

ETHNOMATHEMATICS: AN EXPLORATION OF FISHERMEN'S MATHEMATICAL ACTIVITIES

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ABSTRACT

The fishing activities carried out by traditional fishermen involve various mathematical concepts that develop contextually through daily cultural practices. However, these mathematical concepts are often not optimally integrated into formal education, leading to mathematics being viewed as abstract and disconnected from real-life situations. This study aims to describe and analyze the mathematical concepts applied by fishermen in their fishing activities. This study employs a qualitative method with an ethnographic approach. The research participants are fishermen at Pamayangsari Beach, Cipatujah Subdistrict, Tasikmalaya Regency, selected through purposive sampling based on their experience and knowledge in fishing activities. Data were collected through observation, semi-structured interviews, and documentation, with the researcher serving as the primary instrument, supported by interview guidelines, observation checklists, and documentation guidelines. Data analysis utilized the Miles and Huberman interactive model, which includes data reduction, data presentation, and drawing conclusions. The research findings revealed several mathematical activities performed by the fishermen, namely counting, measuring, locating, and explaining. Counting activities were observed in calculating fuel requirements and distributing the catch. Measuring activities were found in measuring sea depth, determining mesh size, boat cargo capacity, and estimating tides. Locating activities were evident in determining the direction and position of nets using natural landmarks, while explaining activities were reflected in the fishermen's ability to describe the fishing process in a sequential and logical manner. The research findings indicate that mathematical concepts develop contextually within the cultural practices of fishermen and have the potential to support mathematics learning based on local culture.

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1. INTRODUCTION

Mathematics, in essence, is not merely understood as an abstract discipline formally studied in school, but is also present and evolving within society through various cultural activities (Rosa & Gavarrete, 2017). Every community has its own way of understanding, using, and applying mathematical concepts in accordance with the needs of daily life and its socio-cultural environment (Rosa & Orey, 2011). This perspective gave rise to the field of ethnomathematics, which is the study of the relationship between mathematics and culture in people's lives (Rosa & Gavarrete, 2017).

Ethnomathematics offers the perspective that mathematics is not universal or context-free, but rather rooted in human activities that take shape within specific social and cultural environments (Rosa & Gavarrete, 2017) explains that ethnomathematics is a form of mathematics practiced by specific cultural groups in their daily activities, such as counting, measuring, determining locations, designing, and explaining phenomena that develop naturally through the lived experiences of communities. Bishop (1988) reinforces this by identifying six universal basic mathematical activities: counting, measuring, designing, explaining, pattern recognition, and locating. These six activities are clearly found in the lives of traditional communities, including fishing communities along the Indonesian coast (Nursyahidah et al., 2020).

One community whose cultural activities are closely linked to mathematics is the fishing community (Herrera Jr. & Palomo, 2022). Fisherpeople are coastal communities whose livelihoods depend on fishing activities at sea (Sudirman et al., 2024). In carrying out their activities, fishermen rely not only on physical strength and experience but also on various forms of local knowledge related to mathematical concepts (Kurniawan et al., 2023). This knowledge emerges contextually through their interactions with the marine environment and is passed down from generation to generation (Kusaeri et al., 2025).

Various previous studies have shown that the activities of fishing communities contain rich mathematical elements that are relevant to mathematics education. A study by Nursyahidah et al. (2020) found that fishermen in Demak and Kendal use geometric concepts and measurements in their navigation and the deployment of fishing nets. Herrera Jr. & Palomo (2022) also explain that coastal communities in the Philippines use various mathematical strategies to determine sailing directions and measurements based on local experience. Feinberg (2022) documented that traditional navigators in Vaeakau-Taumako used knowledge of ocean swells and wave patterns to guide inter-island navigation without relying on modern navigational instruments. Sousa et al. (2015) found that fishing communities in Portugal possess strong proportional reasoning in shipbuilding and fishing activities. Albanese et al. (2017) demonstrated that Polynesian paddlers possess exceptional proportional and spatial understanding in navigation.

In Indonesia, research on fishermen's ethnomathematics is also growing. Sudirman et al. (2024) revealed that ethnomathematical practices in fish auctions in Indramayu involve the application of social arithmetic, set theory, and basic statistics. Kusaeri et al. (2025) found that the Lungkak community's tidal calendar in East Lombok incorporates mathematical reasoning such as trigonometry, arithmetic sequences, and modular arithmetic. Kurniawan et al. (2023) confirmed that traditional navigational knowledge has a significant influence on the operational success of fishermen in Bengkulu. Dodi et al. (2026) explored the mathematical activities of coastal communities in West Kalimantan, which include traditional measurement systems and geometry in boat building.

Nevertheless, previous studies have generally focused only on identifying mathematical concepts in fishing activities and have not systematically examined fishermen's mathematical activities using Alan J. Bishop's framework of mathematical

activities, which consists of counting, measuring, locating, designing, playing, and explaining. Bishop's framework is considered relevant in ethnomathematics research because it provides a comprehensive perspective for identifying mathematical practices embedded in cultural activities, not merely the final mathematical concepts produced. Compared to general mathematical concept identification, this framework enables researchers to analyze how mathematical thinking develops through daily cultural practices and social interactions within a community (Bishop, 1988; Rosa & Orey, 2011). Previous studies have also rarely explored how these cultural activities shape the mathematical thinking of fishing communities from both emic and etic perspectives. In addition, research on fishermen's mathematical activities in the coastal area of Pamayangsari is still very limited. Therefore, this study offers a novel approach by exploring fishermen's mathematical activities from an ethnomathematics perspective using Bishop's framework of mathematical activities, supported by emic and etic analyses to reveal the cultural meaning and mathematical understanding embedded in fishermen's daily activities.

Therefore, this study aims to describe and analyze the mathematical activities of fishermen and identify the mathematical concepts they use in the fishing process. The results of this study are expected to contribute to the development of ethnomathematics research, the preservation of local cultural knowledge, and serve as a source for more contextual and meaningful culture-based mathematics education (Rosa & Orey, 2011).

2. METHOD

This study employs a qualitative research method using an ethnographic approach. The ethnographic approach was used to understand the cultural practices of fishing communities related to the application of mathematical concepts in daily life. Data were collected through triangulation of methods, including observation, interviews, and documentation (Sugiyono, 2022). The researcher serves as the primary human instrument responsible for determining the research focus, selecting informants, collecting data, and interpreting findings (Miles et al., 2013). Supporting instruments in this study include interview guidelines, observation sheets, and documentation guidelines. The interview guidelines were developed based on Alan J. Bishop's framework of mathematical activities, which consists of counting, measuring, locating, designing, playing, and explaining. This framework was used to systematically explore and identify the mathematical activities embedded in fishermen's cultural practices and daily activities. The research procedures are illustrated in Figure 1. Research Procedure.

Based on Figure 1. Research Procedure, the research began with a preliminary study involving a literature review and initial observations to gain an understanding of the fishermen's mathematical activities during the fishing process. The results of the preliminary study were used to identify the central phenomenon, research objectives, and research questions as the basis for data collection. Subsequently, the researcher developed a semi-structured interview guide to gather in-depth information regarding the fishermen's mathematical activities. The next stage was a field study conducted through observation, interviews, and documentation. The data obtained were then reduced, transcribed, and analyzed qualitatively based on an ethnomathematics framework to identify mathematical activities and mathematical concepts contained in the fishermen's activities. The final stage of the research involved drawing conclusions as answers to the research questions based on the results of the data analysis.

Data analysis in this study followed the interactive model proposed by (Miles et al., 2013) which consists of data condensation, data display, and conclusion drawing and

verification. The data condensation stage was carried out through the processes of transcription, data selection, open coding, categorization, and theme identification based on

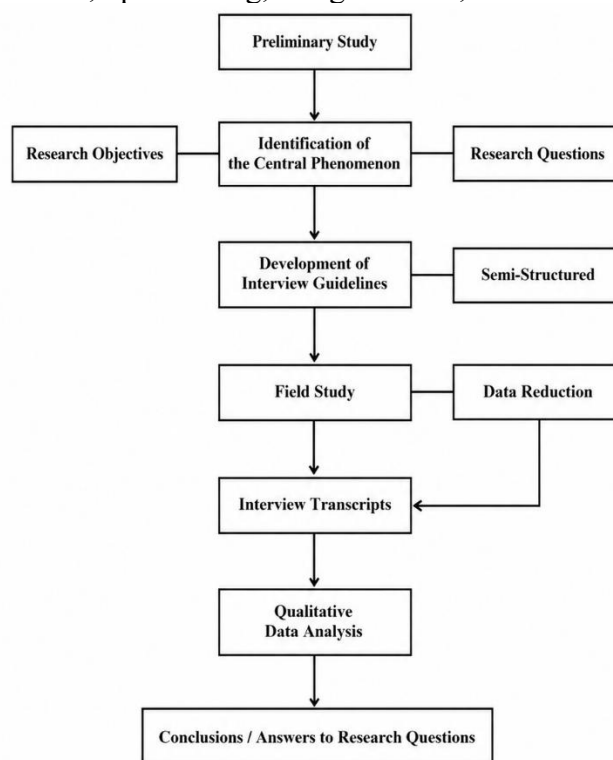


Figure 1. Research Procedure

Alan J. Bishop's six mathematical activities, namely counting, measuring, locating, designing, playing, and explaining. Furthermore, the data were presented in the form of descriptive narratives to facilitate the interpretation of the findings regarding fishermen's mathematical activities. The validity of the data was ensured through triangulation techniques by comparing the results of observations, interviews, and documentation in order to obtain valid and consistent findings.

This study was conducted at Pamayangsari Beach, Cipatujah Subdistrict, Tasikmalaya Regency, West Java. The research participants consisted of four traditional fishermen selected purposively based on several criteria, namely: (1) having more than 20 years of seafaring experience, (2) being directly involved in fishing activities from preparation to catch distribution, (3) using traditional fishing gear, (4) possessing knowledge of marine navigation and determining fishing locations, and (5) understanding the cultural practices and traditions of the fishing community in Pamayangsari.

3. RESULTS AND DISCUSSION

3.1. Results

This study identifies mathematical activities found in fishermen's work based on Bishop's (1988) six categories of mathematical activities: counting, measuring, locating, designing, playing, and explaining. The results show that four mathematical activities dominate fishermen's work: counting, measuring, locating, and explaining. These findings indicate that fishermen's activities incorporate mathematical concepts that develop contextually through cultural practices and the empirical experiences of coastal communities. In the process of determining when to go out to sea, measuring fishing gear,

determining the direction of the voyage, and dividing the catch, fishermen indirectly apply concepts of arithmetic operations, measurement, spatial reasoning, comparison, and logical reasoning. The following are mathematical activities found in fishermen's daily routines.

Table 1 Mathematics Activities in Fishermen's Daily Lives

Types of Mathematical Activities	Fishermen's Activities
Counting	1. Calculating fuel requirements 2. Dividing the catch
Measuring	1. Measuring ocean depth 2. Measuring mesh size 3. Measuring boat capacity 4. Determining when to go out to sea based on the tides
Designing	Not found
Locating	Determining the position of the net
Playing	Not Found
Explaining	Fishermen can explain the entire fishing process

Fishermen calculate their fuel requirements based on the travel distance and the duration of fishing activities at sea. On average, they need approximately 20 liters of fuel per day. Fishermen have two fuel purchasing options: a mini gas station located near the beach that sells fuel at Rp12.000 per liter and a full-service gas station that offers fuel at Rp10.000 per liter. However, the full-service gas station is located 9.1 km from Pamayangsari Beach and requires an additional transportation cost of around Rp10.000 for a round-t.

The total cost of purchasing fuel at the gas station is Rp210.000, while at the mini gas station it reaches Rp240.000. The difference is Rp30.000 per day, or approximately Rp720.000 per month if fuel is purchased 24 times. In practice, fishermen still tend to choose the mini gas station because it offers credit purchase facilities that can be paid after the catch is sold. Purchases at the gas station must be made in cash.

Counting activities were also identified in the catch-sharing system used by fishermen to distribute the fishing catch among boat owners, crew members, and porters. Fishermen apply two different profit-sharing schemes.

1. **Scheme A:** 10% of the catch is deducted to cover the porters' fees. The remaining catch is divided so that the crew receives 20% (which equals approximately 18% of the total catch).
2. **Scheme B:** No initial deduction for porters. The crew receives 30% of the catch and directly covers the porters' wages of Rp50,000.

The break-even point for both schemes is modeled as:

$$(0.3 - 0.18)H = 50,000$$

The calculated break-even point occurs at a catch value of approximately Rp416,667. In practice, fishermen tend to choose Scheme B during seasons of abundant fish and Scheme A during lean seasons. Based on field experience, fishermen estimate the break-even point to be around Rp400,000.

Measuring activities were identified when fishermen determined sea depth using a weighted rope measured in a non-standard unit called "depa." Although the length of a depa

varies among individuals, fishermen generally agreed that 1 depa is equivalent to 1.5 meters based on the average arm span measurements, which range from 1.45 to 1.55 meters. The relationship between the rope length and sea depth is modeled as follows:

$$D = d + \frac{1}{2}d$$

where D is sea depth and d is rope length in depa.

Measuring activities were also identified when fishermen determined net mesh size using inches as a unit of measurement. Based on their experience, fishermen estimated that the maximum length of a fish that can escape through the net is approximately four times the mesh size used.

$$P = 4M$$

where P = fish length, M = mesh size. For example, a 1-inch mesh is used for small fish, and a 10-inch mesh for large fish. Fishermen estimated that a 50 cm fish requires a mesh size of approximately 5 inches. Researchers' calculation gave 4.9 inches.

Measuring activities were also identified when fishermen determined a boat's safe load limit by observing the freeboard, which is the vertical distance between the gunwale and the water surface. Fishermen used a non-standard unit of measurement in the form of a fist, with a general safe limit of approximately 8 – 10 cm. Based on field findings, an empty boat had a freeboard of about 40 cm, while a boat carrying a maximum load of 200 kg had a remaining freeboard of approximately 8 cm. The relationship between load and freeboard is modeled as follows:

$$h = 40 - 0,16W$$

where h = remaining freeboard, W = cargo weight. In moderate waves, fishermen use a limit of approximately 12 cm with an estimated cargo weight of 170 – 180 kg. In rough seas, the safe limit is increased to about 16 cm, reducing cargo weight to approximately 145 – 150 kg. Researchers' calculations yielded values close to the fishermen's estimates.

Measuring activities were also identified when fishermen estimated low tide using the moon's position as a natural indicator. Fishermen followed a practical rule stating that for every 10° decrease in the moon's position, low tide was expected to occur approximately one hour later. For example, when the moon was directly overhead at an angle of about 90° , fishermen estimated that low tide would occur one hour later, whereas when the moon's position was around 70° , low tide was estimated to occur approximately three hours later.

Locating activities were also identified when fishermen determined the position of fishing nets using fixed landmarks on land, such as towers and trees. Fishermen aligned the visual positions of these landmarks to relocate the nets at sea. Based on the observed positions, the two land-based objects and the net's location formed a triangular plane used as a reference for positioning the nets.

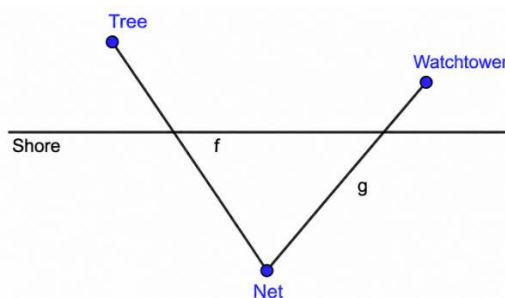


Figure 2 Visualization of Net Positioning

Explaining activities were identified in fishermen's ability to describe the sequential stages of fishing activities, the functions of fishing gear, and the cause-and-effect

relationships that occur during the fishing process. Fishermen were able to explain how to locate fish, interpret natural signs such as waves and the moon's position, and determine the appropriate time and direction for going out to sea.

3.2. Discussion

This study reveals that fishermen on Pamayangsari Beach naturally apply mathematical concepts in their fishing activities, even without formal symbols or formulas. This finding reinforces Rosa & Gavarrete (2017) view that mathematics is a cultural product born from human activities. Bishop (1988) identified six universal mathematical activities (counting, measuring, locating, designing, playing, explaining), and this study found four dominant activities (counting, measuring, locating, explaining), while designing and playing were not identified.

Counting activities are reflected in the calculation of fuel needs and the distribution of the catch. Although arithmetically speaking, buying at a gas station is cheaper (Rp210,000/day) than at a mini-gas station (Rp240,000/day), fishermen still choose the mini-gas station because of the credit facility. This decision demonstrates the application of the concepts of opportunity cost and liquidity constraint in microeconomics. In the profit-sharing system, fishermen use two schemes with break-even analysis: mathematically, the break-even point is at Rp416,667, while the fishermen's estimate is Rp400,000 based on experience. This closeness indicates an intuitive internalization of the break-even concept. This finding aligns with the research by Sudirman et al. (2024) in the Indramayu fishing community, which revealed that ethnomathematical practices in fish buying and selling transactions incorporate concepts such as set theory, basic statistics, social arithmetic, and arithmetic operations.

Measuring activities are found in the measurement of sea depth, mesh size, safe load limits, and tidal predictions. Fishermen use the non-standard unit "depa," which has been standardized to 1.5 meters based on the average collective arm span (1.48–1.52 m), demonstrating the application of basic statistics (mean). The proportional rule $P = 4M$ for the relationship between mesh size and fish length aligns with the findings of Sousa et al. (2015) regarding the proportional reasoning of Portuguese fishermen. The linear relationship $h = 40 - 0.16W$ for freeboard, as well as the simple linear rule "for every 10° decrease in the moon's phase, ebb tide duration increases by 1 hour," indicates a preference for models that are easy to remember and reliable, rather than absolute precision. These findings reinforce the research by Kusaeri et al. (2025) on the Lungkak community's tidal calendar, which revealed the presence of mathematical reasoning such as trigonometry, arithmetic sequences, and modular arithmetic.

Locating activities are evident in navigation practices that utilize sea waves (the perpendicular relationship $l_1 \perp l_2$), the eastern star (Cartesian coordinate system), and triangulation using two landmarks on land (triangle $\triangle APB$). These findings are consistent with the study of Nursyahidah et al. (2020), which highlighted the spatial abilities of fishermen in the Demak–Kendal region. Similarly, Albanese et al. (2017) reported that Polynesian seafaring communities possess strong proportional and spatial understanding that supports their navigation practices.

Explaining activities are reflected in fishermen's ability to describe the stages of fishing in a coherent, logical, and causal manner, demonstrating systematic reasoning. According to Albanese et al. (2017), ethnomathematics emphasizes that mathematical knowledge is closely related to cultural contexts, including the ways communities think, explain, and solve problems in everyday activities.

A comparison with previous research shows that this study expands upon the findings of Herrera & Palomo (2022) by placing greater emphasis on the dynamic process of decision-making, rather than merely identifying concepts in cultural products. This study also contributes by systematically applying Bishop's framework to classify fishermen's mathematical activities (Rosa & Orey, 2013). A unique aspect of this study is the existence of a collective standardization of the "depa" unit (based on an average), in contrast to the findings of Sousa et al. (2015), which still maintained individual variations.

Overall, fishermen's activities involve mathematical reasoning such as economic optimization, proportions, linearity, and spatial geometry (Rosa & Orey, 2011). This has the potential to serve as a source of contextual mathematics learning (Rosa & Orey, 2013), helping students understand mathematics as part of life and local wisdom (Rosa & Gavarrete, 2017).

4. CONCLUSION

Based on the research findings and discussion, it can be concluded that fishing activities among the fishing community at Pamayangsari Beach involve various mathematical activities that develop contextually within daily cultural practices. The mathematical activities identified include counting, measuring, locating, and explaining, as outlined in Alan Bishop's framework of fundamental mathematical activities. Counting activities are evident in the process of calculating fuel needs, comparing gasoline prices, and dividing the catch, which demonstrates the application of concepts such as arithmetic operations, percentages, and economic optimization. Measuring activities are evident in measuring sea depth, mesh size, safe boat cargo capacity, and determining tide times, which demonstrate the application of concepts such as measurement, estimation, and quantitative relationships. Locating activities emerge in determining direction and position using land features, demonstrating the application of concepts of geometry, spatial orientation, and coordinate systems. Meanwhile, explaining activities are evident through the fishermen's ability to describe the fishing process in a coherent and logical manner based on marine environmental conditions and seafaring experience.

The findings of this study confirm that mathematical concepts in fishing culture do not exist in formal forms such as mathematical symbols or formulas, but are integrated into actions, strategies, experiences, and decision-making processes that develop naturally in the lives of coastal communities. Thus, the cultural activities of fishermen can be understood as a form of ethnomathematics, demonstrating that mathematics evolves through human interaction with the environment and the demands of daily life. Furthermore, the results of this study indicate that fishing culture has the potential to serve as a source of context-based, ethnomathematics-driven mathematics learning, as the mathematical concepts that emerge are directly linked to the community's real-world experiences.

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