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Exploring Ethnomathematics in the Context of Fishing Squids (Pambubo) in Gigantes Islands, Philippines

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ABSTRACT
Teaching mathematics in the context of cultural groups is one of the priorities in the mathematics curriculum of the Philippines. These include localization, contextualization, and indigenization of mathematics instructions. The study of ethnomathematics is a special way of deriving mathematical concepts that are embedded in the practices and activities of cultural groups. This study explored the ethnomathematics in the context of Pambubo (fishing squids through traps). This study highlights the ethnomathematical concepts generated from the preparation of materials to the selling of squids. The ethnomathematical concepts present in the activities of Pambuboinclude basic counting, measurement and estimation, ratio and proportion, operations in whole numbers, fractions, and decimals, lines, angles, triangles, quadrilaterals, solid figures, distance, volume, time, average, surface area, and even mathematics of investment that are being applied by the fisherfolks. This study shows that the island community has strong ethnomathematical concepts that can be utilized by educators in teaching and learning mathematics.

Keywords: Ethnomathematics, Mathematics Education, Ethnography, Squid Fishing

INTRODUCTION

Every country is experiencing an increase in demand for mathematics education, and ethnomathematics can assist in addressing some of the teaching and learning challenges that exist globally. D'Ambrosio (1985) defined ethnomathematics as "mathematics employed by identifiable cultural groups" (p. 45), and these cultural groups can generate mathematical concepts and are capable of producing their own mathematics (Bishop, 1988). Because it is generated by the members in response to their own conditions, ethnomathematics developed by diverse groups is likely to be more effective at solving culturally-related problems (Borba, 1990). In this regard, students should recognize these mathematical practices and concepts as their own ethnomathematics; excluding them from the curriculum implies that they do not exist (Zaslavsky, 1994). Ethnomathematics' inclusion in the mathematics curriculum helps us make sense of the world, and by recognizing the cultural component of mathematics, we can gain a greater appreciation for its breadth and its capacity to provide a fascinating, artistic, and useful perspective on the world (Barton, 2007).

Ethnomathematics is more acceptable to indigenous peoples, as well as more accessible and economical, especially for those who live in rural and coastal areas. Ethnomathematics presented students with enrichment and new themes that they had not before encountered, illustrating that mathematical applications may be found not only in many areas of science, industry, and everyday life, but also in cultural activities all around the world (Rosa, D'Ambrosio, Orey, Shirley,Alangui, Palhares, &Gavarrete, 2016). Many studies have been conducted over time across the globe and any of these can be translated into the classroom with proper research. We can also look at communities based on a specific professional activity for ideas. There are numerous instances, such as Zaslavsky's (1973) book Africa Counts, which discusses the mathematical concepts that exist in African culture, Gerdes' (2005) research of artifact manufacture in Mozambique and its application in mathematics education, and the Code of Quipo – the numerical system of the Incas by Ascher and Ascher (1981). Also, Orey (2000), explored the ethnomathematics of the Sioux tipi and cone, to teach high school mathematics, Babbitt, Lachney, Bulley, and Eglash (2015) compared the use and non-use of Ghanaian Adinkra designs. The pattern of these designs which is based in their cultural context were translated into software programs. There are many other ethnomathematics studies conducted in different cultures, some of these can be found in "Ethnomathematics and its Diverse Approaches for Mathematics Education" by Rosa, Shirley, Gavarrete, and Alangui (2017).

In Asia, the ethnomathematical research studies include the mathematical activities of bus conductors (Naresh, 2015) in India and mathematical ideas from carpet and carpet weavers (Rafiepour&Moradalizadeh, 2022) in Iran. A lot of the latest publications of ethnomathematics studies were conducted in Indonesia which includes marriage in Javanese "Primbon" (Utami &Sayuti, 2019), Batik patterns (Prahmana&D'Ambrosio, 2020), season's systems and funeral dates (Prahmana, Yunianito, Rosa, &Orey, 2021), Tedhaksiten tradition for 8th month of the baby's age (Primaniarta& de Mattos, 2022), traditional game Bahasinan (Jabar, Gazali, Ningrum, Atsnan,, &Prahmana (2022), and architecture of Sasak traditional residence (Fauzi, Hanum, Jailani, &Jatmiko, 2022).

These studies were done for the improvement of mathematics education with cultural relevance. People who learn mathematics outside of school base their learning on situational knowledge rather than algorithmic learning and are more adaptable in their reasoning schemes (Nunes, 2010). According to D'Ambrosio (2006) the mathematics of cultural groups can aid in the contextualization and, more importantly, the humanization of mathematics (Palhares 2012).

In the Philippines, localization, indigenization, and contextualization of curriculum content and teaching strategies are essential features of the K-12 Curriculum which considers students' diversity and the unique contexts of a particular locality. Inclusion of students, which is achieved by creating spaces for their individual cultures, guarantees that educational practices remain relevant for all learners (DepEd Order N. 35 S. 2016). In addition, the Department of Education, through the mentioned order, empowered teachers and educational systems to involve community members to participate in indigenization processes so that the curriculum is accurate and true to the culture being studied. Gigantes Island is a component of Visayan Sea, Philippines, and one of the fishing activities here is squid catching using traps "Pambubo". This kind of fishing is a great activity that provides a wealth of ethnomathematical information that can be translated into mathematical concepts and utilized in classroom instruction. Hence, this study aims to examine the fishing tradition of "Pambubo," which entails the use of traps to capture squid. The aim is to derive mathematical principles from the traditional knowledge and practices of the fishermen, also known as "Manugbubos." The primary objective of this study is to identify the specific activities performed by the "Manugbubos" and to identify the ethnomathematical concepts underlying these practices.

METHODS

The methodology of this study was drawn from Creswell's (2013) notion of ethnography, by studying a culture-sharing group through identifying a single site, locating a group within it, and gathered data about the group who have shared behaviors, beliefs, and language. This study used ethnography to "uncover meanings and perceptions on the part of the people participating in the research, viewing these understandings against the backdrop of the people's overall world view or culture" (Crotty 2003, p.7). I used ethnographic tools (e.g. ethnographic interviews, participant observations, field notes) to better understand the culture of the group and the culture of the people interacted with throughout the research process, particularly those living on the island.

The setting of the study was at Islas de Gigantes (11.60° N, 123.34° E), also known as the Gigantes group, an island chain in the Visayan Sea that is part of the larger Western Visayas archipelago. It is located in the municipality of Carles, Iloilo, Philippines, and is in the province of Iloilo's northernmost area. Gigantes Norte (North Gigantes) and Gigantes Sur (South Gigantes) are the two largest islands in the Gigantes archipelago. In the Visayan Sea, the Gigantes islands are about 18 kilometers (11 miles) from Panay Island. The highest point of Gigantes Norte is 213 meters (699 feet), whereas the highest point on Gigantes Sur is 232 meters (761 feet). The two islands are separated by a narrow 800-meter-wide (0.5-mile) waterway.

Before gathering the data needed for the study, I secureda permit from the university, municipality, and local officials for the conduct of the study. After securing the permit, I identified and selected the manugbubos (fisherfolks that catch squids using "bubo" as traps) based on the set criteria as participants of the study with the help of barangay officials. After selecting the participants, I conducted the orientation of the study's purpose and goals to the manugbubos and handed in the informed consent. I stayed for 6 days per month for 10 months to gather and collect data needed for the study. The procedure of research adopted the ethnographic approach by Esterberg (2006) which includes the following: immersing in the field for an extended period of time, participation in different activities, observation while participating, taking notes while observing, conducting informal or formal interviews, taking more notes, analyzing notes, and writing the analysis.

Limitation of the Study

One possible limitation of the study is that it was limited to the "Manugbubo" community on Gigantes Island, Philippines. Despite the fact that this community exhibited strong Ethnomathematical knowledge, it may not be representative of other communities in the Philippines or around the globe. In addition, the study relied on self-reported data from "Manugbubo" community members, which may be subject to bias or inaccuracies.

Ethical Considerations

I collected the data in an open and transparent manner. I also explored individuals' locations with care, ensuring that they are not harmed, that their dignity is preserved, and that their privacy is protected. After the conduct of the study, the results were explained to participants to triangulate the results of the study and to avoid misleading or deceiving information to participants or readers (for example, fabricating evidence, falsifying data, or plagiarizing). The data gathered were disposed properly by deleting the files and burning the field notes.

RESULTS AND DISCUSSIONS

Pambubo as one of the fishing activities in Gigantes Island, Philippines was rich in ethnomathematical knowledge that can be transformed into mathematical concepts which can be used in teaching students. The ethnomathematical knowledge can be seen in different phases of Pambubo, from preparation of materials to selling of squids.

"Preparasyon sang GamitsaPambubo" (Preparation of Materials for Pambubo)

Constructing "bubo" or squid traps

In constructing the "bubo" or traps, the fisherfolks need to prepare the following materials: bamboo (for the skeleton of the "bubo"), nails, "binder" (plastic straps), nylon (1.2mm or LBS 90), nets (for wrapping the "bubo"), and guava branches with leaves or other trees that are available in the surroundings (this will serve as the nest of the squids).

The bamboo sticks will be the first to prepare and it is estimated to have 1.5 inches of thickness. The length of the bamboo sticks is estimated based on its "sukat" (a bamboo stick with an estimated length that serves as a standard guide in constructing the "bubos"). There are two (2) standard guides used by the "manugbubo". The first standard guide has an estimated length of 34 inches. This is used to construct the top and bottom main frame of the "bubo" and for the braces (serve as a scaffold of the trap so that it will not deform). The second standard guide has an estimated length of 26 inches and serves as the standard height of the trap that connects the top and bottom frames of the trap.

To construct the "bubo" they need 20 pieces of 34 inches bamboo sticks. Nine (9) pieces of 34 inches long bamboo sticks are for the top frame which includes 1 piece of stick for the brace while 7 pieces of 34 inches of bamboo sticks are needed to construct the bottom frame of the trap which also includes 1 brace. The remaining 4 pieces of 34 inches long bamboo sticks are intended for the side braces. Moreover, additional 8 pieces of 26 inches long sticks are needed to connect the top and bottom frames this also serves as the height ofthe trap.In summary, the "manugbubo" needs 28 pieces of bamboo sticks, 20 pieces of 34 inches and 8 pieces of 26 inches. Furthermore, this led to the dimension of the "bubo" or trap which is 34 inches x 34 inches x 26inches, which is a rectangular prism or a cuboid.

Figure 1: "Sukat" (34 inches long)

Figure 2: "Sukat" (26 inches long)

For the nails, the "manugbubo" usually used "uno ngalansang" or 1-inch-long nails. They commonly buy ½ to 1 kg of nails to construct the "bubo", depending on the number of traps to be constructed. Approximately 87 pieces of nails are used to construct the whole trap. Two (2) pieces of nails are used on every edge of the frames and also 2 pieces when they are going to connect the two frames (top and bottom) using 26 inches of bamboo sticks. The rest of the parts of the traps that need nail has 1 piece of it. The purpose of 2 nails on each edge is to strengthen the connection between the sticks and the two frames. To make the connection of the sticks stronger and more durable, the connection is tied by 1 span of an average person of nylon (approximately 1 ½ meters). Twenty-eight (28) bamboo stick connections in the traps mean that they need 42 inches long of nylon to finish tying the parts and complete "bubo" skeleton. The constructed skeleton is a perfect solid figure (rectangular prism, specifically cuboid)).

Figure 3: Skeleton of "bubo"

Before wrapping the skeleton of the traps, the manugbubo starts to create an entrance of the trap. The entrance of the trap is a 10 inches x 10 inches dimension. Attached to it are the 16 pieces of "sudyang" (7-inch-long thin bamboo sticks) which are bound together to create a circular shape enough for the squid to go in and will not able to go out. The nest for squids was also installed which is made of small branches of guavas or other durable trees.

Figure 4: "Sudyang" a 7-inch-long, thin bamboo sticks

Figure 5: Entrance of the "Bubo"

To wrap the "bubo" they used a net which has "sies matas" (1.25 hole 6 to 8 ft width/ no. 6) which means if you try to measure the dimension of the square formed in the net it is 1.25 inchx 1.25 inch. The hole in the net allows the small squids to go in and out of the traps to avoid exploitation of it. To completely wrap the trap, they need an approximately 3 meters long net. To close all the edges of the net wrapped in the "bubo" a nylon was used.

Figure 6: Net "sies matas" (1.25 hole 6 to 8 ft width/ no. 6)

Figure 7: Finished "Bubo"

Constructing of Payaw

The term “payaw” is commonly by Cebuano and Ilonggo which is a structure used as a marker for their traps made of small bamboo or small tree pole or trunk with Styrofoam (from the broken Styrofoam box) attached to it and a flag, plastic or coconut leaves that will make it more visible from afar. It is approximately 5 to 7 meters long depending on how big is the stem which is usually 2 to 3.5 inches in diameter. The Styrofoam is attached 3 meters from the bottom part of the stem which approximately weight 1 ½ kilograms. At the bottom of the “payaw”, “manugbubo” tied a binder (plastics strap) or rope which serves as the main connector of the “payaw” to the “bubo” and to the main foundation.

Figure 8: “Payaw”

Based on the activities of “manugbubo” in the preparation of materials, ethnomathematical concepts applied were basic counting, operations of whole numbers, fractions, and decimals, ratio and proportion, measurement and estimation, lines (which includes parallel, intersecting, and diagonal), rectangle, square, circle, and solid figure (rectangular prism, specifically, cuboid). The ethnomathematical concepts were reflected in table below.

Table 1:Ethnomathematical Concepts in the Preparation of Materials in Pambubo

Activities	Ethnomathematical Concepts
Preparation of materials to be used in construction of “bubo” (bamboos, nails, etc.)	• Basic counting • Operations on whole numbers, fractions, and decimals • Ratio and proportion
Preparation of “sukat”, frames, and braces	• Measurement and estimation • Ratio and proportion
Construction of bubo • Connection of frames and braces	• • Basic counting • Operations on whole numbers, fractions, and decimals • Lines (bamboo sticks), includes parallel lines, intersecting lines, and diagonal lines • Rectangles and squares • Solid figure (rectangular prism/cuboid)
• Entrance of trap and wrapping of “bubo”	• Square and circle • Surface area
Construction of “payaw”	• Measurement and estimation

“Pagpalawod” (Sail out to Sea)

In sailing out to sea, the manugbubo needs the “bubo”, “payaw”, motor boat, and fuel.Finding the specific location for the placement “bubos” or traps seems challenging for the manugbubo considering the wide ocean without using devices like GPS. However, they have a technique for locating the specific area of their traps. They call it "mirmada". It is a term used by the fishing community in the island to identify the specific location of an object or traps placed in the sea through angles using islands or any stationary object that is visible to them as a reference. The distance of the "bubo" is 13 to 25 "dupa" (arm span which is approximately 1.5 meters) approximately 20 to 38 meters. The manugbubo usually set up 15 to 100 traps. In one day, the manugbubocan consume 1 liter to 8 liters of gasoline or diesel depending on the distance of the area where they placed their traps. They estimate the consumption of fuels based on the number of engines of their boats and the distance of the location of the traps.

Setting Up the "bubo" or traps

In setting up the "bubo", manugbubo needs a "payaw" that will serve as a marker. There are two part submerge that is connected to the "payaw", the main foundation or "pamato" and the "bubo". To set up the main foundation or "pamato", they tied a 40 to 50 kilograms of stones with a binder whose length depends on the depth of the sea floor. Once the main foundation reaches the ocean floor, they added 5 or 8 "dupa" of binder. The basis of whether they add a 5 or 8 "dupa" is based on the estimated weight of the stones, for stones approximately 40 kilograms, they added an 8-dupa while a 5-dupa for stones approximately weighted 50 or more kilograms. They call this additional length of the tie for the main foundation or "pamato" of the marker "kulami". With "kulami", the "bubo" can survive the strong current on the sea floor and big waves. After setting the "pamato", it will then be attached to the "payaw".

To set up the "bubo", the "manugbubo" starts to count the number of dupaas the length of the binder. The length of it depends on the depth of the sea where they are putting their traps. The length of the binder is approximately less than 8-dupa (12 meters) from the bottom of the sea. Once they reach the intended length of the binder, one end is attached to the "payaw" and the other is connected to "parusnak" (an innovation they create which will protect the "bubo" from touching the floor of the sea and may cause of its destructions). In setting a "parusnak", the manugbuboneeds a small stone (approximately 8 kilograms) and a styrofoam (approximately ½ kilogram). The manugbubothen tied the stone with approximately 8-dupa of bindersuch that it will reach the bottom of the sea once they drop it. Once the "parusnak" is done, they attached it to the other end of the binder that is attached to the "payaw". Then they measure 1 ½ dupa of binder to tie the "bubo" or trap and then attached it to the "parusnak".This setup cannot be easily destroyed. However, illegal fishers are to blame for the destruction of the "bubo," as they placed fish nets in the location of the "bubo" which led to the disconnection of the primary foundation of the "payaw".

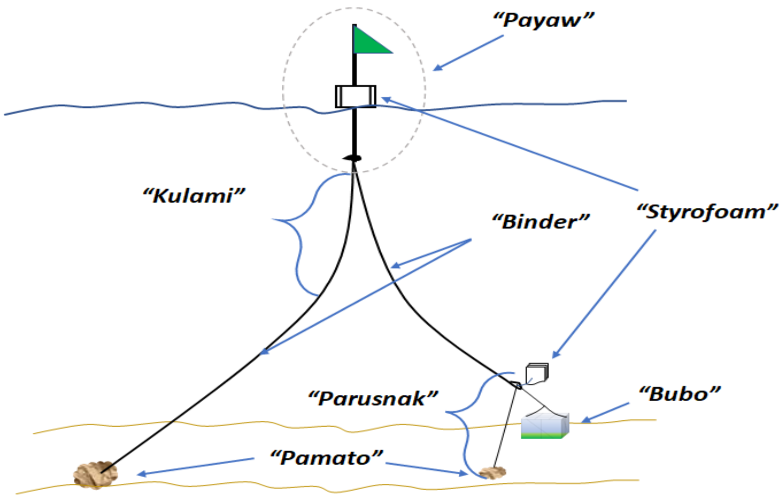

Figure 9: Set-up of "Bubo"

In sailing out to sea for fishing, the ethnomathematical concepts derived from each activity were basic counting, measurement and estimation, ratio and proportion, distance, volume, and time. The ethnomathematical concepts were reflected in the table below.

Table 2:Ethnomathematical Concepts in Sailing out to Sea for Fishing

Activities	Ethnomathematical Concepts
Selection of area for placement and retrieval of "bubo"	• Angles (formed from stationary objects, examples are mountains, island, lighthouse, etc., local term is "mirmada") • Distance
Fuel consumption	• Volume • Distance • Time
Setting up the "bubo"	• Basic counting • Measurement and estimation • Ratio and proportion
Construction of "payaw"	• Measurement and estimation

"Pagpakilo" (Selling of Squids)

The manugbubo sell their catch to the buyers called "amo" (middleman). The catch is put into the weighing scale. Usually, the kilo of the catch is expressed in kilograms. For example, 2.3kg (this means 2 kilograms and 300 grams) locally it is read as "dos tres" or 4.2 kg (4 kilograms and 200 grams) read as "quatro dos" and so on. The payment for the manugbubo has two options, "husayay" and "bayranay". In "husayay", the "amo" will pay the manugbobo at the end of the week or any day they agreed on. The manugbubo were also allowed to borrow money or materials they need for fishing from their "amo" which is locally called "bali". For every catch, the "amo" will issue a ticket (a small piece of paper) that reflects the weight (in kilograms) of the catch for a certain day. These tickets will be presented on the day of the "husay" for the manugbubo to get paid. The manugbubos were not allowed to sell their catch to other "amo". Once they decide to go to "pahusay" (computing all their catch and paying for it), the middleman is summing all their catch and multiplied it by the cost per kilo. After which, the middleman will deduct all the "bali" or expenses paid by the middleman. The remaining amount is the "abanse" or net of the fisherfolk. If the fisherfolk is in deficit, the deficit amount will be added to the future expenses which will be paid by the "amo". Themanugbuboapproximates the average catch in a month and the average expenses and losses of traps to determine the profit or loss.

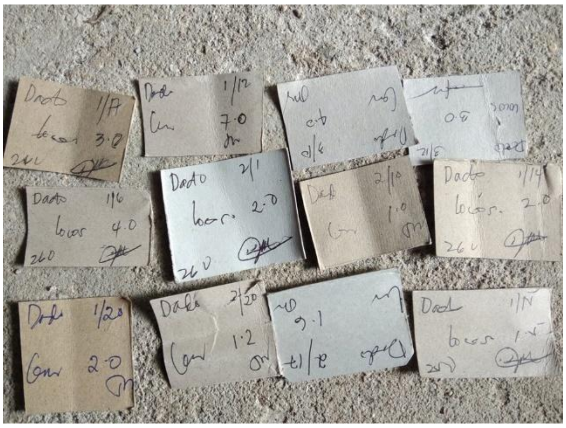

Figure 10: "Ticket"

In selling the squids, the ethnomathematical concepts derived from this activity were basic counting, measurement and estimation, ratio and proportion, average, distance, volume, and time. The ethnomathematical concepts were reflected in table below.

Table 3: Ethnomathematical Concepts in Selling of Squids

Activity	Ethnomathematical Concepts
Selling of squids	• Basic counting • Operations in whole numbers, decimals, and fractions • Average (mean) • Measurement (weight in kilograms)

	• Mathematics of investment

CONCLUSIONS

The community of manugbubohave been accustomed to employing symbolic mathematical calculations in daily activities in the of Gigantes Island's culture, such as the basic counting, measurement and estimation, ratio and proportion, operations in whole numbers, fractions, and decimals, lines, angles, triangles, quadrilaterals, solid figures, distance, volume, time, average, surface area, and even mathematics of investment. Angle expertise of manugbubowas outstanding, they ability to pinpoint the exact location of their traps utilizing islands and other stationary objects. Furthermore, existing mathematical computations are used to simulate and predict specific natural events. Ethnomathematics, for example, is still frequently employed, particularly among rural communities. This demonstrates that the island society has strong Ethnomathematical abilities, which must be institutionalized, utilized, and maintained in particular by formal educators. Apart from providing an overview of the community on the island, which is rich in Ethnomathematics, it must be preserved. This study is expected to inspire and motivate government officials, particularly those in charge of education, to preserve culture through Ethnomathematics on a realistic mathematics education program.

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