Ethnomathematics in Traditional Farming Systems in Pegalongan Village, Patikraja

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Abstract

Pegalongan village is located in the south of Purwokerto city and the majority of the population work as farmers. Rice farming in this area is an important part of local culture and tradition, as well as a major source of livelihood for the local community. The purpose of this study is to find the mathematical elements hidden in the operation of rice farming and the philosophical value contained in it. To understand how rice farming communities use mathematics in their cultural context, this study used a descriptive qualitative ethnographic approach. The research involved farmers and farm labourers. The focus of the research includes the planting land, and the process of planting rice, the cultivation of the farmers in the form of mimiti and mbawoni. Data was collected through direct observation of farmers, documentation, and in-depth interviews. Data were analysed thematically to find key themes related to ethnomathematics in rice cultivation. These themes included the use of mathematics in agricultural activities, the use of traditional tools and units of measurement, and agricultural processes rooted in local culture. The study also emphasised that ethnomathematics should be part of the education curriculum to improve students' understanding. The results showed that mathematical concepts such as arithmetic, and measurement can be applied in land cultivation. The results show that local knowledge is critical to agricultural practices, and how ethnomathematics can be incorporated into the education curriculum to improve students' understanding of mathematics in a cultural context.
Keywords: Culture, Ethnomathematics, Rice Field, Traditional Farming.

Introduction

Maths and culture are still often considered as two unrelated factors. This is because mathematics is considered a neutral, abstract, and culturally independent discipline that is often alienated from social values (Maryati & Prahmana, 2019; Rosa & Orey, 2011). Mathematics is a science concerning the value of truth and absolute so it is not related to cultural and social reality (Prabawati, 2016). Maths is an important aspect of culture that emerges from daily activities, so the two cannot be separated (Ergene et al., 2020). One of the similarities between the two concepts is universal value. Culture has universal elements that can be used to justify the characteristic values in a culture (Umbara & Suryadi, 2019). One of the socio-cultural sciences that can be related to mathematics is ethnomathematics.

Ethnomathematics is a branch of science that studies the relationship between mathematics and cultural contexts in everyday life (Kusno et al., 2023) that is relevant to be transmitted, and disseminated in systems and disseminated in systems of cultural diversity (Zhang, 2010). In addition, ethnomathematics can play a role in understanding, articulating, and applying concepts, procedures, and techniques identified as mathematical practices (Rosa & Gavarrete, 2017). Based on this, it can be understood that mathematics has a role in various contexts such as personal, work, social, and scientific contexts.

The study of ethnomathematics is so broad that it is considered as one of the components of understanding mathematics. Because mathematics is an abstraction of the human brain that is used to solve problems (Aini, 2020). So, the idea arises that ethnomathematics should have a big role in society and education, especially in mathematics education. This role and influence is actually very real; it all depends on how well we maintain and relate it in the learning process. If the concepts taught to students are related to what they do every day, students will find it easier to understand mathematics. According to (Barton, 2017), 'Ethnomathematics is a field of study which examines the way people from other cultures understand, articulate and use concepts and practices which are from their culture and which the researcher describes as mathematical'.

The main role of mathematics, which is unique in learning it, is that mathematics can be a solution to solve everyday life problems contextually through the transformation of thinking skills from concrete to abstract (Umbara & Suryadi, 2019). Agriculture is one of the branches of the agricultural science family related to ethnomathematics (de Mattos & de Mattos, 2020; Suprayo et al., 2019). Activities carried out by farmers in the field of ethnomathematics are in the form of farmers' activities in calculating, measuring, or in the process of cultivating rice plants with primitive methods (Pathuddin et al., 2023). Ethnomathematics can also examine the cultural activities of Pandawangi rice farmers containing mathematical concepts that appear when determining the class of seeds, the number of seeds, seedbed preparation, final seed selection with salt water, seeding in the nursery, nursery maintenance, preparation of planting land, planting, fertilisation in the planting field, plant maintenance, harvesting, and post-harvesting to produce mathematical concepts in agricultural activities in the content of geometry, including determining points, lines, angles, flat area, flat building equality, and algebra, including comparison, percentage, and social arithmetic (Sugiarni et al., 2023).

The novelty in the research that will be studied on mathematics learning associated with socio-cultural aspects (Ethnomathematics) is carried out in Pegalogan Village in Patikraja District. The livelihood of the residents of Pegalongan Village is farmers. In their daily activities, farmers consciously or unconsciously utilise mathematical concepts and traditions. The majority of farmers in the village are farm labourers who do not own their own land, this causes farm labourers to communicate with the owner of the rice field with the 'Majeki' or 'Maro' model. Furthermore, in the planting process, land measurements still use bamboo slats as rulers, sometimes using plastic ropes called 'kentheng'. During the rice planting process, the land is outlined using traditional tools made of wood or bamboo called 'cakar', then the contour conditions of the rice fields are terraced. In addition, the ethnomathematics tradition of rice cultivation in the village is in the form of a mimiti tradition carried out before harvesting in the form of a cone cone, and when harvesting farm labourers who memajeki the results are weighed shared with the landowner called 'mbawoni'. The purpose of the research on Ethnomathematics in Traditional Agricultural Learning in Pegalongan Village, Patikraja is important to find out ethnomathematics in the culture of farmers in Pegalongan Village, Patikraja District, Banyumas Regency, which can be used for cultural preservation and mathematics learning resources.

Method

This research was conducted in Pegalongan Village, Patikraja District, Banyumas Regency. This ethnomathematics exploration study research is a descriptive qualitative research conducted using an ethnographic approach. Ethnography is a research approach to describe a culture (Spradley, 2016). The main purpose of ethnography is to understand a way of life from the perspective of cultural members (Windiani & Rahmawati, 2016). The approach method in this research is able to explore information data on how farmers recognise land contours and traditions during the farming process in Pegalongan Village, Patikraja. The data collection technique uses primary data. Primary data sources are data sources obtained by researchers by collecting information from primary sources. Primary data sources are informants and respondents. Informants are data sources related to third parties or who know data about an institution, while respondents are data sources involved in social situations, so they have attitudes, feelings, motives, and habits related to the social

context under study. Primary data can be obtained by conducting interviews, observations, and documentation first. The intended data source is the farmer as a respondent, this aims to explore information about mathematical practices. Then the information data that has been collected will be analysed with a thematic analysis approach.

This interview technique aims to explore information directly to farmers as resource persons to find out their opinions, understanding, concepts, thoughts, and practices in the field. The results of this research were obtained from initial observations and reference collection. Observations were made of the contour conditions of the research land and the traditions carried out by the community in agricultural cultivation in Pegalongan Village, Patikraja District.

Results and Discussion

Farmers in Pegalongan Village still maintain a culture of rice cultivation using traditional cultivation techniques. These techniques contain mathematical values and have philosophical values that can be used as a source of knowledge. The results of observations in this study in Pegalongan Village have terraced land contours.

In addition, most farmers' land ownership in the cultivation process is majeki and mbawoni culture that has been in the rice field farmers rent land where the results are divided by 1/5 between the landowner and farm labourers. The stages of the process in rice cultivation are as follows.

1) Land Contour

Terraced rice field contours are also known as terraces or swales. Terracing is a method of agriculture and soil conservation that is done by creating a terraced soil structure. Figure 1. The black coloured line has a terraced pattern. While the blue coloured line shows that it resembles a trapezoidal flat shape.

Based on Figure 1, the contours of the land in Pegalongan village are stepped, if you draw a line it will form flat shapes, such as parallelograms, trapezoids, rectangles and the shape of two combined shapes. According to the interview with the respondent ‘For many years, farmers in this area have used tools such as bamboo, paralon, plastic rope, or string for ngrucik. The size of the medium must be the same, which is 125 cm. The bamboo or similar is marked at 25cm. Farmers stick a short piece of wood or bamboo at

the 0, 25 and 125 cm points when measuring the land. The purpose is to create straight lines that can be drawn for the next process, so that the size of the field and irrigation are even (symmetrical) across the area.' The flat design of land contours can be related to the area and perimeter formulas of various shapes, such as rectangles, trapezoids, parallelograms, composite flat shapes, and kites.For rectangular land, the area is calculated using the formula L=p×l (length times width), while the perimeter is K=2(p+l).If the land is trapezoidal, the area can be calculated with L=21×(a+b)×t, where a and b are the lengths of the parallel sides, and t is the height. The perimeter is K=a+b+c+d. For a parallelogram, the area is calculated by L=a×t (where a is the base and t is the height), and the perimeter uses the formula K=2(a+b), with b as the hypotenuse. Farmers in Pegalongan Village use the term 'seprapat bau' to describe the amount of seeds to be sown, with a rice field area of approximately 1250 m^2. Some use units of measurement such as kilograms, however. Farmers can estimate the number of seeds to be sown based on the size of the rice field. For example, since a sakwalon is equal to half of a seprapat bau, the seeds sown should be half the amount of seeds of a seprapat bau paddy field.

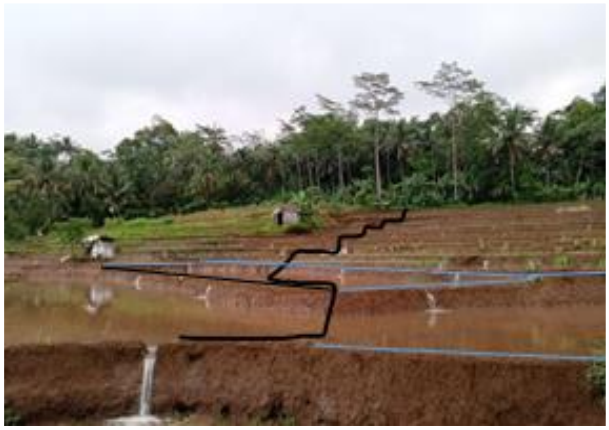

Figure 1. The condition of agricultural land in Pegalongan Village.

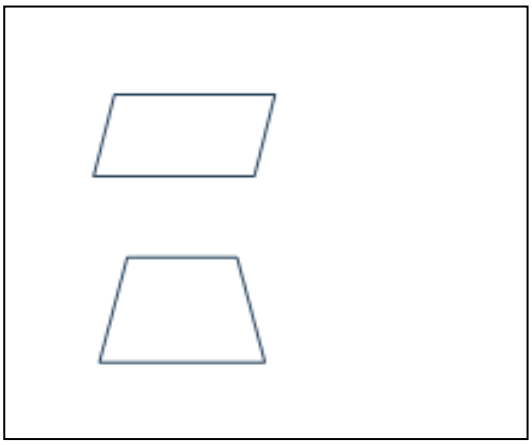

Figure 2. The appearance of rice paddies with terraces resembling trapezoidal flat shapes

In the case of a composite flat, the area is the sum of the areas of each part, while the perimeter is the sum of all the sides.Finally, for a kite, the area can be calculated using the formula $L=21\times d1\times d2$ (where d1 and d^2 are the lengths of the diagonals), and the perimeter using the formula $K=2(a+b)$ (with a and b being the lengths of the different sides). With this understanding, farmers can plan and utilise the land more effectively. This configuration optimises rainwater absorption and reduces soil erosion. Farmers can increase crop yields and optimise land use with this geometric shape.

Farmers in Pegalongan use the term '*seprapat bau*' to describe the amount of seeds to be sown, with a rice field area of approximately 1200 m^2. Some use units of measurement such as kilograms. Farmers can estimate the number of seeds to be sown based on the size of the rice field. For example, since a sakwalon is equal to half of a seprapat bau, the seeds sown should be half the amount of seeds of a seprapat bau rice field (Pratama & Lestari, 2017).

2) Claws

The development of mathematics learning in the lives of farmers, especially in the cultivation of rice plants, farmers still use traditional tools used for generations in the planting process using claws Figure 3. Interview respondents 'farmers added in rice cultivation, claws are usually used after the land is processed with a tractor. The claw is made of wood or bamboo with each point marked with bamboo as a barrier measuring 27 cm x 27 cm. The claw plays a role when planting rice. Where running the claw the farmer pulls so that the line is symmetrical. So that the plants look neat and can be for jajar legowo.

Figure 3. Traditional claw tool measuring 27cm x 27cm

Rice plants are often planted in rice fields with regular spacing, the most commonly used by farmers is using *jajar legowo (Jarwo)*. *Jajar legowo* is an arrangement between two or four and six rows of rice plants and one empty row (2:1, 4:1 and 6:1). Farmers in Pegalongan Village use the 6:1 *jajar legowo* rice planting pattern using traditional tools in the form of claws with a planting distance size of 20 cm x 25 cm. The tools used in the jarwo planting pattern use claws with a planting distance of 20 cm x 25 cm. Utilisation of the 6:1 *jarwo* planting pattern generates an income of Rp.11,659,828 (Nurhayati et al., 2023).

After the harvest, farmers in the village hold a *Mimiti* tradition as an expression of gratitude to God for the abundant crops. In a solemn atmosphere, they gather in the fields to pray together, accompanied by offerings of harvest products such as rice, vegetables, and fruits. This tradition not only strengthens the sense of community among farmers, but is also a moment to share with others, where a portion of the harvest is donated to the needy. In this way, they maintain a harmonious relationship between man and nature, as well as honour a long-established cultural heritage.

3) Mimiti

Mimiti is a tradition carried out by the village community as a form of gratitude to the creator and a form of gratitude to share with neighbours ‘This tradition is very important to us,’ he said, ‘as an expression of gratitude for the abundant harvest, Mimiti is not just a ritual, but also a reminder that everything we have is a blessing from God. By sharing, we also strengthen the sense of togetherness in farmers in this village still prioritise the tradition of mimiti by way of tumpengan. Mimiti has ethnomathematical value in the form of tumpeng, which is a cone-shaped shape that signifies gratitude to the Creator.

A cone is a three-dimensional space that has a circular base and curved sides that narrow to a single apex point. Here are the formulas related to cones:

Volume Cone

The formula for calculating the volume of a cone is:

$$V - \frac{1}{3}\pi r^2 h$$

- V = Volume of the cone
- r = Radius of the base circle
- h = Height of the cone, i.e. the distance from the base to the apexa)

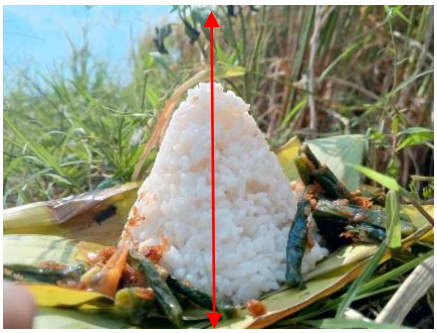

Figure 4. *Sedekah bumi mimiti* with cone-shaped *tumpeng* (rice cone)

a) Post-harvest counting

The calculation of post-harvest results in Pegalongan Village still uses the tradition of sharing results in the form of *mbawoni.* In rice farming, the term '*mbawoni*' refers to the process of maintaining rice plants until harvest. '*Mbawoni*' comes from the lexeme bawon, whose first phenomenon is ditasal. *Mbawoni* is the act of reaping the rice crop between the rice field owner and the penderep after they have harvested the rice in the field. The harvest is shared between the farm labourer (*majeki*) and the landowner generally 1:6 (Emha et al., 2024).

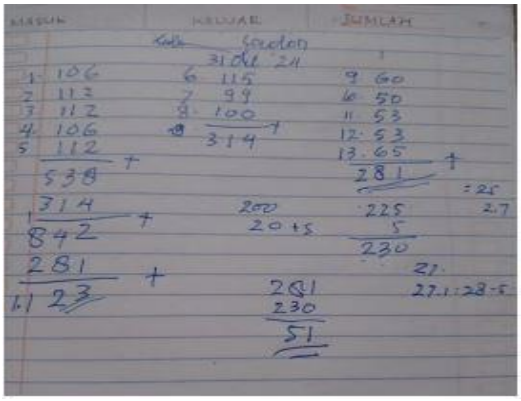

Figure 5. Calculation of "*mbawoni rice*"

b) Numeracy Activity Discussion

The activity of counting appears when farmers count the number of rice seeds and the area of rice fields. We can find this activity when farmers count the number of seeds by estimating how many rice seeds are needed to be planted, they usually use the size of bengket or ikat. A bundle means 1 bundle. In addition, counting the number of harvests, harvest hail relates to units of weight (tonnes, quintals, kg units are often used) but sometimes they only count using the size of the sack (sak), such as 1 sak, 2 sak and so on which usually 1 sak = 50 kg (1/2 quintal).

c) Measuring Activity

In the measurement seen during planting, planting includes mathematical concepts, namely the distance between rice seeds to be planted and the measurement of the swah area. measuring activities are seen when farmers plant rice which is always done by first pulling the rope along the planting path so that the planting distance between one seed and another seed is the same. Pegalongan villagers use the size of a *jengkal,* which is approximately 15-20 cm. Measuring the area of land using the unit used by farmers is bau, for farmers there are still other units of area such as quarter bau, half bau, and telo perampat bau. One *bau* or *sebau* is equivalent to 500 m x 14 m or approximately 7,100 square metres.

d) Counting Activity

This counting activity most often appears in mathematical concepts such as addition, subtraction This counting activity most often appears in mathematical concepts such as addition, subtraction, multiplication and division, for example during the fertilisation process and the distribution of wages that will be obtained by workers/farmers. Addition, this is usually rice farmers always calculate the costs needed from planting and caring for rice to harvesting it. Subtraction, subtraction arises when farmers calculate profits or losses. In the farming system, if the selling price is higher than the total cost then the farmer makes a profit. The concept used is to subtract the farmer's selling price and the total cost of expenses. Conversely, if the selling price of the field is lower than the total cost then the farmer makes a loss. Multiplication calculation, multiplication arises when farmers pay wages to workers. The calculation method is to multiply the salary per person by the number of employees. usually using the system ren aren/harian (07.00-

10.00)=Rp.25,000 and peddukan (07.00-12.00)=Rp.50,000. For example, 2 people working daily 3 labourers (3×25,000=75,000) the wage to be paid is 75,000. Division, division calculation activities will appear when calculating the ipah of the workers. For example, 1 plot of rice fields to be harvested will be done by 4 labourers at a cost of Rp.320,000,. So to calculate the wages of these workers we use the division calculation, namely Rp. 320,000: 4 people = 80,000 / person. After seeing the agricultural activities of people in Pegalongan Village, it turns out that many mathematical concepts are embedded in the community and used by farmers without realizing it. Unfortunately, teachers in secondary schools around Pegalongan Village are not aware of this situation. Teachers still use textbooks and student worksheets provided by publishers as a reference. This condition may affect the understanding of mathematical concepts and the process of grounding mathematics in real life (Irfan et al., 2019).

Conclusion and Suggestion

The results of this study show that ethnomathematics in the application of traditional agriculture as a reference source in learning mathematics can be applied in traditional agricultural culture. The results of this research are in the form of stepped agricultural land applications. If described, it resembles a flat building. Furthermore, in the planting process farmers use traditional tools made of bamboo or wood called claws or *nyakar*. The claw is used to divide the planting distance from one another so that the plants can grow optimally. The implementation of this claw tool is number measurement in mathematics learning. Farmers still maintain the preservation of village culture in farming before the harvest by holding the *Mimiti* tradition. *Mimiti* is an earth alms by bringing tumpeng implementation of tumpeng shape resembles a wrinkle-shaped space. The tradition of farmers at harvest time in Pegalongan Village, Patikraja District is *Mbawoni*. *Mbawoni* is a profit-sharing system between landowners and farm labourers in the form of wet grain for farm labourers. The mathematical application used in *mbawoni* uses social arithmetic.

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