula $(n-1)!$, but also to analyze rotational patterns and determine the time it takes for the arrangement to return to its original order (Sabon et al., 2021). Questions such as determining when the chicken reaches the front position and how long it takes for the arrangement to reset encourage students to think logically, systematically, and to meaningfully connect cultural practices with abstract mathematical concepts.

To assess the extent of students' understanding of the given problem, their answers were analyzed based on the work submitted on paper. Each student was asked to write down the steps of their solution, including the formula used, the logical reasoning behind their calculations, and the accurate determination of the year based on the rotation pattern of food arrangements in the *Nyadran* tradition (Gombo, 2024; Irfan et al., 2023; Sulistyowati, Kuncoro, Nugraheni, et al., 2019; Sulistyowati, Kuncoro, Setiana, et al., 2019). This analysis of the written responses provides a concrete picture of how students apply the concept of cyclic permutations within a local cultural context and reflects their individual level of mathematical thinking skills (Trisnawati, 2022). The following section presents examples of student responses that illustrate their thought processes and final answers to the completed problem.

Question Number 1

How many different circular arrangements can be formed from the arrangement of the food items?
Student's Answer:

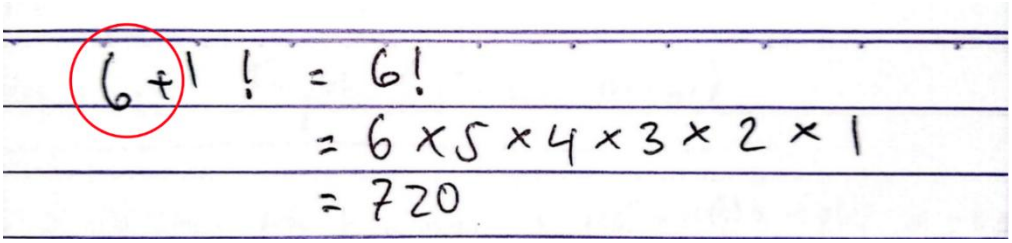


Fig 2. Student's Answer

Based on the analysis of one student's answer to the question in Figure 2, it is evident that the final answer given was incorrect. The student wrote the final result as 720, whereas according to the concept of circular permutation, the correct answer should be 24. This result is obtained from the formula $(n-1)!$ with $n=5$, so $(5-1)! = 4! = 4 \times 3 \times 2 \times 1 = 24$. The error occurred because the student applied the formula for linear permutation instead of circular permutation. In addition, the solution lacked the correct formula notation, and there were mistakes in the initial numerical setup from the problem, as well as using the addition sign (+) where the subtraction sign (−) should have been used. Nevertheless, the steps taken indicate that the student has begun to understand the pattern of rotation and the logical structure of the problem, although there was a misapplication of the formula.

Learning circular permutations through an ethnomathematical approach using the context of the *Nyadran* tradition still provides a positive impact on students' thinking processes. Culturally contextualized problems make students more engaged and help them visualize the problem in a concrete way. The student also demonstrated the ability to calculate arrangement possibilities based on the yearly rotation of food in the *Tenong* (Herizal, 2021). This shows that the ethnomathematical approach can strengthen the connection between abstract mathematical concepts and students' cultural realities (Gustina et al., 2025). It helps

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enhance conceptual understanding, accuracy, and analytical skills in learning mathematics more meaningfully.

Question Number 2

If this year (2025) the front position is occupied by fruit, in what year will chicken be in the front position?
Student's Answer:

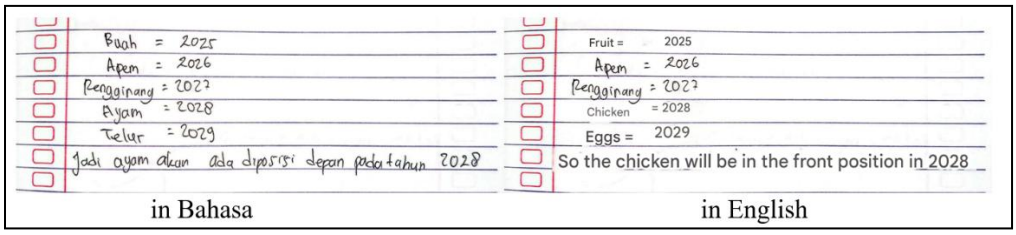


Fig 3. Student's Answer

Based on the analysis of the student's answer in Figure 3, it shows that the student was able to accurately determine the position of food items in specific years based on the rotation pattern in circular permutations. For example, when asked to determine in which year the chicken would be in the front position if the starting year (2025) was occupied by the fruit, the student was able to calculate and conclude that the chicken would be in the front in 2028, which is three years after the initial position. This step indicates that the student not only understood the concept of circular position shifting but also successfully applied it in the context of time, based on the number of elements and the direction of rotation stated in the problem. This accuracy reflects a solid understanding of cyclic patterns and their application in real life. Interestingly, through a learning process that connects mathematical concepts with local culture such as the *Nyadran* tradition, students not only showed more focus in understanding the material, but also demonstrated the ability to confidently predict which type of food would be in the front position in the coming years. This indicates that the ethnomathematical approach not only fosters learning interest but also cultivates analytical thinking and skills in projecting long-term patterns (Rachmawati & Purwaningrum, 2019). In other words, students are not just learning mathematics they are practicing how to identify patterns in real life in a meaningful and enjoyable way.

Question Number 3

After how many years will the arrangement return to its original order?
Student's Answer:

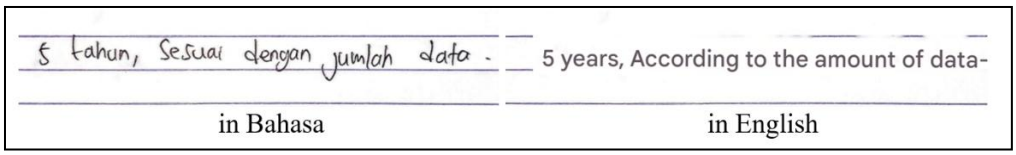


Fig 4. Student's Answer

Based on the analysis of the student's answer in Figure 4, it shows that the student successfully answered the question correctly, particularly in determining when the food arrangement in the *Tenong* would return to its original position. The student demonstrated an understanding that, since there are 5 types of food arranged in a circle and the positions rotate one step clockwise each year, it would take 5 years for the arrangement to return to its original order. This response indicates that the student comprehends the fundamental principle of circular permutations and is able to relate it to the context of annual rotation in the *Nyadran* tradition. This accuracy reflects the student's ability to recognize patterns and apply mathematical concepts logically and contextually (Saminanto et al., 2024). Furthermore, the student was also able to

accurately predict when the food arrangement would return to its initial form, specifically in the year 2030 if the starting position was in 2025. This ability serves as evidence that ethnomathematics-based learning not only strengthens conceptual understanding of mathematics but also develops a systematic way of thinking, enabling students to read and forecast cyclical events mathematically (Hia et al., 2025). This makes the learning process more meaningful and relevant by connecting it to real-life experiences.

Thus, in line with the understanding of (Rosa et al., 2016) through learning based on local culture such as the *Nyadran* tradition in Banyon Village, students not only successfully comprehend the concept of circular permutations mathematically, but also become aware that such concepts exist in their real-life experiences. This understanding reinforces the belief that mathematics is not merely a collection of numbers and formulas, but a living and meaningful part of cultural heritage (D'Ambrósio & Knijnik, 2019; Ridho'i, 2024). The integration of ethnomathematics into learning provides an educational experience that is closer to students' realities, enhances their sense of ownership over the material being studied, and enriches their understanding of the connection between science and culture (Fatimah et al., 2024). Therefore, such an approach is highly relevant for implementation in mathematics education, especially in supporting contextual learning rooted in local wisdom.

4. CONCLUSION

The results of this study indicate that the Nyadran Tradition in Banyon Village is not only rich in cultural and spiritual values but also reflects a mathematical concept, namely cyclic permutations in the arrangement of food in Tenong. The results of the interview indicate that the round shape of Tenong symbolizes equality in a society without hierarchy. The annual rotation of food symbolizes social harmony and Javanese philosophical values, namely *urip iku mung mampir ngombe* (life is temporary and always rotating) and *sangkan paraning dumadi* (everything will return to its origin). The observation results show that the arrangement of food in Tenong is not random but follows a systematic circular pattern. Every year, the position of the food shifts one step clockwise sequentially. This characteristic reflects the principle of cyclic permutation, where elements shift positions systematically without changing their relative order. The results of student tests in solving cyclic permutation problems in the context of Tenong in the Nyadran tradition show that students tend to better understand the given context because it is in accordance with everyday life, although there are errors in finding possible arrangements in Tenong due to reading errors. Through an ethnomathematics approach, students are able to understand and apply the concept of cyclic permutations contextually, such as counting the number of arrangements, determining the position of food in a given year, and identifying when the arrangement returns to its original form. This learning experience not only strengthens students' understanding of mathematical content but also fosters awareness of the presence of mathematics in their daily lives and cultural practices. This approach aligns with the Indonesian National Curriculum, which emphasizes meaningful, contextual learning based on local wisdom.

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