Exploring Ethnomodeling to the Traditional Stocking Practices of Milkfish Farming in Banate, Iloilo

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Abstract: This study investigates the indigenous knowledge and integrate it to academic mathematics with the use of ethnomodeling in the context of the traditional practices of milkfish farming in Banate, Iloilo. It focuses on local fish stocking methods specifically the techniques of bansutan and larguhan. It seeks to uncover the underlying mathematical concepts that inform to these practices and analyze the impact in fish production. Employing a qualitative ethnographic research design, the study involved six experienced participants consisting of pond owners and fishermen and used semi-structured interviews, direct observations, and focus group discussions to collect qualitative information. Thematic analysis informed using ethnomodeling led to the identification and interpretation of traditional mathematics practices like estimation, measurement, and ratio use that exposed the symbiotic relationship between local cultural practices and formal mathematical structures. This research not only to highlight the relevance of ethnomathematics in promoting culturally responsive mathematics education, but also speaks to the necessity of integrating indigenous knowledge systems into aquaculture business planning and sustainable resource management. The findings contribute to the broader theme of localized curriculum design mandated by the Philippine Department of Education, and aligned these cultural practices in fish stocking to the most essential learning mathematics competencies.

Keywords: Ethnomathematics, Ethnomodeling, Indigenous Knowledge, Milkfish Farming, Fish Stocking Practices, Brackish Water Aquaculture, Cultural Mathematics, Sustainable Fish Production

INTRODUCTION

Globally, teaching mathematics in a significantly more effective way requires innovative and culturally relevant methodologies. Ethnomathematics satisfies this need by integrating cultural contexts and everyday experiences into traditional mathematical instruction, thereby furnishing many learners' access, significance, and relevance to study mathematics. Coined by Ubiratan D'Ambrosio in 1977, ethnomathematics refers to the study of mathematical concepts within cultural practices and activities in everyday life. This perspective challenges the assumption that mathematical reasoning cannot take place outside school or school-like education. Rather, it focuses on the fact that various societies perform sophisticated mathematical thinking subject to lived experience. For instance, traditional livelihoods such as aquaculture, particularly in brackish-water fish culture, use such concepts as measurement, estimation, working with proportions, and pattern recognition. Such practices may not be typical of the definition of math, yet these are forms of indigenous mathematics influenced by nature knowledge, experiential learning, and generational wisdom.

Although there exists literature-increasing proof regarding ethnomathematics' potential in education for contextualizing learning and integrating it into culture (D'Ambrosio, 2006; Rosa & Orey, 2012), practice-to-life-based research employing this framework in aquafarming applications is limited. Ethnomathematics has most of its studies in areas such as agriculture (Paz-Alberto et al., 2022), weaving (Gerdes, 1999), and architecture (Knijnik, 1997), making aquatic resource-based livelihoods under-explored. The notable exception to these studies is Sulatra (2023), who researched the squid fishery in the Philippines' Gigantes Islands and has demonstrated how aspects of activity associated with the preparation of catches and sales in the market are reliant upon mathematical concepts of estimation, ratio, and spatial knowledge. However, little research focuses on traditional practices in brackish water aquaculture and related decision-making that have mathematical dimensions, especially relevant to the Philippine context.

Given the extensive coastline of the country and the vital contribution of brackishwater aquaculture to rural livelihoods, there is a need to explore the indigenous mathematical knowledge incorporated in these practices. This type of research holds the promise not only to advance culturally responsive mathematics education but also to advance sustainable development efforts that respect and draw upon local knowledge.

In Philippine educational landscape, emphasis on inclusiveness also enhances the importance of culturally embedded instruction. The Department of Education (DepEd), through Order No. 35, s. 2016, has mandated curricula contextualization, localization, and indigenization such that instruction becomes sensitive to students' cultural identity. The nipping issue is how these ideals can be implemented in real classroom practice.

Ethnomathematics provides a valuable model for exploring this issue by acknowledging that mathematical knowledge is developed both in and outside of formal educational contexts. As Bishop (1988) and D'Ambrosio (1985) contended, mathematical thought is rooted in the ordinary practices of cultural communities. In this broader context, ethnomodeling is a methodological instrument that records and scrutinizes these cultural mathematical practices thereby building a connection between indigenous knowledge and academic mathematics (Rosa & Orey, 2010, 2012). The application of ethnomodeling to brackish water aquaculture, such as the quantitative practices and decision making processes of fish stocking, feeding, transferring and harvesting, performed by the fishermen of the municipality of Banate, Iloilo gives good eye for how indigenous belief and practice brings mathematical concepts into view.

This study aims to document and analyze indigenous brackish water aquaculture systems, in particular to local fish stocking practices by local fishermen in Banate, Iloilo as viewed through ethnomodeling. It aims to uncover the underlying mathematical concepts of these practices and analyze their effect on fish production. By highlighting its relevance to mathematics education, sustainable resource management, and aquaculture business strategies, the study intends to integrate indigenous knowledge systems with academic mathematics.

DEFINITIONS OF TERMS

Semilyahan- it is where the semilya (fingerlings) are initially stock. And should stay at around 15 days.
Bansutan- serve as the intermediate holding area. Derived from the local term
Larguhan- serve as the main stocking area. It was the largest section area of the pond and the fish remain here until they are ready for harvesting.
Semilya- term for the fingerlings typically measuring around 1 pulgada (inch) in length.
Lablab- traditional term for indigenous food or algae that serve as the main food source of the semilya.
Haw-as – local term for harvest.
Sikla – traditional term use by the local for high tide.
Ayahay- traditional term use by the local for low tide.

METHODOLOGY

This study employed a qualitative ethnographic research design grounded in the principles of ethnomodeling, a methodological approach that bridges indigenous cultural practices with academic mathematics. As described by Rosa and Orey (2012), ethnomodeling facilitates the interpretation and translation of cultural practices into formal mathematical representations. Guided by this framework, the research explored, documented, and analyzed traditional fish stocking practices in milkfish farming specifically through the use of bansutan and larguhan in Banate, Iloilo, in order to reveal the underlying mathematical concepts.

This study was conducted in Banate, a coastal municipality in the fourth district of Iloilo province, which has a successful brackish water aquaculture and deep-seated fish production traditions. The environment provided a rich cultural setting influenced by generations of indigenous knowledge. Six participants were chosen, comprising a pond owner, caretaker, and local fishermen—all with more than five years of experience in traditional fish farming. They were selected purposively for interviewing to make sure that they were all involved in fish farming actively and were decision-makers in their respective communities (Palinkas et al., 2015).

Data collection drew on a range of qualitative approaches: semi-structured interviews uncovered information about the tools, processes, and strategies involved in fish stocking, and direct observation provided an experiential, first-hand appreciation of indigenous mathematical thinking such as estimation, measurement of volume, and application of ratios; rich field notes, together with photographs and video footage taken with informed consent, supplemented the analysis, and focus group discussion assisted with the validation of emergent findings through promoting collective consideration of the embedded mathematics.

Data were thematically analyzed under the guidance of ethnomodeling principles, with interview transcripts and observation notes coded to determine common themes and mathematical concepts, making sure that local terminologies and practices were re-translated into scholarly mathematical concepts without loss of cultural authenticity; combining local context and wider mathematical structures finally revealed the structure and logic of informal mathematics thinking, and the validity of the findings was supported through triangulation across different sources of data and member-checking with participants. Before data gathering, the researchers also got informed consent from all the participants, guaranteeing that they are well informed about the purpose, procedures of the study, and their freedom to withdraw at anytime without consequence. Confidentiality and anonymity was strictly observed using pseudonyms, and all data gathered were kept safely.

RESULTS AND DISCUSSIONS

Stocking practices are fundamental to the success of brackish water fish culture, directly influencing fish growth, health, survival rates, and overall system productivity. In Banate, Iloilo, a coastal municipality renowned for its strong aquaculture tradition, local fishermen have developed practical and systematic stocking methods that are tailored to their specific environmental conditions and available resources.

Local Stocking Areas: Semilyahan, Bansutan, and Larguhan

Figure 1. A Sketch of Local Stocking of a Pond Area in Banate, Iloilo

There are three distinct areas within the fishpond that make up the Banate fishermen's three-stage fish stocking system. These are the Semilyahan (nursery area), the Bansutan (temporary stocking area), and the Larguhan (main grow-out area).

Semilyahan (Nursery Area). It is where the fingerlings (semilya), typically measuring around 1 pulgada (inch) in length, are initially stocked. It offers a regulated environment with suitable depth and protection from predators and extreme environmental conditions. In this Area, fishermen put Lablab, traditional term for indigenous food or algae, that serve as the main food source of the semilya. They closely kept an eye on fingerlings for healthy growth before transferring them to the next stage.

Figure 2. Semilyahan (Nursery Area)

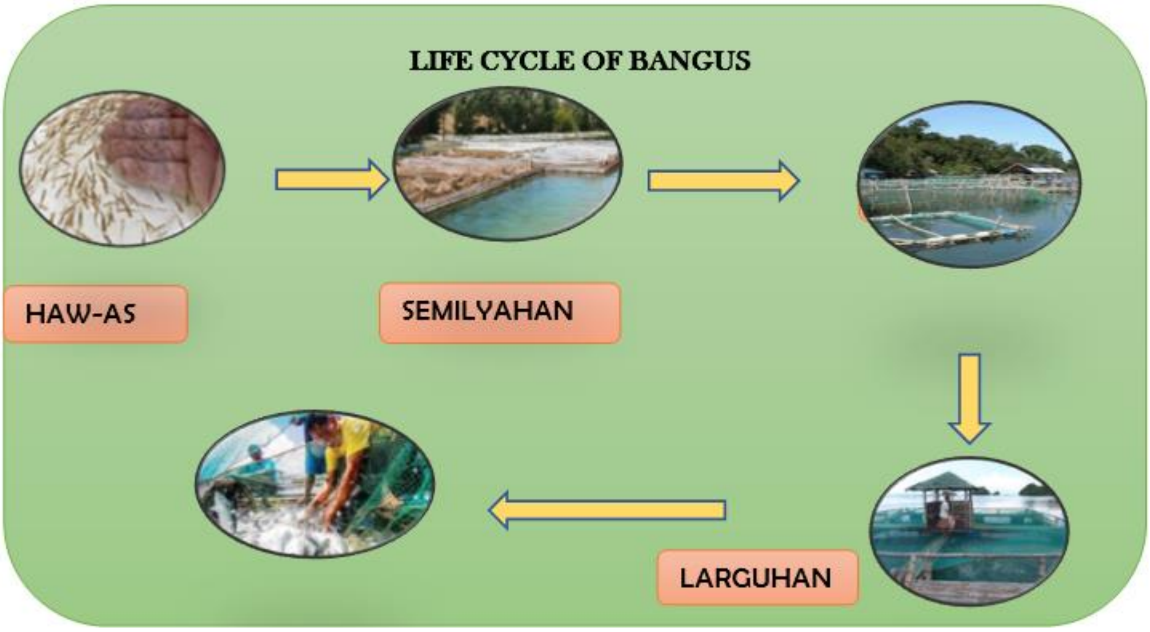
Bansutan (Intermediate Holding Area). Derived from the local term "bansut," which means a small or cramped area, is generally smaller than a larguhan and serves as a transition zone for fingerlings that are too small for the larguhan but ready to leave the nursery. Since they have limited pond space, they utilize this area to temporarily raise fish while preparing or waiting for space to open up in the larguhan. It is a practical solution that helps maximize space usage while still allowing fish to grow gradually. They usually moved fingerlings to the Bansutan after around 15 days in the nursery or when they have reached a length of between about 1.5 to 2 pulgadas (inches), to continue development and growth.

Figure 3. Bansutan (Intermediate Holding Area)

Larguhan (Main Stocking Area). The **larguhan** is the **largest section** of the pond and serves as the final grow-out area for fish before harvest. Once the fish have grown to a suitable size in the bansutan, they are transferred to the larguhan. The fish remain in this spacious area until they are ready for harvesting, a process locally referred to as *haw-as*. They considered fish are ready for harvest once it reach a body width of approximately 2 pulgadas (inches). After harvesting, they restocked the larguhan with the fish from the bansutan, which in turn is replenished by new fingerlings from the semilyahan.

Figure 4. Larguhan (Main Stocking Area)

This three-level system is a functional, responsive method because it facilitates fish growth and health, and maximizes pond space and resources. The method also demonstrates mathematical thinking in sequencing, measurement, and reason-based decision-making, which illustrates ethnomathematics in practice.



Cyclic Stocking Strategy

The fishermen in Banate apply a cyclic or rotational stocking approach, which helps provide a constant yield. This system functions like a relay:

- The nursery fingerlings are initially stocked in the bansutan.
- When fish in the larguhan are harvested, the bansutan fish are transferred there.
- The empty bansutan is restocked by fish from the semilyahan.

This technique ensures a constant supply of fish that can be harvested while also ensuring that the fish will always have space to grow. The system reduces overcrowding, faster and healthier fish growth, and it also showcases important mathematical concepts like mapping, cycles, and resource optimization emphasizing the role of ethnomathematics within traditional knowledge systems.

Direct Stocking Practice

In some cases, fishermen choose to **stock fingerlings directly from the semilyahan to the larguhan**, bypassing the bansutan. This occurs when there is sufficient space in the larguhan or when the fingerlings are already large enough to thrive in a bigger area. While this method can reduce labor and time for them, it carries a higher risk if the fish are not fully adapted or if the environmental conditions in the larguhan are not optimal for smaller fish. This highlights the **conditional decision-making** used by local fishermen, balancing practicality and risk management.

Local Knowledge and Beliefs

Banate fishermen rely not only on routine practices but also on generational ecological knowledge and cultural beliefs handed down by their elders. Central to this is the idea that fish grow better in spacious environments, influencing how and when fingerlings are transferred. This aligns with scientific findings that link overcrowding to stress, poor growth, and disease, while ample space promotes healthier, faster-growing fish. They also consider environmental cues like tides (*sikla* and *ayahay*), and follow traditional sayings such as *"mas dasig magdako ang isda kung may dako nga espasyo"* (fish grow faster when they have enough space). These beliefs, passed from one generation to the next, reflect a deep, holistic understanding of aquaculture that integrates environmental, biological, and cultural factors embodying the kind of reasoning ethnomathematics seeks to highlight in education.

Ethnomodeling and Mathematical Connections

Local stocking practices provide meaningful opportunities for **ethnomodeling**—linking cultural practices with mathematical concepts. The table below summarizes how these practices align with specific mathematical ideas and the Department of Education's (DepEd) K to 12 Most Essential Learning Competencies (MELCs):

Table 1. Ethnomodeling and Basic Mathematical Concepts in Banate Fish Stocking Practices

Local Practice	Ethnomodeling Insight	Basic Mathematical Concept	DepEd Math Competency
Fish transfer follows a cycle to maintain continuous production	Sequential movement of fish through pond zones (Semilyahan → Bansutan → Larguhan → Harvest) ensures continuous production through a cyclic system	Life Cycle and Sustainable Production	➢ *S7LT-IIIc-3 -Describe the reproduction process in animals* ➢ *S7LT-IIIa-1-Describe the different modes of reproduction in animals such as fish, frogs, and insects*
Fishermen visually assess fish size to decide movement timing	Informal, experience-based visual estimation of fish size—measuring length and width in *pulgadas*—guides decisions on when to transfer fingerlings between pond areas and when to time harvests.	Estimation, Approximation	➢ ***M5NS-Ia-43***: *Estimate and calculate using appropriate strategies* ➢ ***M4NS-Ic-25:*** *Use estimation in solving routine and non-routine problems*
Stocking based on fish-to-space ratio to avoid overcrowding	Managing optimal fish density per area to balance growth and prevent stress	Ratio and Proportion	➢ ***M6NS-IIIa-53***: *Illustrate and solve problems involving ratio and proportion*
"If fish are big enough and space is open, then transfer to Larguhan"	Conditional transfer decisions based on fish size and available space, reflecting logic-based ecological reasoning	Conditional Logic (If–Then)	➢ ***M7SP-IVa-1:*** *Use simple logical reasoning to make decisions* ➢ ***M10SP-IVa-1:*** *Use "if–then" statements to describe real-life situations*
Bansutan is smaller; Larguhan is larger and deeper	Matching fish growth stages with pond size and depth using spatial reasoning and measurement	Measurement (Area, Volume), Spatial Reasoning	➢ ***M5ME-IIIc-40***: *Convert units of measurement for area and volume* ➢ ***M6ME-IVa-47***: *Solve routine problems involving area and volume*
Output from one area becomes input for the next	Functional flow of fish across pond zones ensures continuous system operation and resource use	Functions, Mapping	➢ ***M9AL-Ib-1:*** *Understand relations and functions* ➢ ***M9AL-IId-1:*** *Illustrate and interpret functions using real-life situations*
Fish are sorted into sets by stage: fingerlings, juveniles, adults	Grouping fish into sets by size and age reflects informal classification strategies	Sets, Classification	➢ ***M7SP-IIIb-1***: *Describe and illustrate sets* ➢ ***M7SP-IIIc-2***: *Classify elements in a given universal set*
Fishermen make efficient use of pond space and time for best yields	Optimizing pond space and labor based on fish growth and harvest cycles under limited resources	Optimization	➢ ***M10GE-Ia-1:*** *Apply geometric concepts to solve problems involving maximum or minimum values (area/volume)*

Fish growth and pond conditions monitored to predict readiness for transfer or harvest	Using environmental and growth trends to inform stocking decisions and anticipate harvest	Data Interpretation, Trend Analysis (Informal Statistics)	➢ ***M6SP-IVa-1:*** *Collect, organize, and interpret data* ➢ ***M7SP-IId-1:*** *Analyze data using measures of central tendency*

Conclusion

The fish stocking practices of Banate, Iloilo, demonstrate a well-integrated system of traditional knowledge and practical aquaculture management. The structured use of Semilyahan, Bansutan, and Larguhan reflects an intelligent, adaptive approach that supports sustainability and productivity. These practices are more than just routines passed down through generations; they represent a living example of **ethnomathematics**, where mathematics is naturally embedded in everyday cultural activities. Concepts such as **sequencing, estimation, spatial measurement, logic, set classification**, and **optimization** are actively applied by fishermen in making decisions about fish transfer and stocking. The **cyclic stocking strategy** and **direct stocking choices** further show the community's adaptability and deep understanding of their environment.

By aligning these real-life practices with DepEd's **K to 12 Most Essential Learning Competencies**, this ethnomodeling approach not only validates indigenous knowledge but also provides meaningful, real-life contexts for teaching mathematical concepts. It promotes culturally responsive education that empowers learners by connecting abstract math to their own community's practices. Ultimately, Banate's fish stocking system exemplifies how traditional wisdom and scientific reasoning can work together to support both education and sustainability.

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