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Identification of Mathematical Concepts in Paiton Community Rice Farming Activities

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ABSTRACT

School mathematics instruction is often perceived as too abstract and rigid because it is presented separately from the realities of life and the cultural backgrounds of students. This study aims to identify and describe the implementation of geometric concepts, comparisons, number patterns, and social arithmetic at various stages of rice farming activities in the Paiton community, Probolinggo Regency. The method used was a qualitative approach with an ethnographic design through semi-structured interviews with three active farmers in Jabung Candi Village, field observations, and interactive analysis of documentation. The results show that Paiton's agricultural activities are rich in applied mathematical concepts: whole number operations and social arithmetic are used in seed selection and profit-loss calculations; equivalent ratios are applied to fertilizer and pesticide dosages; the geometric structure of spiral curves is formed on tractor plowing tracks; and the Jajar Legowo planting system implements sequences of number patterns. This study concludes that Paiton's rice farming activities validly integrate formal mathematical concepts, thus having strategic implications for their transformation into realistic mathematics learning tools.

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1. INTRODUCTION

Mathematics is a discipline that studies patterns, structures, relationships, and changes logically to explain various phenomena in life (Tambunan, 2025). However, in reality, mathematics is often perceived narrowly by students as a rigid, scary subject, identical to a series of numbers, complicated formulas, and abstract and procedural working procedures (Aisyah, Annisa, & Rizkis, 2023). As a result, they often have difficulty understanding formal concepts because learning is presented separately from real experience (Hidayatulloh, Alghar, & Usman, 2025). Therefore, the learning paradigm must be shifted to associate mathematical concepts with the students' environment to make them more meaningful (Yanti, 2024).

Studies that discuss the relationship between mathematics and culture are known as ethnomathematics (Bani, Dominic, & Madu, 2025). According to Alan Bishop, ethnomathematical theory states that mathematics is a *pan-cultural activity* that can be reviewed through the activities of calculating, placing, measuring, designing, playing, and explaining (Triansyah, Mustika, Meilinda, Anjani, & Dzakkiya, 2025). In agrarian Indonesia, rice farming activities contain a wealth of local knowledge that *has been* inherited from generation to generation. This farming practice is actually a "natural laboratory" that contains the concepts of geometry, comparison, and calculation that are applied intuitively by farmers ((Rosa & Orey, 2011; Annisa, Jabri, & Rahmat, 2025).

Although the study of ethnomathematics is evolving, most of the literature still focuses on physical artifacts and traditional tools (Aulia & Rista, 2019). Research that identifies mathematical concepts in the dynamic stages of rice cultivation is still limited, especially in Paiton District, Probolinggo Regency. In fact, Paiton is a year-round rice farming center, where the majority of students grow up in farmer families. Unfortunately, this close daily context is rarely used by teachers in the classroom (Sudihartinih, 2020; Chabibah & Khoiri, 2025).

For this reason, this study limits its focus to the concepts of geometry, comparison, number patterns, and social arithmetic contained in the paiton community's rice farming activities. The main objective of the research is to identify the implementation of these concepts from the seed selection stage to post-harvest, which is then used as the basis for the preparation of a question test package based on *Realistic Mathematics Education* (RME). The main conclusion of this study shows that rice farming activities in Paiton are rich in applied mathematical concepts that are intuitively practiced by farmers. The structure of the mapping of the activity stages and their concepts is presented briefly in Table 1.

Table 1. Mapping of Mathematical Concepts in Paiton Rice Farming Activities

Yes	Agricultural Activities	Math Activities	Mathematical Concepts
1	Soaking prospective seeds	Counting	Summing up
2	Seed Selection	Counting	Addition and Subtraction
3	Ploughing Rice Fields	Counting	Geometry
4	Planting	Measuring, placing, designing	Geometry and number patterns
5	Plant maintenance • Fertilization • Cleaning weeds • Spraying • Water distribution	Counting	Comparison (Ratio)
6	Harvesting process	Counting Activity	Social arithmetic

2. METHODS

This study uses a qualitative approach with ethnographic design to describe, explain, and analyze in depth the mathematical concepts (ethnomathematics) contained in the culture of a society through the observation of behavioral patterns and ways of thinking (Assayakurrohim et al., 2023). Through a qualitative approach, human or social phenomena can be understood comprehensively and complexly in a natural setting (M. Fadli, 2021). The subjects in this study were determined using purposive sampling techniques, consisting of 3 active rice farmers domiciled in Jabung Candi Village, Paiton District, Probolinggo Regency. The main criterion for selecting subjects is active farmers who understand all stages of rice farming activities from seed preparation to post-harvest. The implementation of this research procedure begins with the pre-field stage in the form of instrument preparation, the field work stage for ethnomathematical data collection, to the post-field stage that focuses on data analysis and the development of learning evaluation instruments.

In the implementation of this qualitative research, the researcher acts as the main instrument (human instrument) to plan, collect, and analyze data regarding ethnomathematics on rice farmers' activities. The supporting materials and instruments used include observation guidelines, semistructured interview guidelines, voice recording devices, and scientific documentation tools (Sari, 2013). Data collection was carried out through direct semistructured interviews with farmers to find problems openly and explore opinions and ideas flexibly (Wardhana, 2023). This technique is combined with a documentation method in the form of indirect data through documents (Aulia & Rista, 2019), which in this study is in the form of photos of the stages of farming activities (soaking / seed selection, plowing of rice fields, planting, maintenance, and harvesting), land conditions, agricultural tools, and farm business analysis records as supporting data. Before being used in the field, the observation and interview guideline instruments are first tested for content validity through expert judgment. The percentage of validity value is calculated by dividing the score obtained by the maximum score, where the instrument is declared suitable for use if it meets the minimum criteria of "Quite Valid" (score 61%–80%) or "Valid" (score 81%–100%) based on the criteria of the instrument's validity level (Arikunto, 2012 in Yahya, 2020).

The data analysis techniques used in the field follow the Miles and Huberman interactive analysis model which is carried out continuously until the data reaches saturation. The data analysis stage begins with data reduction through the process of summarizing and selecting important data, and focusing attention on relevant information (M. Fadli, 2021). This reduction step is carried out by listening carefully to the results of voice recordings, summarizing transcripts, and applying capital letter coding to distinguish researchers (P) and informants in order (I1, I2, and I3). The data that has been reduced then enters the data display stage which is presented in the form of a systematic narrative text description to facilitate understanding of the phenomenon that occurs. In the final stage, conclusions are drawn and verified to provide a clear meaning of the ethnomathematical concepts found (activities of counting, measuring, patterns, and comparisons). The results of these conclusions were used as the basis for compiling an instrument in the form of a Test Question Package based on the agricultural activities of the Paiton community. The test package created was then validated by two mathematics lecturers and its validity level was analyzed using the same analysis formula as the instrument analysis before being implemented into the context of mathematics learning.

3. RESULTS AND DISCUSSION

The research on the identification of mathematical concepts in the rice farming activities of the Paiton community, Probolinggo Regency aims to describe the mathematical concepts that emerge in various stages of agriculture. Data collection was carried out in Jabung Candi Village, Paiton District, Probolinggo Regency from July 06, 2026 to July 08, 2026 through semi-structured interviews with three rice farmers as research subjects.

Table 2 shows a list of the subjects of the research involved, where the identity of the subjects was disguised using a code to maintain the confidentiality of the informant.

Table 2. List of Research Subjects.

Yes	Subject Name	Subject Code
1	Edi Sugiantoro	S1
2	Edi	S2
3	Herul	S3

The subject's real identity is disguised at the request of the informant.

The data obtained from the results of interviews and documentation in the field are then analyzed through three main stages, namely data reduction, data presentation, and conclusion drawn.

Soaking and Seed Selection

Based on the results of interviews regarding the determination of seed needs, information was obtained that all informants determined the initial seed quantity by considering the area of land to be planted.

- **Informant 1 (S1):** Determine the need for seeds based on quality standards with high growth power (97–99%), where for 1 hectare of land it ranges from 40–45 kg. If the land area changes, the need for seeds is calculated proportionally.
- **Informant 2 (S2):** Emphasis on the selection of superior seeds before soaking for 1 day and 1 night. For a plot of 400 m², the required seeds are about 15 kg pure without defects.
- **Informant 3 (S3):** Explained that for a land area of about 200 m², a maximum of 10 kg of seedlings soaked in water for 2 days and 2 nights is needed to bloat and grow quickly. The feasibility of the seeds after soaking is identified through physical indicators: the seeds that contain and are of good quality will sink, while the empty or damaged seeds (kopong) will float. After this selection process, the three informants agreed not to reweigh because the quantity was considered sufficient and the remaining seedlings could be flexibly arranged at the time of planting in the field.

Ploughing Rice Fields

The land cultivation process through ploughing activities starts from the water source area (upstream) to the disposal area (downstream). This is done so that water can flow well and the soil becomes looser, making it easier for the tractor to run.

Regarding the influence of the geometry of the rice field shape, S1 and S3 stated that the shape of the map did not affect the ploughing pattern because the main focus was still following the direction of the water flow. However, S2 added that regional topography (such as the difference between lowlands in Paiton and highlands/mountains) greatly affects the speed of tillage and the stability of water management. In the process of plowing, the trajectory of the tractor formed in the field follows certain rules of regularity. The three informants explained that the tractor moved in a consistent circle from the edge of the rice field map gradually to the midpoint. This circular circular trajectory pattern that narrows down to this center visually resembles the shape of a burning mosquito repellent.

Rice Cultivation

- At the planting stage, farmers use an aid in the form of a slap rope or raffia rope that has been marked with a certain distance size marker to maintain the regularity of the row. S1 implements the Legowo Row system (e.g. 2:1, 4:1, or 6:1 row pattern) with a size specification of 15 cm to the back, 20 cm to the sides, and provides a 30 cm wide empty passage as a maintenance road.
- S2 and S3 use planting spacing ranging from 20 cm to 30 cm to the side and back, and provide a 2.5 meter wide wind circulation passage/treatment road every few row blocks.

The purpose of this regular planting distance arrangement is to facilitate air circulation (oxygen), maximize the intensity of sunlight for the photosynthesis process, increase the number of rice seedlings, and facilitate the continuous maintenance process (fertilization and pest spraying). The total need for seeds at this stage is again adjusted to the land area and the planting system chosen, where the legowo row system generally requires an additional seed of about 5 kg more per hectare than the usual conventional system.

Plant Maintenance

Plant maintenance activities include fertilization, pesticide spraying, and irrigation management (water distribution). In fertilization activities, farmers use a certain dosage composition. S1 uses a global comparison for 1 hectare of land, namely 1 ton of organic fertilizer, 2.5 quintals of urea fertilizer, and 1.5 quintals of Phonska fertilizer. S2 details the use of fertilizers based on the growing phase: using *buradan* at the beginning, followed by Phonska 1.5 quintals at the age of 15 days for a 400 m² land, as well as a mixture of 25 kg of urea and 50 kg of ZA in the vegetative-generative phase. S3 uses a combination of 12 kg of urea and 13 kg of Phonska during the early growth period.

In spraying activities, the determination of pesticide dosage is directly proportional to the severity of pest attacks in the field. For a mild attack intensity, farmers use a minimum dose of about 5 ml of pesticide dissolved in 20 liters of water (capacity of 1 spray tank). If the pest attack is already in the severe category, the dose is increased to 10 ml per 20 liters of water. In addition, S1 also uses a standard dose of 50 grams of pesticides per 20-liter tank for the working capacity of 10 rice fields.

For water distribution, arrangements are not made continuously but based on the critical phases of the plant, such as at the beginning of planting, during fertilization, and the period of pregnant rice. The height of standing water in rice fields is conventionally stable in the range of 3–5 cm from the soil surface (or about 5 cm from the bed based on the S3 description) so that the roots of the plant can adapt well without decay.

Harvest is a phase of economic evaluation of the entire series of rice cultivation. Harvest production in the field is generally expressed in standard weight units such as kilograms (kg) for independent consumption/harvesting, as well as quintals or tons if sold to the slashing party (slashing system). All informants calculated production costs which included expenses from the hatchery phase, plowing (tractor rental costs per hectare around IDR 2,700,000), fertilization, purchase of pesticides, and labor wages. Financial evaluation to determine the value of profit (profit) or loss is calculated linearly by looking for the value of the difference between the total income from the sale of the harvest and the total operational costs that have been incurred.

Formatting Mathematical Components

In the calculation of seed selection and analysis of farming, there is a simple mathematical modeling applied by farmers. This is an example of an equation of the quantity of remaining plantable seeds derived from the soaking selection activity:

Blayak =B initial − Bdefect,

(1) Text that follows the equation doesn't need to be a new paragraph. Please punctuate the equation like plain text. Based on Equation (1), if a farmer prepares the initial seeds

(Bawal) of 25 kg and after soaking there are 3 kg of floating kopong defective seeds (Bcacat), then the remaining sunken seeds that are suitable for sowing (Blayak) are 22 kg.

Likewise, in the financial calculation of social arithmetic at the harvest stage, the determination of the net profit of farming can be noted through the following equation:

L = Hsell − Bproduction,

(2) where L represents net profit/profit, Hsell represents the total selling price of the crop, and Bproduction represents the accumulation of all operational production costs. As a concrete example in the field, S1 recorded a total revenue from the sale of slashing of Rp33,500,000.00 with total operational expenses accumulated in the general ledger of Rp7,192,000.00. Based on the formula in Equation (2), the result of the deduction resulted in a net profit value of IDR 26,308,000.00.

This discussion section highlights how research findings in the field relate to initial questions, provide scientific interpretations of the data, and examine their consistency with previous research and universal ethnomathematical theories.

Discussion

Relevance of Findings to Initial Research Objectives

This research successfully answers the main questions described in the Introduction section regarding the existence and application of mathematical concepts in the paiton community's rice farming activities. Based on the data collected, there are four domains of formal mathematical concepts that are intuitively practiced by farmers, namely: counting operations (addition and subtraction) of integers, concepts of geometry (position, orientation of space, angles, and spiral shapes), comparison (composition ratios), and concepts of social arithmetic (scale of units of weight, cost of production, profit, and loss). This phenomenon confirms the initial argument that the agricultural environment of rice fields in Paiton District is a real forum rich in realistic mathematical contexts.

Scientific Interpretation of Findings of Agricultural Activities

Soaking Stage and Seed Selection

The application of addition and subtraction operations arises from the need for the logistics of arranging seeds so that they are proportional to the land area. The dependence of seed numbers on land area contains the idea of implicit linear functions that are intuitively calculated by farmers for the efficiency of initial capital costs.

the stage of ploughing rice fields; The pattern of the tractor's trajectory that is circular from the edge to the center forms a visual representation of the spiral curve. Farmers choose this pattern not without scientific reasons; Mechanically, the concentric spiral pattern minimizes the frequency of the tractor making sharp turns (turning) at the corner of the map, thus saving fuel consumption and making the ground loosening time effective.

Cultivation Stage; The use of distance marker ropes forms the spatial regularity of flat plane geometry. The Legowo Row planting pattern (2:1, 4:1, 6:1) is a real application of the mathematical number and row pattern. Biologically and geometrically, the 30 cm thick empty aisle is designed to manipulate the border effect so that the entire rice row gets optimal sunlight penetration and air circulation for photosynthesis.

Maintenance and Harvest Stages; The determination of the dose of pesticides (5 ml or 10 ml per 20 liters of water) indicates an understanding of the ratio or comparison of values that depend on the variable severity of the disease. Meanwhile, the analysis of farming at the harvest stage implements the basic structure of social arithmetic economics regarding the function of operational profit and loss to evaluate the financial success of farming businesses.

Consistency and Comparison with Previous Research

The findings in this study are in line with the ethnomathematical theory of Alan J. Bishop (1988) which states that mathematics is a universal cultural activity that includes six fundamental activities. Counting activities appear at the seed selection and harvest stages; Location

(determining position) and *designing* appear in determining the direction of spiral plowing and designing the planting distance of the legowo row; while *measuring* is clearly seen in the application of fertilizers, pesticide doses, and height restrictions on paddy fields.

When compared to previous studies, the results of this study expand the scope of the existing findings: as revealed by Aulia & Rista (2019), which identified the general activity of counting and measuring in rice farmers. This research is consistent with these findings, but provides a new contribution in the form of identification of the concept of spatial geometry of the trajectory of the plow and visualization of number patterns in the Jajar Legowo system specific to the Paiton community. Hafis & Busrah (2023) focus on the static geometric aspects contained in artifacts of traditional agricultural tools of the Bugis Tribe. The difference is that this research in Paiton examines ethnomathematics on dynamic aspects, namely a series of physical actions or activities of farmers directly in the rice fields from upstream to downstream of the production process. Yuliani (2022) explores the concept of geometry in Ludruk performing arts, while this research complements the cultural treasures from the perspective of agrarian culture (peasant society).

Overall, these findings prove the strong relevance between formal school mathematics and practical mathematics of agrarian culture. The practical implication of this finding is that the data from this identification can be validly integrated by mathematics teachers in the Paiton area to develop realistic mathematics learning tools based on local wisdom. Future research directions are suggested to develop digital learning media (such as *e-lkpd*) that utilizes the context of Paiton rice farming concretely in the classroom.

4. CONCLUSION

Based on the analysis of field data, the rice farming activities of the Paiton community, Probolinggo Regency validly integrate formal mathematical concepts into traditional agricultural practices. This study concludes that the concept of mathematics is not only limited to social arithmetic calculation operations and linear comparisons in determining fertilizer doses, pesticide doses, and the calculation of financial profit and loss of farming businesses. More than that, complex and efficient spatial geometry manifestations were found, such as the application of a dynamic spiral curve structure to the trajectory pattern of a rice field ploughing tractor for fuel efficiency, as well as the use of row lines of plane geometry number patterns in the Legowo Row planting system to optimize air circulation and solar radiation in rice plants.

The next research is suggested to move from the identification stage (exploration) to the stage of development (developmental research), namely converting the agricultural ethnomathematics activity of Paiton into the form of teaching modules, electronic-based student worksheets (LKPD), or contextual assessment instruments for students in secondary school. Currently, further research is underway focusing on the design of a draft *e-LKPD* mathematics based on the local wisdom of Probolinggo agriculture to test the effectiveness of its application in improving the numeracy literacy skills of students in rural areas.

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