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Ethnomathematical Insights: A Thematic Analysis of Geometrical Concepts in Daily Lives of Fishermen Community

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Abstract: This study examines the embedded geometrical concepts in the traditional fishing practices of inland fishermen in West Bengal, India. Despite having no formal training in mathematics, fishermen use advanced geometric ideas in their daily work. Using the ethnographic case study design, this study employed reflexive thematic analysis of in-depth interviews with 13 experienced fishermen, the research identifies three main subthemes related to geometric concepts aligned with the Indian educational levels: primary, high school, and college & universities. The findings show that various geometric ideas, usually taught in formal education, such as length, area, 2D and 3D shapes, vectors, coordinate systems, topological structures, and geometric optimization, are used intuitively in net-making, fish catching, and spatial navigation. These findings indicate that mathematical concepts are naturally ingrained in culturally established practices. The study emphasizes the importance of incorporating ethno-mathematical perspectives into geometry teaching to make mathematics education more relevant.

Keywords: Ethnomathematics, Geometry, Fishermen, Thematic Analysis, Indigenous Knowledge, Mathematics Education.

1. Introduction

1.1 Global Challenges of Mathematics Education

One of the highest priorities for governments worldwide is raising the quality of mathematics education in schools (Goos, 2025). Learning mathematics improves one's capacity to apply numbers, solve problems, reason, comprehend abstract visual information, and evaluate cause-and-effect connections, among other skills (Dockendorff & Zaccarelli, 2025). Unfortunately, conceptual comprehension is pushed down to second place in mathematics education due to the widespread use of rote techniques like memorisation of formulae, repeating processes, and completing algorithms (O'Meara *et al.*, 2017). Over time, the issue of students' poor mathematics ability has spread beyond certain nations to become a worldwide problem. The ASER (2024) reports that only 50% of Indian students in grades 11 and 12 (16–18 years old) were able to divide a three-digit number by a single-digit number in 2023. Globally, the data is also not so satisfying. The 2022 National Assessment of Educational Progress (NAEP, 2022) reveals that in the USA, 40% of eighth-grade students achieved below basic competency in mathematics. School-based mathematics curriculum should provide students with the knowledge and abilities they need for everyday life as well as for studying more complex arithmetic that is necessary for success in higher education. However, formal education too often falls short of achieving such goals (Banerjee *et al.*, 2025).

1.2 Bridging Epistemological Understanding with Practice: The Role of Real-World Context

Klanderma *et al.* (2019) argued that teachers should keep seeking real-world applications in the learning activities they provide for students since these linkages are a big source of motivation for students at all levels of school. Freire (1978) asserts that this is especially true when students are encouraged to address the issues that most directly impact them and their communities. One of the main issues in mathematics education is the connection between theory and application. Sometimes it might be difficult to make the right choice and figure out how to



manage both of these groups (Fiorentino & Favilli, 2007). Numerous studies also evidence this; for example, research by Banerjee *et al.* (2025) shows that children who work in markets might be expected to more easily learn abstract maths, but just as students who master abstract maths may struggle to apply it to real-life problems

Despite our culture being mostly governed by mathematics-driven technology, many often associate mathematics only with academic mathematics. Early in their schooling, the majority of pupils develop a tendency to dislike for maths or believe they are not capable of "doing" maths as the standard academic method defines it. Instead of encouraging fear and disdain, maths education can promote a deeper understanding of how mathematics is used in our increasingly technologically advanced society (Brandt & Chernoff, 2014). Teaching mathematics is a demanding endeavour that is made even more difficult in multicultural classrooms due to the many linkages between these components. In recent years, educators have been forced to change their instructional practices and reevaluate the goals and structure of their curricula (Favilli & Tintori, 2007). Students who disengage from mathematics frequently discontinue their studies beyond the mandatory years, leading to restricted life and career prospects in sectors that necessitate mathematical proficiency (Baroody *et al.*, 2016). To more accurately reflect the mathematics that students experience in their daily lives, the scope of maths in the classroom must be expanded. One way to achieve this and inspire children to take an interest in mathematics is to include aspects of ethnomathematics, or culturally-based mathematics (Orey & Rosa, 2004). Presmeg (2007, p. 435) argued that mathematics education had "experienced a major revolution in perceptions," so that "mathematics, long considered value- and culture-free, is indeed a cultural product, and hence that the role of culture—with all its complexities and contestations—is an important aspect of mathematics education".

1.3 Ethnomathematics as a Pedagogical Solution

Ubiratan D'Ambrosio, a Brazilian mathematician, is often regarded as "The intellectual father of Ethnomathematics" (Scott, 2012, p. 241). He describes in his paper, "Overall Goals and Objectives in Mathematics Education," how he developed the idea of ethnomathematics in large part because of the panel he organised on "Why Teach Mathematics" at the Third International Congress on Mathematics Education (ICME 3) in Karlsruhe, Germany, in 1976 (D'Ambrosio, 2008, p. 255). In his 1977 lecture to the American Association for the Advancement of Science, he first used the word "ethnomathematics." He presented the idea and examples that resulted in the well-known conceptualisation of ethnomathematics as follows: ethno [culture] + mathema [explaining, understanding] + tics [techné, arts, methods] at ICME 5 in Adelaide, Australia, in 1984. He proposed that

"Ethnomathematics is the mathematics which is practised among identifiable cultural groups such as national-tribe societies, labor groups, children of certain age brackets and professional classes." (D'Ambrosio, 1985, p. 45)

Therefore, even if the application of mathematics may take a distinct form, ethnomathematics may be characterised as the use of mathematics by members of a cultural group who share similar experiences and practices (Cimen, 2014). Each of these many ethnic groups has its own language and approach to learning practical mathematics, and ethnomathematicians study these approaches. Research indicates that ethnomathematics techniques have constructivist implications, enabling learners to use known cultural practices and resources to comprehend taught ideas (Mogari, 2014). Despite the growing popularity of ethnomathematics, Ukpokodu (2011) observed that teachers have not used it in the classroom. Multiple reasons, such as curriculum constraints, teacher training, and the perception of mathematics, may lead to the underutilization of ethnomathematics techniques in mathematics education (Sunzuma & Maharaj, 2019). These variables may originate from the learners, educators, and educational institutions, resulting in a lack of mathematical knowledge about the cultural community.

1.4 Focusing on Geometrical Concepts in Fishing Communities

Within this framework, ethnomathematics provides a powerful method to fill the gap between formal and informal mathematics (Putra, 2018). Ethnomathematics can serve as a pedagogical technique that emphasizes students' backgrounds and their local contexts, integrating them with Eurocentric mathematics in a manner consistent with curricular requirements (Machaba & Dhlamini, 2021). In this connection, this study contributes to examining geometrical practices in fishing communities. Specifically, it investigates how everyday fishing activities,



such as net weaving, knot tying, and boat navigation, embed mathematical concepts that can be interpreted using formal mathematical concepts.

The aim of this study is twofold: firstly, to analyze the geometrical concepts embedded in fishing practices through the perspective of ethnomathematics; secondly, to establish a framework that links these practices to advanced mathematical theories. The study examines and elaborates the hidden geometrical concepts in traditional fishing activity and suggests pedagogical implications for enhancing mathematics education

This research focuses on finding the hidden geometrical concepts in the fishing community.

2. Literature Overview

2.1 Ethnomathematics: Conceptual Foundations

A primary justification for teaching Mathematics is its recognition as a manifestation of human progress, culture, and intellect, underscoring its essential contribution to the cultural legacy of humanity. Bishop (1990) demonstrates how mathematics is used as a tool for cultural imperialism, while Haggerty & Porter (1997) see mathematics as a technology of distance because it widens the gap between informal and formal mathematical knowledge. Social interactions produce ideas, facts, concepts, principles, and talents relevant to mathematical difficulties, as mentioned by Orey (2000). Each cultural group possesses a distinct approach to Mathematics, with connections reflecting a specific cultural system, particularly in their methods of quantifying and utilizing numbers, geometric forms and relationships, as well as measuring or classifying objects within their environment. Consequently, teaching mathematics requires an understanding of the students' daily social and cultural settings (d'Entremont, 2015). D'Ambrosio (1994) characterizes Ethnomathematics as the mathematical practices of cultural groups, including urban and rural communities, labor groups, professional classes, children in groups, indigenous societies, and various other collectives defined by shared objectives and traditions. Rosa & Orey (2020) argued for the value of culturally responsive education ideas from an ethnomathematical perspective. They underlined that the purpose of the ethnomathematics and culturally relevant pedagogy-based approaches to mathematics curriculum is to promote students' involvement with and knowledge of the subject matter. Since a class consists of students from different cultures, and different culture produces different mathematical knowledge (Clivaz & Miyakawa, 2020), it is necessary to explore mathematics from multiple cultural perspectives.

2.2. Ethnomathematics and Geometry

Considering the mathematics curriculum as imbued with values and cultural significance is essential for teaching and studying geometry within a sociocultural framework (Kyeremeh, Kwadwo Awuah, & Orey, 2025). In his study, Gerdes (2011) utilized illustrations from African art, particularly the adornment of handbags, hats, mats, and basket trays in Mozambique, to exemplify the geometric concepts intricately integrated into these decorations, encompassing the area of circles, symmetry, and transformation. The work of ethnomathematics researcher Eglash *et al.* (2006) is partially based on content from West Africa. His computer program, Culturally Situated Design Tool, enables students to independently create and modify traditional cultural patterns. Aboagye (2015) researched the mathematical strategies used by kente weavers and their possible impact on Ghanaian mathematics education. Some participants showed that the 'kente' weaving technique efficiently demonstrates geometric concepts such as rhombuses, trapeziums, and parallelograms. The researchers Sunzuma & Maharaj (2020) used a convergent mixed-methods approach to examine the knowledge level of in-service mathematics teachers in Zimbabwe on the incorporation of geometry in cultural activities and experiences. Wolfers (2020) studied distinct tribes of Papuans and New Guineans. Their study mostly focused on the numerous equipment and procedures used in counting products, people, livestock, etc. Using a 4D development model, Sutarto *et al.* (2022) created an ethnomathematics-based e-module to enhance students' metacognitive skills. The study was done at a West Lombok primary school. Ten grade five and three grade six children were chosen for large-scale experiments. The validity test demonstrated that the ethnomathematics-based e-Module was an effective learning resource. Fauzi *et al.* (2022) observed that the traditional architectural design of the Sasak people has geometric elements that are also seen in mathematics instruction. The architectural composition of the typical Sasak residence includes different aspects, such as an isosceles triangle-shaped side roof and a truncated pyramid-shaped staircase. The goal of Iskandar *et al.* (2022)



was to assess how well student worksheets featuring ethnomathematics-based West Java batik patterns assisted students in resolving their mathematical challenges. A subsequent study by [Malalina et al. \(2022\)](#) examined the use of mathematical principles in nomadic commerce along the Musi River. Their research revealed that mobile trade behaviours on the river unwittingly include several mathematical notions, including solid figures (spherical, cube), planar figures (rectangle), comparisons, social arithmetic, and systems of linear equations. Furthermore, [Angraini & Rakhmawati \(2023\)](#) examined the operations of fish vendors in the Punggulan Village Traditional Market. Their study identified three principal activities: measuring, packaging, and buying and selling, each encompassing mathematical concepts including measurement, sets, one-variable linear equations, weight comparisons, social arithmetic, relations and functions, two-variable linear equations, plane figures, and probability. [Sudirman et al. \(2023\)](#) examined the distinctive calculating techniques used by traditional merchants, emphasising their application of a backward calculation methodology, which differs from the typical methods taught in educational institutions. [Sudirman et al. \(2024\)](#) further examined the concept of mathematics involved in auction-based buying and selling practices in coastal fishing communities. Using Ndebele artefacts, [Motseki et al. \(2025\)](#) explore how to teach basic geometric ideas from an ethnomathematical perspective. Recently, [Kyeremeh, Kwadwo Awuah, & Orey \(2025\)](#) used multiple case studies to investigate the mathematical forms present outside of academic settings that may be included in geometry instruction in Ghanaian college classrooms.

2.3. Strengths, Limitations, and Gaps in Existing Studies

Research of [Kabuye Batiibwe \(2024\)](#) suggests that the most common ethnomathematics research areas are cultural games and weaving, which account for 45.9% and 40.9% of the total ethnomathematical research areas, respectively. Other not-so-popular research areas include cultural dance, buildings, meals, pottery, etc. Most of this research was conducted in Indonesia, and some in the Philippines, ([Kabuye Batiibwe, 2024](#)). According to the report of The State of World Fisheries and Aquaculture 2024, in 2022, around 62 million people participated in the primary sector of fisheries and aquaculture as full-time, part-time, occasional, or undefined workers. There are very few articles on the ethnomathematics aspect of fishing activity.

On the other hand, research shows that one of the subjects that contributes to students' overall poor performance is geometry ([Jones, 2002](#)). Among the causes of subpar performance are inadequate teaching methods, visualization skills, and geometric terminology. Studies of ([Kyeremeh, Kwadwo Awuah, & Clark Orey, 2025](#); [Sunzuma & Maharaj, 2019, 2021, 2022](#)) explored the challenges mathematics teachers face in teaching geometry through an ethnomathematical perspective. Their findings show that one of the challenges is the lack of knowledge of geometrical concepts embedded in different cultures. On the other hand, the research of [Telima \(2011\)](#) shows that most mathematics teachers' knowledge in geometry is poor. Again, due to the increasing number of students from varied ethnic backgrounds in schools, teaching geometry following a particular cultural aspect is often challenging ([Kyeremeh, Kwadwo Awuah, & Clark Orey, 2025](#)).

2.4 Justification for the Present Study

The above discussion reveals a significant research gap in ethnomathematics literature. Studies targeting the fishermen community and exploring geometrical concepts in fishing activity are especially lacking. This lack becomes particularly problematic when viewed in light of the current global challenges in geometry education. Research shows that school geometry does not have the necessary ability to enhance curiosity among students, and most of the time, students struggle to apply geometric concepts in the real world ([Mirna, 2018](#); [Widada et al., 2019](#)). International research indicates that a student-centered pedagogical approach significantly enhances students' comprehension of mathematical topics ([Nurbavliyev et al., 2022](#)). Hence, it is necessary to express school geometry in the local language. However, Different cultures have distinct geometric examples and artifacts that may challenge teachers since they must choose those that benefit all learners without disadvantaging any group ([Rosa & Orey, 2010](#)).

West Bengal ranks as the sixth biggest economy by nominal GDP and is the second largest inland fish-producing state ([Handbook Fisheries Statistics, 2023, Department of Fisheries, Government of India](#)). According to the report of Social Development and Sustainable Fisheries: West Bengal (2023), more than 2 million people are



actively engaged in fishing. They use mathematics to make nets and traps and find their way around the river or pond. On the other hand, a large number of people in West Bengal consume fish in their daily diet (Padiyar *et al.*, 2024). Hence, most students in West Bengal are familiar with the fishing activity. Therefore, exploring hidden geometric concepts and patterns will be beneficial for most of the students from primary to university level. Connecting traditional geometric teaching with the fishing activity is therefore highly relevant. This study fills a gap in the literature by collecting and discussing the mathematical ideas of West Bengal fishermen. This type of research can help make maths lessons more culturally relevant and suggest new ways to teach geometry that are based on real-life situations.

3. Research Question

Based on the research gap, the following research question we want to address in this article:

RQ 1: How do fishermen use geometric concepts in fishing activity?

4. Methodology

4.1. Research design

This study employed the ethnographic case study design to obtain in-depth information on the various geometric concepts embedded in traditional fishing activities. This approach was selected as it provides the necessary framework for an in-depth, contextualized investigation of the geometrical concepts embedded within the cultural practices of a defined community. Ethnographic research is one of the approaches under the roof of qualitative research. According to Reeves *et al.* (2013, p. 1365) "*Ethnography is a type of qualitative research that gathers observations, interviews and documentary data to produce detailed and comprehensive accounts of different social phenomena*". One of the main characteristics of ethnographic research is its focus on an entire culture-sharing group with the goal of developing a complex, complete description of that group's culture. As Coffey (2018) pointed out, ethnographic research is perfectly applicable for those research topics that are concerned with process and practice; this component of this design is essential for understanding the shared patterns of fishing practices and the underlying knowledge of the inland fishermen of Purba Bardhaman.

On the other hand, a case study is an empirical inquiry that is characterized as an approach "*that facilitates exploration of a phenomenon within its context using a variety of data sources.*" (Baxter & Jack, 2015). According to Yin (2017) case study refers to both the process of inquiry and the product of that inquiry. In our research, the case is defined as the "traditional fishing community of Purba Bardhaman district". A case study is appropriate for complex subjects with little existing information, requiring comprehensive examination, or when the research issue is inextricably linked to its setting (Käss *et al.*, 2024).

In essence, ethnographic case studies are case studies "employing ethnographic methods and focused on building arguments about cultural, group, or community formation or examining other sociocultural phenomena" (Schwandt & Gates, 2018, p. 344). An ethnographic case study is perfectly aligned with our study because we want to explore and discover the hidden geometric pattern behind the fishing activity, which requires an in-depth investigation of the cultural context and tacit knowledge systems of this community.

4.2. Participants

A total of 13 fishermen from the Purba Bardhaman district were taken as participants. This sample size is consistent with the principle of data saturation in qualitative research, more specifically, reflexive thematic analysis, as 13 participants were sufficient to reach the point where no new codes or themes were emerging (Braun & Clarke, 2022). To acquire more information, we have set the age range from 30 to 70 years old. We only considered men, as women's participation in fishing is comparatively less in India (Gopal & PS, 2022). The inclusion criteria were: (1) the fisherman has more than 5 years of fishing experience, and (2) Fishing is the primary source of income. These fishermen spend more than 12 hours a day on fishing activities. These fishermen were selected in a way that some have formal training and others have informal training.



4.3. Instrument for data collection

A semi-structured interview schedule served as a tool for data collection. The method was chosen to allow the researcher to gather open-ended information, such as people's thoughts, feelings, and beliefs about a subject, as well as their personal problems (Denzin *et al.*, 2023). This interview schedule is divided into three sections. The first section comprises eight closed-ended questions regarding demographic information. This section was designed to collect information about participants' names, location, educational qualifications, mother tongue, and other relevant details. The second section, containing eight open-ended questions, is about their indigenous practices, including various traditional fishing methods, obsolete techniques, planning, and rituals. The third section comprises twelve open-ended questions, focusing on mathematical concepts embedded in fishing techniques, including daily planning, fishing instruments, fishing spots, boats, and breeding. The researcher initially designed a pre-determined open-ended interview question based on an informal conversation with the fishermen. With this preliminary interview schedule, a pilot study has been conducted with three (3) fishermen who met the study's inclusion criteria. This pilot study aims to check the language appropriateness, question misunderstanding, and the addition of new questions that potentially affect the outcome (Collins, 2010). The interview schedule was then intensively reviewed by the respective Research Advisory Committee (RAC) members of the authors' institution.

4.4. Trustworthiness of the study

To ensure the trustworthiness of the qualitative data and findings, the framework proposed by Lincoln & Guba (1985) is applied in this study. Credibility criteria were checked using several techniques. Prolonged engagement was achieved through data collection across multiple months (September 2024 to April 2025) for a deeper understanding of the context. The present study used data triangulation, using several data collection methods to augment the credibility and validity of the results. Data was specifically gathered via semi-structured interviews, participant observation, and photographic recording. Member checking was conducted by engaging three fishermen and sharing our interpretation with them to check whether our result correctly aligned with their experience. Furthermore, peer debriefing was performed among the research supervisors and a colleague to evaluate the study's transcripts and reports. To eradicate the researcher bias in the findings, both researchers maintained reflexive journals to document their preconceptions and assumptions regarding the mathematical concepts in fishing practice and discussed these openly.

4.5. Procedure for data collection

Data were collected from September 2024 to April 2025, covering both winter and summer seasons. The snowball sampling technique was employed to select participants, as it is highly effective for accessing the study population, which is challenging to reach (Noy, 2008). These interviews were conducted in person. Formal ethical approval for this study was granted by the Doctoral Committee (DC) of the University of Burdwan (Registration no.: R-PhD./Regn./A/Education/70 Dated: 26-06-2023). Informed oral consent was obtained from each participant prior to data collection. Considering the literacy levels of the participants, oral consent was more appropriate than formal writing. This process was thoroughly documented, and the consent script was clear enough so that they could fully understand the study's purpose, their right to withdraw, and the measures for confidentiality. All the interviews were recorded in audio form, and then these were transcribed verbatim. As all these interviews were in the Bengali language, at first, the verbatim transcripts were translated into English. The researchers, who are fluent in both Bengali and English and are familiar with the cultural and technical context of fishing, performed the initial verbatim transcription and translation. Then these translated interviews were checked and verified by an independent bilingual peer, an experienced English teacher of a higher secondary school of West Bengal, whose mother tongue is Bengali, to evaluate the translations for conceptual accuracy and the appropriateness of indigenous technical terms related to fishing. Finally, this translated work has been checked by three RAC members (one of them is the head of the department of Education) of the researchers' institution to verify the appropriateness and contextual accuracy of the language. Videos and pictures have also been captured during the data collection process. Preliminary data analysis was also continuing simultaneously with the data collection to check the saturation point of the data (Morse, 1995). Thematic saturation was determined through an iterative process. Preliminary data analysis was conducted concurrently with data collection. After conducting 10 interviews, we found the repetition of codes and themes. To



confirm that no new themes or codes were emerging, we further conducted three more interviews to check the saturation point (Wutich *et al.*, 2024).

To clarify the relationship between traditional fishing practices, identified geometric ideas, and their pedagogical applications, we developed a conceptual framework (Figure 1). This framework illustrates the analytical pathway of the study:

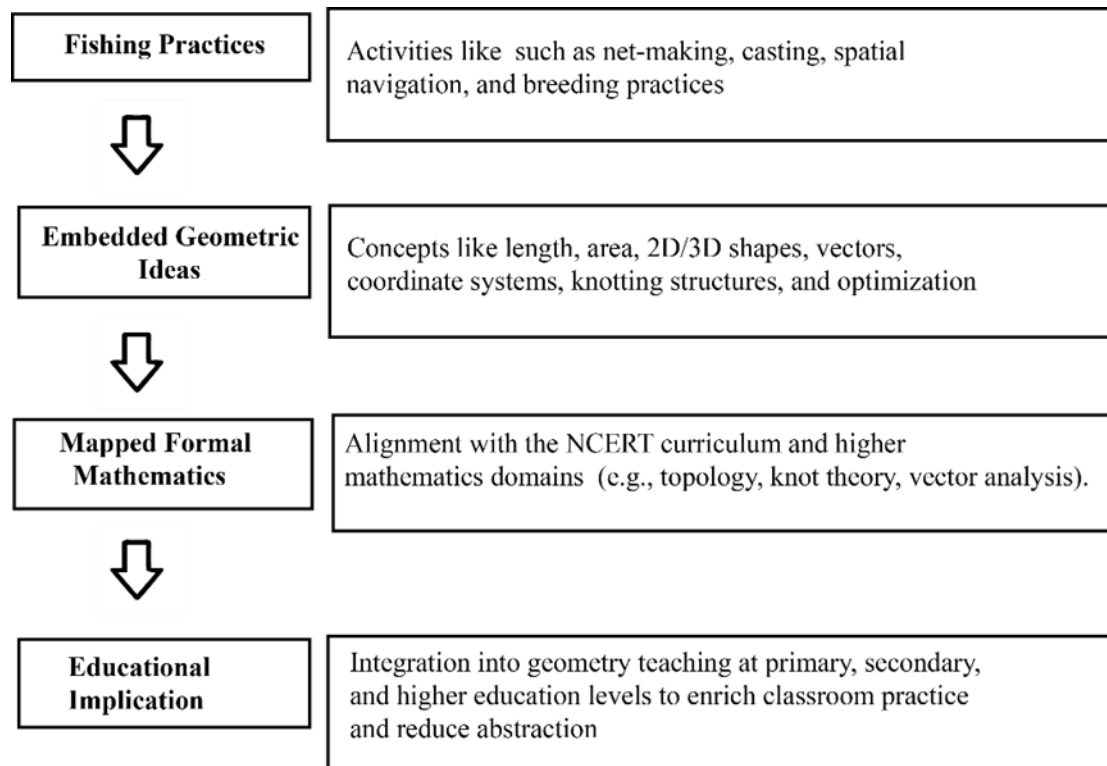


Figure 1. Conceptual framework illustrating the progression from traditional fishing practices to embedded geometrical ideas, their mapping to formal mathematics concepts, and potential applications in mathematics education.

4.6. Data analysis

The interview data from the fishermen were analysed using reflexive thematic analysis (Braun & Clarke, 2022). We picked this method because of its effectiveness in summarizing essential points and drawing unforeseen conclusions by analysing the perspectives and experiences of individuals (Braun & Clarke, 2022). Reflexive Thematic Analysis (RTA) was appropriate for our study over any other qualitative data analysis for several reasons. Unlike grounded theory, which aims to generate a new theory, our aim is to explore the underlying themes and patterns for a given data set (Ahmed *et al.*, 2025). On the other hand, content analysis prioritizes systematic coding and quantification of textual content, aligning it with positivist or mixed-method frameworks (Ahmed *et al.*, 2025). In contrast, RTA delves into deeper meanings and subjective experiences by identifying and interpreting recurring themes and narratives within the data through a more flexible and inductive approach. We found RTA to be particularly suitable, given the constructivist foundation of our work, to make sense of the complicated, real-life experiences of the fishermen. It is also the most effective way to answer our research question regarding how geometric ideas are intuitively used within fishing practices.

The six phases of the reflexive thematic analysis proposed by Braun and Clarke (2022) as follows:

- i. Familiarizing with data
- ii. Coding
- iii. Generating initial themes
- iv. Developing and reviewing themes



- v. Refining, defining and naming themes
- vi. Writing a report

Both researchers began the analysis process by reading and rereading the transcript, as well as watching recorded videos to become familiar with it (phase 1). We shared our initial impressions and took notes on what was essential to our research questions, and also discussed preliminary coding. We verified that the replies were clear and consistent, and we ensured that we had all the necessary data to answer our study questions. Our initial thoughts and feelings were very similar, and we did not differ in our impressions of each other. We also examined how we conducted the interviews to identify potential biases, such as whether the questions were asked reasonably, whether any unexpected results arose, and whether any additional questions needed to be asked. For example, after analysing the initial interviews with some participants, we realised that we needed to ask them directly whether they use any mathematical concepts in their fishing practices.

In the second phase, researchers began coding the transcript using MAXQDA 24. We used open coding rather than a set of predefined codes. As Braun & Clarke (2022) suggested, we are always aware that when extracting a meaningful sentence or paragraph from the data, we verify whether it is relevant to the existing codes or if a new code is needed to avoid overcoding. We follow Saladana's (2016) method of two-cycle coding. In the first cycle, we use concept coding to get primary codes. After that, we use pattern coding to categorise codes.

We collected the categories and proceeded with creating preliminary themes and subthemes (Phase 3). In Phase Four, we reviewed these themes and subthemes by examining overlapping areas and developing new themes as needed. Following the development of a comprehensive thematic map for the data, we meticulously refined and delineated the themes to ensure their distinctiveness and the clarity of the relationships among them (Phase 5). The final analysis and composition of the report were completed after the themes were established (Phase 6).

In our ethnomathematical study, we explored how mathematical concepts emerge within a specific social group, fishermen, by drawing on various data sources. Since ethnographic research is deeply personal and varies by context, applying standard intercoder reliability test was not suitable, so we chose not to include them (Cheung & Tai, 2023).

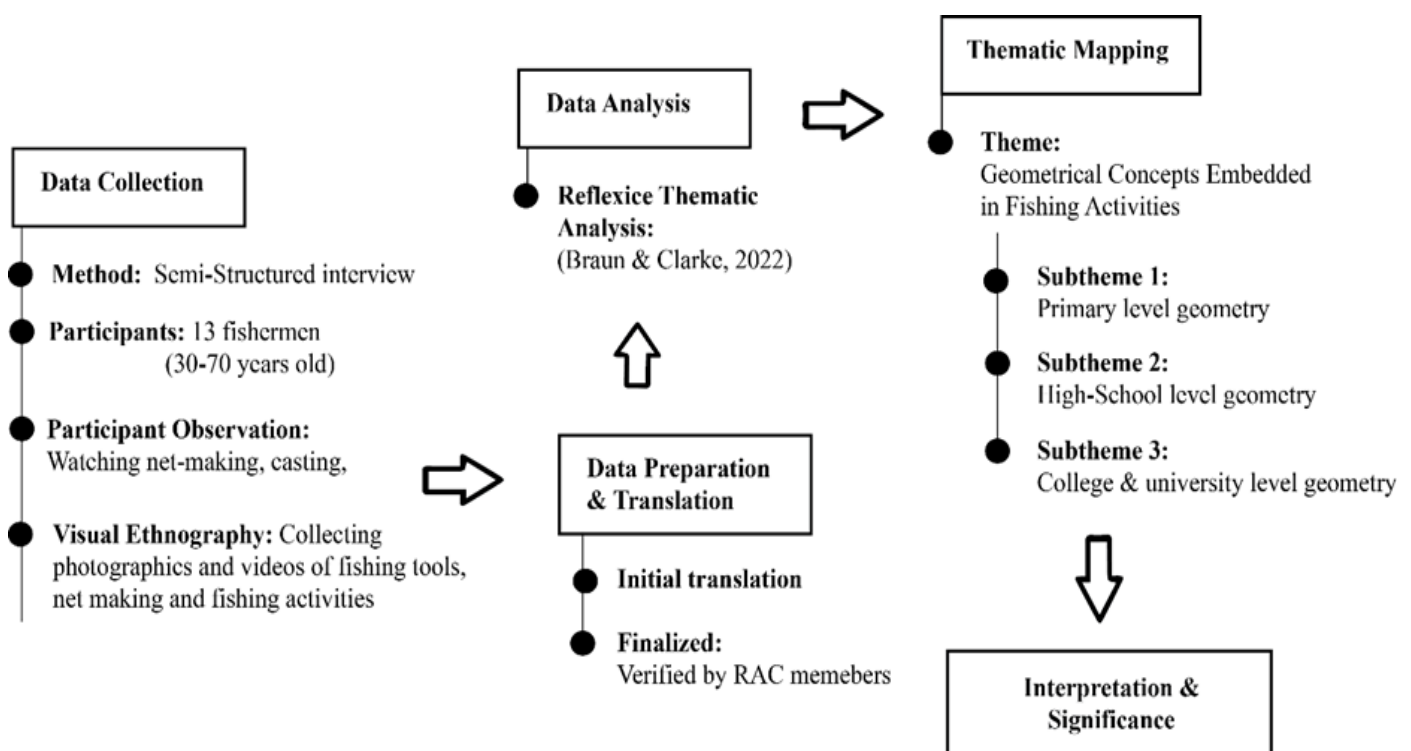


Figure 2. Conceptual Framework of the Methodology

5. Results

To address our research question, the theme of finding geometrical concepts in fishing activity was delineated into three subthemes: primary level geometry, high school level geometry, and college & university level geometry. We follow the NCERT mathematics syllabus for elementary and high school level geometry, but for college and university geometry, we mostly follow the normal mathematics curriculum of Indian universities. See Table 1 for subthemes and definitions. To maintain confidentiality, all potentially identifying information (e.g., specific village names, personal identifiers) was removed from the transcripts and field notes. Participants are referred to by pseudonyms (e.g., Fisherman 1, Fisherman 2) throughout the research.

Table 1. Embedded Geometrical Concepts in Fishing Practices Interpreted Through Formal Mathematical Lenses

Theme	Subthemes	Definition
<i>Geometrical Concepts Embedded in Fishing Activities</i>	Primary level geometry	Includes basic concepts such as length, area, perimeter, and 2D shapes, which are comparable to what is taught at the primary school level (Classes I–V). Examples in fishing include measuring the size of nets, estimating boat lengths, and recognizing shapes in tools and traps.
	High School level geometry	Involves slightly more advanced ideas, such as volume, patterns, and 3D shapes, generally taught at the secondary level (Classes VI–XII). These may appear in practices like estimating the capacity of boats or storage containers, recognizing repeating net patterns, or informally reasoning about water flow and directions.
	College & University Level Geometry	While fishermen may not consciously use higher-level mathematical theories, certain practices can be viewed by researchers as having parallels with advanced geometry (e.g., knotting techniques that resemble topological structures, or symmetrical designs in nets). These are interpretative connections rather than direct applications.

5.1 Subtheme: Primary level geometry

At the primary level, length, area measurement, and identifying 2D shapes are essential concepts in geometry. It depends on the shape and size of geometric objects such as fishing nets, fishing traps, and pond sizes. It also relates to quantities, such as how many fish we are to catch or how much food we need for breeding. The following quotes reveal the length and area measurement concepts in the fishing activity:

"Gaps refer to the specific spacing in the net that can trap fish of a certain size, like 2 inches wide...For larger fish like Pangas, we use nets with specific gaps to trap them...For medium-sized fish, usually around 800-900 grams or 1 kilogram, we often buy more nets with a three-and-a-half-inch mesh size..." (Fisherman 1)

"Well, we usually use nets with one-inch or half-inch holes...They are large nets, typically about 22 to 24 hands long, but we also have smaller ones, around 18 to 20 hands...Ghunsi nets can catch fish of all sizes, while Kheya nets are better for small fish...We look at the size of the holes in the net to decide what kind of fish it can catch..." (Fisherman 2)

"Usually we use nets — like encircling nets, drag nets, circular nets, and traps. In small areas, we also use fishing rods or bamboo traps. In rivers like the Damodar, encircling nets and drag nets work best...With an encircling net, we surround the fish in a specific area and then slowly pull the net in. This works well in wider parts of the river..." (Fisherman 10)

The following quote from fisherman 8 indicates how the concept of area and length measurements is used in making a fishing net:



"To make a fishing net, you first need good quality nylon thread. Suppose I'm making a net 10 meters long and 2 meters high — then it's good to keep the holes between 10 and 20 centimeters. Next, I built a wooden frame or a simple loom to weave the thread. I tie a knot every 10 centimeters so that the net remains strong and the holes stay even...I use different types of nets. For small fish, I use mosquito nets, and for big fish, I use "ghunsi" or drag nets. The net hole sizes range from 1 to 50 millimeters, depending on the type and size of the fish..." (fisherman 8)

"To make a net, you need nylon thread, a needle, and a wooden frame or your hands for measurement..." (fisherman 10)

Instead of formal measuring units, some traditional measuring systems are used in fishing activities, like measuring by hand and the use of 'Laga' to measure length. These concepts can be found in the following quotes:

"A 'One Laga' net has a larger gap between the mesh. We call it that when the net has a bigger size gap. But if we are catching smaller fish, we use a "Gujuri" net, which has smaller gaps...The gap in a "One Laga" net is around half an inch, while the "Gujuri" net has a smaller gap, about a quarter inch..." (fisherman 4)

"If we want to catch small fish, the gaps are small. For bigger fish, the gaps are made larger. Typically, in encircling nets, the gap is about 2 to 3 lagas, and in circular nets, it's smaller — around one laga..." (fisherman 10)

"...The nets have sizes like 1 laga, 2 laga, some are finger-sized—2 fingers, 4 fingers, 5 fingers..." (fisherman 12)

"There are different mesh sizes like one-finger, two-finger, four-finger, and five-finger gaps in the nets..." (fisherman 13)

The following quotes reveal various geometric shapes of 2D and 3D, such as circle, ellipse, rectangle, cone, cylinder, etc.

"For small fish like shrimp, we use specific methods. In our village, we use tools like polo, birti, or jhapa. Various size and shape like cone, drum and cage...some methods we used in childhood are no longer in practice, like blocking certain areas of water and cutting small channels for fish to enter." (fisherman 1)

"The net is casted by divided into three parts—one at the elbow, one in hand, and the third in the other hand...We carry plastic drums, pots, and bamboo sticks for netting..." (fisherman 3)

"I use nets—sometimes small nets, sometimes large ones. I also use a fishing rod, but for catching more fish, nets are more reliable...You have to swing and throw it in one motion so the net lands in the water in a circular shape..." (fisherman 7)

5.1.2 Subtheme: High School level geometry

Although the high school level geometry includes more advanced geometrical concepts than the primary level, there are some grey areas. For example, mensuration is taught in primary and high school. Some advanced mensuration of 3D objects can be found in the following quotes:

"Yes, some methods we used in childhood are no longer in practice, like blocking certain areas of water and cutting small channels for fish to enter..." (fisherman 1)

"We don't choose a particular spot. Usually, we start from one side of the pond, circle around the edge, and adjust the net placement depending on which side is more convenient...Yes, depending on the size of the water body, we adjust the size of the net. Larger ponds need bigger nets, and smaller ponds need smaller nets..." (fisherman 4)

"Earlier, we used large bamboo baskets, but now we use sacks and large pots. The fish are stored in these and then taken to the market..." (fisherman 5)

One of the optimization problems in both geometry and mensuration is the isoperimetric problem, i.e., finding the specific shape with the same perimeter that covers the largest area. Fishermen use the solution to this problem unknowingly in fishing practice, see the following quotes:



"Before casting, I neatly arrange the net, wrap one side around my hand, and throw it with a spin so that it spreads out in a circle on the water..." (fisherman 8)

"We spin the net with our hand... (shows by pointing to his elbow and hand). We swing it around and throw it..." (fisherman 5)

"The circular net is usually used by one or two people — the net is thrown in a circular motion and spreads out in the water... To cast a circular net, you hold the rope in one hand and throw the net in a round shape with the other hand so that it spreads nicely in the water..." (fisherman 10)

Vector is one of the important geometric concepts. It is a mathematical object that has both magnitude and direction, for example, force, velocity, etc. This concept can be extracted from the following quotes:

"Then you have to wait a bit and pull it in slowly—if you pull too fast, the fish will escape... If you throw the net toward the current, fish are more likely to swim into it..." (fisherman 7)

"Sometimes, when the river current is strong, we use a drag net, which is pulled from both ends... Usually, we throw the nets where the water is a bit deeper and the current isn't too strong... To cast a circular net, you hold the rope in one hand and throw the net in a round shape with the other hand so that it spreads nicely in the water. First, we try to understand the direction in which fish are moving -that comes from habit and experience... For the encircling net, you slowly spread it in the water to surround the fish from all sides and then pull it in..." (fisherman 10)

Coordinate geometry is primarily taught in high school and college. According to the NCERT syllabus, two-dimensional coordinate geometry is covered in high school. Fishermen frequently use the coordinate system for various tasks such as deciding on fishing spots, pulling in the fishing net, setting fishing traps, and more. The following quotes reveal some concepts of the coordinate system.

"If we start pulling from the east, we lift it from the west, and if we start from the south, we lift it from the north..." (fisherman 6)

"We start from one corner of the pond and pull the net across to the opposite side. For example, if we release the net from the east side, it will be pulled up on the west side..." (fisherman 5)

"One person holds one end of the net from the shore, and another person takes the other end and spreads the net in a half-circle, either by walking through the water or using a boat... For example, in rivers like the Damodar, we need boats—because we can't walk into the river, and we have to go to the middle to catch fish..." (fisherman 13)

5.1.3 Subtheme: College and University level geometry

The geometry at college or university level is much more abstract. There are many branches of geometry, such as topology, which is sometimes called rubber sheet geometry, and coordinate geometry, which are also taught in high school. At this level, sometimes geometry is mixed with other branches of mathematics like algebra, calculus, etc., making geometry more abstract.

In the following quote, we get a glimpse of topology:

"They are floating structures made of "Shola," but now we use motor tubes... They look like vehicle tire tubes." (fisherman 6)

"The fish get tangled in the net and go in by themselves. Once caught, they get stuck." (fisherman 9)

"You start with one knot, then keep making knots in a line. After that, more rows are added. You have to keep the gaps in the net uniform, otherwise, fish might escape..." (fisherman 10)

"Sometimes, if the pond has more water channels, we even use tubes (rubber tubes) to float and catch fish." (fisherman 13)

A different branch of geometry deals with discrete objects like discrete points, sequences, and patterns. This branch is called discrete geometry. The more advanced topic in geometry is geometric optimization, where we try to



solve those kinds of problems that involve geometric shape, area, volume, distance, or other geometric quantities. This solution focuses on finding the best configuration (maximum or minimum) of geometric objects under some given constraints. The isoperimetric problem in two dimensions is an example of this area we have already discussed in the high school level geometry section. In this section, we shall demonstrate other aspects of geometric optimization.

Some concepts of discrete geometry and geometric optimization can be seen in the following quotes:

"First, we need to gather people. We decide whether to go at 2 AM or 3 AM. We talk about it, take phone numbers if we have mobile phones, or go to their houses if we don't. Then, we gather everyone... We bring fish eggs, earlier from Bankura, now from Kulhuri. When the eggs hatch, we transfer them using nets. After 25-30 days, they grow to a certain size... Then, we feed them mustard oil cake, flattened rice, and other food. During the breeding season, we mix gram flour, four chicken eggs, and 100 grams of mustard oil to feed the eggs. This helps the eggs hatch properly..." (fisherman 5)

"I mostly use the drag net because this method helps catch a lot of fish at once. It needs two or more people. First, we choose a spot where the water is calm and there's a good chance of finding fish, like a bend in the river. One person holds one end of the net from the shore, and another person takes the other end and spreads the net in a half-circle, either by walking through the water or using a boat. The net has floats on the top and weights at the bottom so that it stays properly in the water. Then we slowly pull the net in from both sides—this is how we use and pull a drag net... But if the place and time aren't right, we may return empty-handed. During the monsoon, or when fish are more active in the water, the drag net works really well... In our area, especially in the Damodar River, this method works best..." (Fisherman 13)

6. Discussion

The objective of this article is to find geometric concepts embedded in fishing practice. We have categorized the main theme into three subthemes. Each of these subthemes reveals the underlying geometric concepts of various levels. Our result shows how fisherman uses geometric concepts from primary to advanced levels without having any formal background in mathematics.

6.1 Subtheme: Primary Level Geometry

Research conducted on primary school students suggests that students are more comfortable understanding geometric concepts better in the ethnomathematical approach (Sunzuma et al., 2021). Therefore, we need to adopt the ethnomathematical approach in teaching practice. A prime example can be found in the daily fishing activities. In their daily fishing activities, fishermen unknowingly use fundamental geometric concepts, especially length and measurement. When they try to catch a particular fish species, they carefully consider the mesh gap size when selecting nets. For example, they catch medium-sized fish that weigh between 800 and 900 grams or one kilogram by using larger gaps that are roughly three and a half inches wide. For larger species, such as pangas, wider gaps are also helpful. On the other hand, nets with finer mesh, about 1 inch or even half an inch in size, are used to catch smaller fish. The nets' overall dimension is also important and is measured in terms of hand spans, which range from 18 to 24 hands in length. According to the size of gaps, different types of nets are chosen for different purposes: Kheya nets are better suited for catching smaller fish, but Ghunsi nets can capture fish of all sizes. The measurements in mesh size and net length demonstrate how geometric concepts are embedded in conventional fishing techniques. Our research supports the findings of Magnate (2025), where they discussed the concepts of mensuration in fishing activity, more specifically, in constructing a fishing trap named "bubos".

When a fisherman constructs a fishing net, the concepts of length and area are directly involved. First, the fisherman mentions making a net that is 10 meters long and 2 meters high by keeping the holes between 10 and 20 centimeters. These steps introduce some concepts of measurement and spacing, which are the key ideas in both mensuration and spatial reasoning. When a fisherman tries to knot every 10 centimeters, this process reflects a practical application of uniform intervals and repetition. This reveals the use of a grid or lattice structure in geometry. At the time of building a wooden frame, a fisherman always needs to maintain a uniform shape, which suggests knowledge of the area, symmetry, and geometric structure. These practices illustrate how deeply geometry is



embedded in everyday activities like net-making. This result extends the work of Nurbaeti *et al.* (2019), where the geometric pattern is described in woven fabrics.

Instead of using standard measuring units, fishermen sometimes use traditional measuring units like the hand measure unit 'laga'. A 'one laga' unit denotes a gap size of half an inch. Different types of nets have various kinds of 'laga' sizes, and accordingly, fishermen decide which nets need to be used for a particular purpose. A similar type of research can be found in the work of Owusu-Darko *et al.* (2023). More specifically, they showed that instead of using modern measuring units, Akan people are still using a traditional measurement system that includes arm-stretching, leg footing, and others. The shapes of various fishing instruments reveal various concepts of 2D and 3D geometry. The tools like polo, birti, and jhapa are described as having forms like cones, drums, and cages, which are explicit references to 3D geometric shapes such as cones, cylinders, and cuboids. In contrast, their different faces reveal various shapes of 2D geometry. The method of casting the net is divided into three parts. Also, swinging the net in one motion so it lands in a circular shape, which demonstrates an understanding of 2D geometry, particularly the circle. On the other hand, shapes like cylindrical, spherical, and linear can be clearly found in plastic drums, pots, and bamboo baskets. The cutting of a small channel describes the use of a trapezoidal shape. This result supports the research of Malalina *et al.* (2022), where they described the geometric aspect of fishing activity in the Musi River. As most of the time geometrical terms are not possible to express in the local language, most students face challenges in understanding the concept (Sunzuma & Maharaj, 2022). Hence, it is necessary to make a bridge between two different worlds: the abstract world and the real world. And we try to establish this connection.

6.2 Subtheme: High School level geometry

The trend in geometry education has focused on improving visual-spatial abilities and facilitating the comprehension of geometric ideas within the context of daily issues (Verner *et al.*, 2019). And this needs to visualize various cultural activities through a geometrical lens. For instance, when cutting channels from a pond or a river, one thing should always be in mind: how much area does it need? Or how much area would be sufficient for adequate water flow? Additionally, the geometric shape of the channel is very significant; a poorly designed shape may disrupt water flow or prevent fish from entering the channel. The shape of the water body plays a key role in choosing the size of the fishing net. This helps in developing a curious mind in finding geometry in every activity by making a balance between the visual aspect and geometric concept (Battista, 2007). Again, fishermen decide how to start fishing by analyzing the shape of a pond or river. From the quote, "*We start from one side of the pond, circle around the edge...*", we can imagine that fishermen always consider the shape of a pond to be approximately circular or elliptical. Then, they cover the whole area by moving along the boundary. This relates to the concept of arc length, perimeter of closed curves, or curvilinear motion. Further, the 3D shape of the bamboo basket or sacks and the volume are always considered when storing fish. One of the fundamental problems in geometry is the isoperimetric problem. From the quote, "*...it spreads out in a circle on the water...*" one thing is prominent, that the fisherman always tries to spread the net in a circular shape as much as possible. They use a spinning technique to throw the net into the river. Spinning helps the centrifugal force act on the net, shaping it like a disc. They use this technique to cover the maximum area. As the circumference of a net is constant, the only solution is to shape it like a circle. As Sunzuma and Maharaj (2022, p. 1097) pointed out, "*learners were not aware of the geometry cultural examples and activities that exist in that own environments*". Research by Kyeremeh, Kwadwo Awuah, & Orey (2025) found that some geometrical concepts, like cones and concentric circles, are embedded in fishing techniques. Our research extends their result and categorizes the geometric concepts in fishing.

The concept of a vector is one of the first abstract mathematical concepts for a high school student. This concept is presented in high school mathematics and physics as an arrow representing force, velocity, and acceleration; or more broadly as a quantity characterized by magnitude, direction, and sense (Cuevas-Vallejo *et al.*, 2023). However, research shows that most university students have an intuitive idea of vectors but lack practical knowledge (Nguyen & Meltzer, 2003). Therefore, it is necessary to teach the vector concept through practical demonstration. And we presented this through the act of fishing. For example, the act of pulling a net in a particular direction can be interpreted through the formal concept of vectors, as it involves direction and magnitude. For instance, when two people pull a drag net from both ends, they use force in different directions to keep the net from moving with the river's current. That is a practical example of how to use forces to balance the river current. They



also pay close attention to where the water is deeper and the current is slower. This is because a strong current can push the net too hard in one direction, which is like knowing how big or small a force is, which is the magnitude of a vector. The way the hand moves in a smooth arc and the net spreads out evenly in circular form also shows a sense of direction and motion.

The method of spreading and pulling the net demonstrates that they seem to apply principles of coordinate geometry intuitively. A fisherman quoted, *"If we commence pulling from the east, we elevate it from the west, and if we initiate from the south, we raise it from the north."* This directional logic reflects that the fisherman is considering the pond surface as the Cartesian plane, and they are moving along opposite axes on that plane. Another fisherman said, *"We start from one corner of the pond and pull the net across to the opposite side. For example, if we release the net from the east side, it will be pulled up on the west side."* Here, the concept of diagonal traversal across the pond resembles the idea of connecting two opposite points, like (0,0) to (a,b), forming a straight path across the pond. Their fishing method thus contains basic coordinate geometry principles, involving orientation, directionality, and the understanding of space within a defined area. This represents a unique approach where abstract knowledge is delivered through direct interaction with the environment rather than abstract instruction. This finding extends the work of Rosa & Orey (2020) on culturally responsive pedagogy by providing a concrete example of how abstract concepts are already embedded in vocational practices.

6.3 Subtheme: College and University level geometry

A very abstract concept of geometry can be found in fishing. While fishing in a pond, instead of using a boat, fishermen use a 'rubber tube' or a 'motor tube'. This type of shape holds great significance in mathematics. The shape of the rubber tube aligns with the properties of a torus in topological terms (more specifically, a two-dimensional torus), which explains its stability on water. It is a two-dimensional compact smooth manifold with one 'hole' (genus one) and no boundary. The first Betti number is $\beta_1=2$. This shows the tube has two one-dimensional holes in the meridian and longitude directions. This ensures that the rubber tube floats on water. The symmetrical shape of this object helps a fisherman maintain stability while floating on the water. This smooth, curved shape minimizes water drag and enables fishermen to float in any direction. Without any formal calculation, a fisherman intuitively adjusts the position where to sit to maintain balance in shallow or deep water. It reveals how a very abstract geometric concept is embedded in various cultural practices. This result can be seen as an extension of the work of Sarkar & Howlader (2023), where it is shown how the topological concept is inextricably linked with the traditional activity of pottery. As Hilton (1971) suggested that topology engages with the world of experience and endeavors to address concerns that appear fundamental, tangible, and natural, clearly our research supports this idea.

Vygotsky (1978) found that students learn best when they are actively involved, making their own meaning, and interacting with others. These ideas are easily supported by knot theory, which uses real examples, pattern recognition, and open-ended tasks. Knot theory is different from many abstract areas of math because it can be felt, seen, and is deeply rooted in both cultural practices and scientific phenomena (Diamantis, 2025). We find various concepts of knot theory while making nets, pulling the nets, etc. In knot theory, a knot is a closed loop in 3D space (like a knotted string with the ends joined), but in practical terms, a fishing net consists of many small, interconnected knots. Therefore, we can consider a fishing net as a braid. The process of "making knots in a line" resembles the creation of a braid. In braid theory, multiple strands are interwoven in a structured, sequential pattern. According to knot theory, a newly formed knot can be understood as a crossing or interaction between threads. When the fisherman says, "more rows are added," it embodies the idea of stacking multiple braids or forming braid lattices. This structure resembles a woven braid mesh, which appears as a 2D braid pattern created from repeated braid moves. Conversely, the concept of geometric regularity in braid patterns can be found in the quote, "Keep the gaps in the net uniform...". In braid theory, the symmetry and spacing between strands determine the mathematical properties of the braid. As weavers use mathematical ideas like formulas and numbers, as well as visualization and transformations in shape and various integrated patterns (Thompson, 2024), fishermen, while making nets, also follow the same mathematical concepts; otherwise, it can alter the braid and distort its topological properties, much like in the net, where uneven gaps allow fish to escape. When fish get trapped in a net and the fishermen try to untangle them, this is the concept of the trivial knot. Whatever knot a fish makes in a fishing net can always be



untangled, and these knots are equivalent to the trivial knot; otherwise, one needs to cut the net to untangle the fish. [Kawauchi & Yanagimoto \(2012\)](#) demonstrate how to teach knot theory to students from primary to university level. Our findings show a possibility that it can also be taught using a fishing technique.

At the beginning of fishing, our fishermen gather people through phone calls or other communication. In mathematical terms, we can consider the people as nodes and the communication medium as edges. Therefore, this system turns into a model of a graph. Again, at the time of the spread of the net, we see an application of graph theory, where people are nodes and the net is an edge stretched between them. When a fisherman chooses a particular fishing spot, he unknowingly applies the geometric optimization principle. This is a location optimization problem, and it involves knowledge of the geometry of the river and fish movement patterns. Here, the target is maximizing fishing production while minimizing resource use, such as human effort, time, and equipment deployment. Discrete tessellation occurs when multiple fishers deploy nets in overlapping arcs; the pond surface could be partitioned into several regions. This shows that the notion of graph is already hidden in day-to-day life, and we are using it in everyday situations. Our finding is aligned with the study of [DiSessa et al. \(1991\)](#). They did an experiment that happened in a classroom where young students were asked to make a model for a motion situation. After a few class periods, they "*invented*" the Cartesian graph.

Many times, it is not possible for a new math teacher to know which class, grade, or education level to use the ethnomathematics activities in their lessons because math subjects cover a wide range from early childhood education to university education. For example, geometry is taught in different ways from kindergarten through university ([Kabuye Batiibwe, 2024](#)). In line with this, research by [Kyeremeh, Kwadwo Awuah, & Orey \(2025\)](#) contend that using geometric shapes observed outside academic settings can significantly enhance classroom instruction, going beyond the quality of the standardized teaching often experienced by student instructors in college environments. Building on this idea, our study covers most of the fundamental geometrical concepts from primary to university level and gives an overview of how to teach these concepts using a fishing activity.

A comprehensive summary linking the identified geometrical concepts, their level of mathematical abstraction, and specific examples from fishing practices is provided in (Table 2) Appendix A.

7. Conclusion

This study highlights the rich presence of geometric concepts in the daily fishing practices of traditional inland fishermen in West Bengal, India. By using the method of reflexive thematic analysis of interview data, we identified the geometric concepts into three subthemes: primary, high school, and college/university-level geometry. Our results suggest that despite limited or no formal training in mathematics, fishermen demonstrated practical applications of a range of geometric principles, including measurement, shape recognition, vector reasoning, coordinate logic, topological structures, knot theory, and geometric optimization. Our findings illustrate that mathematical thinking is deeply embedded in culturally rooted occupational practices. Fishermen use the geometric concepts of different levels, from very elementary to very abstract, in their day-to-day work. Different types of nets are used for catching different types of fish. So, it makes a bridge between the shape of fish and the types of nets with various gap lengths. Fishermen always throw the net in a circular motion. Even though they don't have particular knowledge of why they are using this kind of shape, it is clear that they always want to maximize catching fish. They are unknowingly using the solution to the isoperimetric problem. Topics like knot theory and geometric optimization are generally taught at an advanced mathematics level, but it is amazing to see how fishermen are using these concepts without having any theoretical knowledge. At the time of making a net, knots are given in a uniform pattern without distorting the shape. This example shows how simultaneously knot theory and geometric optimization are acting. While fishermen may not formally conceptualize their work in mathematical terms, these practices can be fruitfully interpreted through advanced mathematical lenses such as vector analysis, topology, and knot theory.

This research contributes to promoting culturally responsive pedagogy in mathematics education. Recognizing and incorporating such community-based knowledge into the classroom could bridge the gap between formal and informal mathematics education. Future research can expand this study across different fishing communities, including those involved in marine fishing, and explore other branches of mathematics, such as algebra, statistics, and probability, in practical contexts.



8. Recommendations

The primary objective of mathematics education is to enhance students' mathematical literacy, which may be accomplished via culture-based learning (Pratama & Yelken, 2024). The ethnomathematical method may enhance the relevance of mathematics education for pupils by linking it to their cultural environment. Ethnomathematics is a pedagogical approach that incorporates the local cultural elements of certain communities, making mathematics more engaging and comprehensible for students (Sunzuma & Umbara, 2025). Our study reveals that the daily practices of fishing communities are a rich, untapped reservoir of geometric concepts. The findings compellingly argue for the integration of ethnomathematical perspectives into the mathematics curriculum to make learning more relevant, engaging, and effective for students from diverse backgrounds.

Based on our analysis, we propose the following specific recommendations:

8.1 For Curriculum Development

Geometry was the first mathematical discipline shown as a universal axiomatic deductive framework. The geometry domain serves as an ideal context for incorporating ethnomathematical techniques into the educational curriculum (Verner *et al.*, 2019). Curriculum frameworks and textbooks should include dedicated modules or case studies based on culturally relevant practices, such as fishing, weaving, or agriculture. For example, in the chapter on teaching geometric shapes and patterns, a section can be included where various fishing nets, traps, and fishing equipment are demonstrated along with their geometric interpretation. In early class, students are provided with the concept of mensuration. As fishing contains an abundant number of mensuration concepts, students can be engaged through real-world problems involving calculating the area of a net, area of a pond, length of a fish, volume of a fishing pot, etc. Some project-related work related to fishing can be given to the student to explore geometric concepts. Hilton (1971) advocated to include topology in high school curriculum by proposing a comprehensive mathematics syllabus for high school topology. Topics like fundamental group, homeomorphism, retraction, and deformation can be demonstrated using many real-life examples, like fishing, pottery, weaving, etc.

8.2 For Classroom Pedagogy

Instead of starting with abstract formulas, teachers can pose problems based on real-world contexts. For example, a teacher can ask, "A fisherman needs to weave a net to catch fish of exactly 5 cm width. What should the gap between the knots be? Let's experiment with strings to find out." Kawauchi & Yanagimoto (2012) in his book "Teaching and learning of knot theory in school mathematics" he demonstrates how to teach knot theory from elementary to university level students. In this context, some techniques related to fishing, like net weaving and trap making, can be used as a pedagogical approach in teaching knots. Concepts like graph theory can be taught like this: "Imagine a group of fishermen, like the ones we've studied, going out on a large lake. They need to coordinate. How do they decide where to meet? How does the fish get from the boat to the market? Today, we'll use math to model this." Similarly, the concept of vector can be demonstrated to the student by showing them videos or pictures of casting and pulling nets, the flow of the river, etc. One of the problems in college and university-level mathematics education is that many times, lectures become so dry that students lose their interest. Research of (Weber, 2012) shows that professors primarily exhibited proofs that explained the ideas and techniques rather than convincing students of the foundation of a specific mathematical assertion. To overcome this problem, we need to reconstruct the pedagogical aspect of classroom teaching.

By implementing these recommendations, we can move towards creating an ethnomathematical classroom and curriculum for a better understanding of mathematical concepts.

9. Limitations

When interpreting the results, the following limitations of the study should be considered:

1. This qualitative study employed a relatively small sample size in a particular geographic region, and the conclusion is drawn based on the interview data. Therefore, these findings may not give a complete picture of the use of geometry in fishing activity. Again, these participants are habituated to fishing only in a pond or a river, and none have any sea fishing experience. This limits our investigation in certain



- aspects of fishing practices that might differ significantly in marine environments. In the future, researchers could include a broader range of people and situations in their studies to get a fuller picture of how maths is used in fishing communities.
2. We excluded women participants. This may result in a loss of gender-based information and a biased result, even though women's involvement in inland fisheries is low.
 3. Although the researchers translated the interview transcripts from Bengali to English, meaning loss or distortion is always possible during translation, particularly when translating indigenous terms related to fishing practices.
 4. Finally, we only focus on finding the concept of geometry. There are other branches of mathematics, like algebra and probability, that can be explored abundantly in fishing practice.

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Mampi Howlader: Conceptualization, Methodology, Investigation, Writing-Original draft, Formal analysis.
Puja Sarkar: Supervision, Validation, Formal analysis, Writing-Reviewing and Editing. Both the Authors have Read and Agreed to the Published Version of the Manuscript.

Does this article screen for similarity?

Yes

Ethics approval

No ethical clearance certificate is applicable for this present study.

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The authors have no conflicts of interest to declare. There is also no financial interest to report. The author certifies that the submission is original work and is not under review at any other publication.

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