LINKING MATHEMATICS AND CULTURAL PRACTICES OF THE AGTA TABANGNON IN THE UPLAND COMMUNITIES OF GOA, PHILIPPINES

Salvador V. Briones II, Partido State University, Goa, Camarines Sur, Philippines (iD)
Shane C. Briones, Partido State University, Goa, Camarines Sur, Philippines (iD)
Marieta P. Palmes, Partido State University, Goa, Camarines Sur, Philippines (iD)
*e-mail: salvador.briones@parsu.edu.ph (corresponding author)

Abstract: The main foundation of ethnomathematics is an awareness of the many ways of knowing and doing mathematics that relate to the values, ideas, notions, procedures, and practices in a diversity of contextualized environments. The ethnomathematical practices of the Agta Tabangnon refer to the form of varying mathematical concepts that are embedded in their cultural practices. This paper presents the results of the efforts in documenting the ethnomathematics of the Agta Tabangnon in Sitio Ruras, Barangay Hiwacloy, Goa, Camarines Sur, Philippines. The significant contributions and challenges relative to their ethnomathematical concepts and cultural practices were also discussed. The Agta Tabangnon is a society that manifests stable cultural practices that capture and address every facet of their daily lives. Their ethnomathematics are instances of cultural practices that are passed down from generation to generation and have had a significant impact on society. Their ethnomathematics and cultural practices are the way their cultural group mathematizes their own realities in order to survive earnestly, so learning their practices is one way for us to embrace cultural diversity in our increasingly interconnected world.

Keywords: Indigenous People, ethnomathematics, Agta Tabangnon, cultural practices, contextualized environment

INTRODUCTION

Mathematics has been used by different people and cultures in different ways. It is the result of human cultural activities such as making patterns, calculating, designing, and application of problem-solving in our daily lives. In almost all instances, it is utilized to meet and understand the basic needs and ways of living of the people (Zaenuri & Dwidayati, 2018). Linking mathematics and culture helps develop an analytic mind and accurate expression of thoughts for a particular cultural group.

D'Ambrosio used the term Ethnomathematics to define the relationship between culture and mathematics (D'Ambrosio, 2001). Conversely, Rubio pointed out that ethnomathematics is the study of the mathematical techniques used by identifiable cultural groups in understanding, explaining, and managing problems and activities arising in their own environment (Rubio, 2016). Understanding the mathematical component of the culture of a particular community will enrich our appreciation of the culture in an interesting and useful view. Cimen offered the assumption that members of each specific culture created their own version of mathematics, therefore, mathematics was developed as a result of various activities based on the practices and experiences of these different cultural groups (Cimen, 2014). Hence, to be able to recognize mathematical concepts in culture, one must first understand mathematics and its role in culture (Hariastuti *et al.*, 2019). Thus, ethnomathematics has been recognized by Furuto and Phillips as a real-world problem-solving empowering students to be locally-minded, global citizens through a sense of place (Furuto & Phillips, 2021).

This article presents the Philippines culture as a source of mathematical thinking. With 7,641 islands spanning more than 300,000 square kilometers of territory divided into three island groups: Luzon, Visayas, and Mindanao, it is no surprise that the Philippines is home to a diverse range of cultural practices, traditions, and groups. The National Commission on Indigenous Peoples (NCIP) estimates that the country's indigenous people population continues to be estimated at between 10% and 20% of the national population of 109,035,343 persons based on the 2020 census population and housing (https://ncip.gov.ph, 2022). Among the archipelago's existing communities, there are indigenous people who have managed to keep their cultural identity.

Indigenous people reflect on their problems on a cultural perception and incorporate solutions based on those perceptions of society. They then develop solutions from the cultural resources of the society itself to address the specific situation. Thus, mathematical knowledge emerges as an immediate response to their needs for survival (Rosa & Orey, 2016).

A significant number of Indigenous People still live in the mountains of the province of Camarines Sur on the island of Luzon. Mt. Isarog, the province's highest forested peak, is located in Camarines Sur's fourth congressional district which is Partido. It covers the upland communities in some municipalities of Partido such as Goa, which has been considered as the ancestral territory of the indigenous Isarog Agta People for thousands of years prior to the arrival of the Spanish. They are a group of Aeta people

with a distinct heritage unique from others and live within Mount Isarog's circumference. Their descendants identified themselves as "Agta Tabangnon".

Goa is a landlocked municipality on the coast of the province and is part of the culturally rich Partido district. It has 206.18 square kilometers with a total of 71,368 populations as of the 2020 Census (https://www.philatlas.com, 2020). It has 34 barangays, one of which is Hiwacloy, which is known among locals as one of the upland communities where some Indigenous People still live (Figure 1). It is composed of different Sitios, and one of them is Sitio Ruras which is approximately seven (7) kilometers away from the mainland of the barangay. Sitio Ruras is located in the heart of Mount Isarog, within the Mount Isarog Natural Park, a protected area.

Figure 1. **The sitemap of the study (Google Maps, 2022)**

Studies focusing on Agta's existence, their concept of self, work and leisure, customs and traditions, socio-economic profile, organization, language, and survival have already been conducted by Avengoza-Almadrones (Avengoza-Almadrones, 2015). Septianawati *et al.* (2017), on the other hand, conducted another study in which they discovered units of length, area, and volume in one of Indonesia's ethnic groups. The findings of their studies provided concrete information on how distinct the Indigenous Peoples's lives are. The researchers discovered, however, that none of the authors investigated the Agta Tabangnon of Sitio Ruras, Hiwacloy, Goa, Camarines Sur, and its surrounding areas. It is in this sense that the researchers conducted a study that explored, documented, and discussed the socio-cultural activities of the Agta-Tabangnon in the upland communities in Goa, Camarines Sur that uncovered their practices, ideas, and concepts of Ethnomathematics and its significant challenges and contributions.

METHOD

This is a qualitative study that used an ethnographic and descriptive research method, as well as theoretical and empirical approaches, to document the ethnomathematics of the Agta Tabangnon in Sitio Ruras, the Philippine, and to discuss the significant contributions of these ethnomathematical practices to their cultural practices.

The theoretical approach was used in the analysis, organization, and generalization of the scientific, educational literature, and fiction on ethnomathematics and its association with the cultural practices of the key informants. Furthermore, as data collection techniques, the empirical approach employs observation, in-depth interviews, focused group discussion, narratology, and field notes.

Field notes were used as a primary way of capturing the data collected from participant observations. This includes data on what was observed such as informal conversations with participants and records of activities. In-depth interviews with the informants were also conducted. Interviews were scheduled and arranged before going to the community. Researchers also employed focused group discussions (FGD) with the key informants. Questions in the in-depth interview were used to brainstorm the answers given during the focused interview. Furthermore, follow-up questions were included in the FGD to allow the researchers to confirm the responses given. Following a series of interviews, the FGD was conducted. Narratology was also used in this study because the data was gathered through the informants' narrative stories about their lives, particularly those that revealed their cultural practices, views, beliefs, judgments, and feelings.

The key informants in this study include the inhabitants of Sitio Ruras, the Indigenous People Mandatory Representative (IPMR) in Hiwacloy, the LGU Council of barangay Hiwacloy, and some residents who originally lived in Sitio Ruras but moved to lowland barangays of Goa. Similarly, personnel from the Office of the Indigenous People in the Local Government Unit of Goa, officials from Barangay Hiwacloy, and school teachers and principals from Hiwacloy Elementary School and Pinaglabanan Elementary School participated in this study.

RESULTS AND DISCUSSION

The main foundation of ethnomathematics is an awareness of the many ways of knowing and doing mathematics that relate to the values, ideas, notions, procedures, and practices in a diversity of contextualized environments (Rosa & Orey, 2016). The

ethnomathematical practices of the Agta Tabangnon refer to the form of varying mathematical concepts that are embedded in their cultural practices. Although their mathematical principles were richly practiced through the years, there are still those who are unaware of their cultural significance. In addition, because modernization is developing at such a rapid rate, cultural preservation is vital, particularly among indigenous people (Nur *et al.*, 2020).

The number of Agta Tabangnon in Sitio Ruras is continuously declining because some are now living in the lowland of the barangay and nearby places while some are in "permanent settlements". The remaining Agta Tabangnon in Sitio Ruras are continuously practicing their archaic way of life. Hence, their mathematical knowledge is remarkable in terms of its possibilities, generation, and distribution (Pradhan et al., 2021).

The inhabitants of Sitio Ruras, affirmed by the IPMR and the LGU Council in barangay Hiwacloy, grow root crops, rice, vegetables, abaca, bananas, and coconut trees on their farms to support their living. In computing the perimeter of their farm, the Agta Tabangnon uses the *tupong* whereas one (1) *tupong* is equivalent to forty *dupa (fathom)*. A *dupa* is the distance from the right fingertips to the left fingertips when both arms are stretched out, including the torso. Figure 2 presents one *dupa*.

Approximately a *dupa* of an adult measures one and seven thousand two hundred seventy-two ten thousandths (1.7272) meters. Therefore, one *tupong* is approximately sixty-nine and eighty-eight thousandths (69.088) meters.

Figure 2. One *dupa*

In planting coconut trees, the Agta Tabangnon are still practicing the idea of nine (9) coconut trees in one (1*) tupong*. The distance of one (1) coconut tree from the other is approximately five (5) *tupong* which is equivalent to eight and six hundred thirty-six thousandths (8.636) meters. The distance between every coconut tree is a little bit higher eight hundred thirty-six thousandths (0.836) meters from the standard distance between coconut trees compared to the suggested distance according to the coconut field planting and farm maintenance of the Philippine Coconut Authority which is seven and eight tenths

(7.8) meters. These substantial distances according to Nimrod Sales, one of the Agta Tabangnon key informants, allow the coconut trees to freely and efficiently grow and not crowd the farm, thus allowing the farmer to plant another crop between these coconut trees. Figure 3 shows the Agta Tabangnon coconut farm that applies the idea of nine (9) coconut trees in (1) *tupong.*

Figure 3. Coconut farm of the Agta Tabangnon

Consequently, when these Agta Tabangnon worked for other farms, they were paid based on how many *tupong* they cleaned or planted. On a normal day, a worker on a farm cleaned or planted crops at least one (1) *tupong*.

Another known product in Sitio Ruras, including those Agta Tabangnon who moved to the lowland barangays of Goa is the *kabud*. A *kabud* is made of dried Abaca leaf stalks and braided manually. Figure 4 presents the *kabud*. Typically, *kabud* is a bunch of braided dried abaca leaf stalks that are folded twenty-five times with a measure of one (1) *dupa* per fold. A string typically has a diameter of five-tenths (0.5) centimeters.

Figure 4. The *kabud*

Another ethnomathematical concept of the Agta Tabangnon used in their everyday lives is the rice measuring equipment which they commonly called *takadan bagas*. This *takadan bagas* is normally used by the merchants in Sitio Ruras to measure the rice they are selling and to prepare rice for cooking. Generally, this *takadan bagas* has three (3) sizes which are commonly called as, *takadan*, *litrohan* and *gantahan*. Rice

was gradually poured into this measuring equipment and quickly ran a lever across its top to level its contents. The *takadan*, *litrohan*, and *gantahan* refer to the rice measuring equipment while the *takad*, *litro*, and *ganta* refer to rice measurements. Figure 5 presents the rice measuring equipment.

Figure 5. **The rice measuring equipment "*Takadan Bagas*"**

The volume of rice in *takadan* is approximately equivalent to four hundred (400) grams. And one (1) kilogram of rice is usually estimated as two and five-tenths (2.5) *takad*. On the other hand, the content of the *litrohan* is equivalent to two (2) in *takad* which is approximately eight hundred (800) grams. Moreover, the volume of *gantahan* is equivalent to six (6) in *takad* and the six (6) *takad* is approximately equivalent to two and four-tenths (2.4) kilograms of rice.
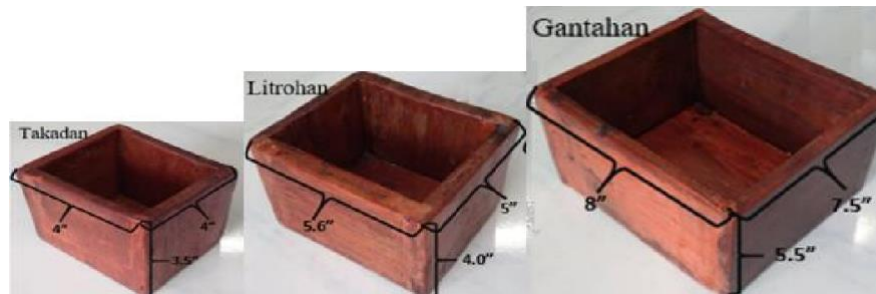

Figure 6. **Dimension of rice measuring equipment**

Noticeably, the dimensions of these rice measuring equipment are not standard. However, for the sample used in this study (Figure 6), the *takadan* has a length and width of four (4) inches and a height of three and five-tenths (3.5) inches. The volume is approximately 56 in^3. On the other hand, the *litrohan* has a length of five and six tenths (5.6) inches, width of five (5) inches, and a height of four (4) inches. The volume is approximately one hundred twelve (112) in^3. Moreover, the *gantahan* has a length of eight (8) inches, a width is seven and five-tenths (7.5) inches a height is five and five-tenths (5.5) inches and a volume are approximately three hundred thirty (330) in^3.

The cultural values, traditions, and practices are manifested in every society. This situation, therefore, holds an imperative point in human life and society. The ethnomathematics and cultural practices of the Agta Tabangnon play a significant role in the lives of the people living in Sitio Ruras and the nearby community. Their ethnomathematical concepts and cultural practices created a society that is distinctively defined by who they are, these are the practices that made our society rich and vibrant. Appreciating their ethnomathematics and cultural practices leads the way in respecting and recognizing their history, tradition, and mathematical thinking that is significantly passed down from generation to generation. It is also one of the instances in our society where we understand better and appreciate the true value and meaning of cultural dynamism.

One of the challenges currently facing the Agta Tabangnon is how to impart the ethnomathematical concepts and cultural practices that define who they are. Considering the influences of other cultures that are blissfully embraced by the younger generation and slowly suppresses their magnificent cultural practices. As Eden Colinares, the IPMR in Barangay Hiwacloy, stated, *"An mga aki na man kaya ngonian nag eereskwela, di su nahiling ninda sa mga kaklase ninda inaarug na man"* (Children these days are already sent to school, so they adapt to whatever they see and observe from their classmates).

The Westernized system of education and the perceived usefulness of mathematics in our daily lives may have been the reason that conceals our cultural inheritance. It is not surprising that the extremely practical concepts of mathematics we have learned from our ancestors, like the ethnomathematical concepts of the Agta Tabangnon, will be replaced by a new and hypothetical mathematical concept that has arisen. This condition perhaps puts them at a disadvantage side of our society and calls for an urgent response for a culture-responsive basic education. A type of education that is socially and culturally appropriate to their context. The lack of access to this type of education may hinder Agta Tabangnon from participating and engaging in the mainstream economy.

To address these pressing issues amongst the Agta Tabangnon and the entire indigenous people in the Philippines, the Department of Education (DepEd), according to the school principal and school teachers in Hiwacloy Elementary School and Pinaglabanan Elementary School, implemented the DepEd Order No. 32, s. 2015 or the National Indigenous Peoples Education Curriculum Framework. This framework was earnestly implemented pursuant to the Department of Education Order No. 62, s. 2011 entitled "Adopting the National Indigenous Peoples Education (IPED) Policy

Framework" and the DepEd Order No. 43, s. 2013, "Implementing Rules and Regulations of Republic Act No. 10533" otherwise known as the "Enhanced Basic Education Act of 2013".

The National Indigenous Peoples Education Curriculum Framework is a specially designed curriculum for learners from indigenous cultural communities. This framework was viewed as a significant step in realizing the Department of Education's "education for all". Primarily, the curriculum was written to be culturally sensitive to help the IP learners become functionally literate and contributors to society. And in response to the DepEd Order No. 32, s. 2015, Hiwacloy Elementary School and Pinaglabanan Elementary School, carry on the efforts in localizing, indigenizing, and enhancing the K-12 curriculum based on their respective educational and social context.

This is also in line with Turmuzi *et al.* (2023) and Retnowati & Marissa (2018) conclusions that pupils who are taught from an ethnomathematical viewpoint have better memory and average success scores than those who are taught from a traditional method and the elementary school children are still at the concrete operational stage, while the characteristic of mathematics itself is abstract. Similarly, in the realm of education, ethnomathematics research may be used to uncover concepts in cultural activities or social groupings in order to design a mathematics curriculum for, with, and by the group.

CONCLUSION

The ethnomathematical concepts presented in this paper are the local knowledge of the Agta Tabangnon developed over centuries of experimentation and passed orally from generation to generation. Their ethnomathematics were found to be an important catalyst to sustainable development due to their direct connection to resource management and conservation. To value and understand their local knowledge is a way of helping us realize that there are different ways of viewing the world, and gaining knowledge on indigenous knowledge, culture, and perspectives.

The continual change in the cultural diversity in the Upland Communities of Goa, Camarines Sur particularly in the areas of Mount Isarog, leads to the development of mathematics activities. The Agta Tabangnon in Sitio Ruras is a good example of a society that manifests a stable cultural practice that captures and addresses every facet of their daily lives. Generally, the ethnomathematics of the Agta Tabangnon are instances of their cultural practices that are passed down from generation to generation and created a great impact on their society that defines who they are. Their ethnomathematics, although accepted and well-practiced in their community, is an example of a situation where their

cultural inheritance has been excluded from the discussion in formal and academic mathematics.

The ethnomathematics and cultural practices of the Agta Tabangnon are the way their cultural group mathematizes their own realities to survive earnestly, therefore learning their practices is one way for us to embrace cultural diversity in our increasingly interconnected world. Moreover, preserving and instilling indigenous knowledge systems and practices is a way of protecting an endangered way of life for the younger indigenous people generation. In these contexts, the world is requiring experts to conduct further studies on the impact of globalization in cultural change and identity.

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