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The construction of the boat hull at Josefa Indigenous Community, from Mura ethnic group, and traditional mathematical knowledge

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Abstract: This paper aims to expose the construction of the boat hull in Josefa Indigenous Community, from Mura ethnic group, aiming to highlight traditional mathematical processes that simultaneously integrate non-indigenous techniques, shaped throughout the historical period that marked and continues to mark indigenous interactions with non-indigenous peoples. This qualitative research is proposed from an autoethnographic perspective, as data is produced by the researcher and their relatives, utilizing photography as a methodological tool. The hull construction is significant as it values Mura culture, affirming their indigenous identity, particularly in promoting the resilience of their cosmology. The proposal materializes as an opportunity to understand the mathematical knowledge produced in the Amazonian region, contributing to new epistemological approaches within the context of Amazonian Mathematics Education.

Keywords: Mura Ethnic Group. Indigenous Mathematical Knowledge. Mathematics. Autoethnography.

La construcción del casco en Aldeia Josefa, de la etnia Mura, y el conocimiento matemático tradicional

Resumen*:* El trabajo en pantalla busca exponer la construcción del casco en Aldeia Josefa, de la Etnia Mura, con el objetivo de exponer procesos matemáticos tradicionales que, al mismo tiempo, están vinculados a técnicas no indígenas, articuladas a lo largo del período histórico que marcó el contacto de indígenas con no indígenas. La investigación cualitativa se propone desde una perspectiva autoetnográfica, dado que los datos son producidos por el autor de la investigación y sus parientes, utilizando la fotografía como recurso metodológico. La construcción del casco es importante porque valora la cultura Mura, reafirmando su identidad indígena, especialmente en la promoción de la resistencia de su cosmología. La propuesta se materializa como una oportunidad para comprender los conocimientos matemáticos producidos en el espacio amazónico, contribuyendo a nuevas posturas epistemológicas en el contexto de la Educación Matemática Amazónica.

Palabras clave: Etnia Mura. Conocimiento Matemático Indígena. Matemáticas. Autoetnografía.

A construção do casco na Aldeia Josefa, da etnia Mura, e os saberes matemáticos tradicionais

Resumo: O trabalho em tela busca expor a construção do casco na Aldeia Josefa, pela Etnia

Mura, objetivando a exposição dos processos matemáticos tradicionais e que ao mesmo tempo se articulam a técnicas não indígenas, articuladas ao longo do período histórico que marcou e marca o contato dos indígenas com não indígenas. A pesquisa de ordem qualitativa é proposta a partir da perspectiva autoetnográfica, uma vez que os dados são produzidos pelo autor da pesquisa e por seus parentes, lançando mão da fotografia como recurso metodológico. A construção do casco é importante na medida em que valoriza a cultura Mura, afirmando sua identidade indígena, principalmente na promoção da resistência de sua cosmologia. A proposta se efetiva como uma possibilidade de percepção sobre os saberes matemáticos produzidos no espaço amazônico, colaborando para novas posturas epistemológicas no contexto da Educação Matemática Amazônida.

Palavras-chave: Etnia Mura. Saberes/Fazeres Matemáticos Indígenas. Autoetnografia.

1 Introduction

The article derives from a specialization course (Lato Sensu) titled 'Indigenous School Education', affiliated with the Federal University of Amazonas, Campus of Manaus. The objective was conceived to understand the process of hull construction within the context of the Mura Ethnicity, and through this perspective, to visualize Mura mathematical knowledge and to perceive the influences and interactions of non-indigenous mathematical knowledge.

With this perspective in mind, knowledge is not understood as antagonistic, but rather generated through an intercultural process, as both are formed within this space, specifically in the context of Aldeia Josefa, in the Miguel/Josefa Indigenous Territory. It is important not to deny power relations in intercultural learning; however, with this established ideology, possibilities emerge to diverge from paths that might essentialize knowledge, cosmologies, and culture. In other words, it involves viewing the context with plural perspectives, always aiming to break away from binary thinking and colonial discourses, which have been forged in different contexts, particularly in the Amazonian region.

According to Santos (2020), indigenous mathematics can be perceived as movements produced by different social groups in the understanding of survival/transcendence, as well as in the production of materials that culminate in concrete and oral artifacts. In other words, these are cosmological knowledge and practices that act as producers of knowledge, primarily enabling connections with ancestral aspects of indigenous culture.

Therefore, the current discussion is conceived through articulations and circulations of knowledge, where it is possible to perceive dialogues between different forms of knowledge production, each in its own way necessary for such dialogue. The research utilized qualitative research methods, with data produced through sequential actions in stages of the work, culminating in the creation of the boat 'hull', which has long been used as a means of transportation by the Mura people. In this way, photography was used to expose to the reader a dimension of the object's construction itself, especially considering the importance of visual records for history in general.

The history of the Mura people is linked to the early 18th century, when, in 1714, Father Bartolomeu Rodrigues sent a letter to Father Jacinto de Carvalho, informing him about the lands, rivers, and the indigenous people along the Madeira River. At that time, the Mura people were feared for their reaction to the colonizers of the Amazon. Known for their fearless and warrior-like nature, their tactics in battle earned them a reputation in history and historiography as the "villains" of the region (Santos, 2002).

Since then, contact with non-indigenous groups has intensified, and over the centuries,

a common scenario reminiscent of the colonial period has emerged: the subordination of groups that diverged from colonial subjects' characteristics, while simultaneously seeking to exclude their ethnic representations in order to form a national subject based on state/nation rules. However, Santos (2020) argues that despite the physical, cultural, religious, and other forms of violence, indigenous groups created counter-power actions linked to strategies of border negotiation processes, thereby emerging articulations and circulations of power.

This portrays the possibility that knowledges have been reinterpreted, articulated, negotiated, and have produced other knowledges to deal with their cosmologies and even their cultures. In this regard, Mignolo (2003, p. 69-70) writes that it is "[...] a way of thinking about otherness, of moving through 'another logic,' in short, of changing the terms not only in the sense of maintaining a conversation." In this sense, it is the quest to perceive other paths that have produced and continue to produce intercultural relationships, whether in the construction of the hull or in social and cultural relationships.

The theme at hand is linked to decolonial processes of seeing and perceiving different dimensions necessary for knowledge production, particularly in intercultural contexts, especially within the Mura ethnic context. Embracing the decolonial option "involves taking a stance - a continuous posture and attitude - of transgression, intervention, and impact on Latin American issues to enable new political, ethical, economic, and social horizons in dialogue with knowledge production" (Tamayo; Mendes, p. 04). Thus, the field of Ethnomathematics is embraced as an articulator in this decolonial principle, attempting to understand Mura Mathematics Education. Therefore, it entails understanding "[...] Mathematics produced by different ways of life as sets of language games that have similarities among them. Thus, there are no superconcepts that are intended to be universal and that can serve as parameters for others" (Knijnik et al., 2014, p. 31).

Therefore, as the proposal focuses on exposing the construction of the boat hull at Josefa Indigenous Community, it is certain that languages circulate, shifting perception away from the centrality of a universal narrative; instead, it is an ambivalent process, articulated within the historical context of this social group. Thus, traditional mathematical processes function as counter-conduct movements (Santos, 2018), aligned with Ethnomathematics teachings, establishing resistances within their cosmologies and Mura ways of being.

Thus, the paper aims to present through the following topics the theoretical and methodological proposal, primarily highlighting how the construction of the boat hull is an important instrument for maintaining Mura tradition, taking into account traditional mathematical knowledge.

2 Contextualizing and situating the research

The Josefa Indigenous Community, the research field or study area, is located on the left bank of Lake Josefa, within the Miguel/Josefa Indigenous Territory[1], in the municipality of Autazes-AM. It consists of three villages named as Josefa, Terra Preta da Josefa, and Miguel. Josefa Community is inhabited by the Mura Ethnic Group with an approximate population of 547 inhabitants, and its economy relies mainly on fishing and subsistence agriculture. Access to the village is primarily by water and partly by land/water through lakes, channels, flooded forests, and rivers that connect it to the city of Autazes.

The Josefa Community has two access routes to the city: The waterway access is through Lake Josefa, passing through Lake Miguel, connecting to the Rio Preto da Pataleão via the

[1] Created by a Federal Decree on April 21, 2001. http://www.planalto.gov.br/ccivil_03/DNN/2001/Dnn9180.htm

Sampaio channel, reaching the city of Autazes in a 4-hour journey by motorized canoe. The land access is via the Josefa branch road, 3.8 km long, connecting to the Sampaio road, a 25-km path, which, in turn, connects to the Rosarinho road, with the last 13 km to reach the city of Autazes. From Autazes, via AM 010 (State Highway) and BR 319 (Federal Highway), one can reach the capital of Amazonas State, the city of Manaus.

The construction of the boat hull is a cultural symbol among the Mura Indigenous people in the Amazon. The hull is a small canoe made of solid wood, suitable for hunting and fishing in hard-to-reach places such as flooded forests, *cacaia, aningal*, and headwaters, as it moves silently and is ideal for catching fish or to play games. Its use is crucial in a region characterized by forests intersected by numerous rivers, streams, filled with lakes, ponds, channels, and small rivers.

According to Lima and Souza (2021, p. 06), "[...] the hull is carved from a single tree trunk using an axe to fell the tree, a machete to shape the trunk, a chisel, and an adze to carve the inside of the wood." According to the authors, the tree trunk hull is called *bũgu* in the general Amazonian language, and its use by Indigenous people dates back to Christopher Columbus in 1492.

This cultural practice has been developed since the time of its first inhabitants and refined over time. In their locality, the Mura people use it as a means of transportation, for fishing, hunting, and other activities. Throughout history, the Muras have always mastered the art of navigating, which is why we have such deep knowledge of these interconnected waters. Only someone with this ancestral knowledge and expertise can navigate in and out at any time of day or night without relying on any geographical orientation equipment.

According to Maria Amélia Batista de Souza, 84 years old, her father Manoel Batista used to make hulls. She and her husband, Antônio Batista da Silva, 65 years old, learned from him how to make hulls, so it is possible to see the extent of this knowledge to the present day through her narratives. However, even though this knowledge is essential for the Mura community and culture, it is being lost, which is of a great concern for them because the lives of many in their village are intertwined with the prow of this small canoe, given that fish is their main source of food. Considering the importance and the need for each family to have a boat hull, it is necessary to think about this issue, thus making the construction of hulls a socio-economic and cultural reality.

The boat hull has been a tool used by the Mura for centuries, as the art of navigation is an integral part of their lives and compels them to build their own boats. This ingenious craft is passed down from generation to generation, from father to son and so on, and over the centuries, it has undergone some modifications and improvements. Lima and Souza (2021) report that the Bũgu, the tree trunk hull, evolved and came to be called a canoe. In this evolution, boards, beams, a keel, nails, screws, and bitumen for caulking began to be used, distinguishing it from the hull, which is made from a single tree trunk and does not require additional materials like nails and screws.

The canoe, which can also be called a “montaria”, is a small canoe made of boards, often replacing the hull due to its practicality and speed of construction. With a log (a tree trunk of approximately 3 cubic meters), it is possible to produce two hulls, whereas if it were built with boards, six or more canoes could be produced. For this reason, the production of hulls has been reduced, resulting in hulls being produced less frequently at Josefa Community.

Even though the canoe is quicker to build, it also has its drawbacks. It requires frequent caulking to fill the gaps, unlike the hull, which has no gaps unless it cracks. Additionally, a

board canoe is quite noisy when fishing or hunting, whereas silence is essential for these activities.

It is important to highlight that the construction of the canoe can be articulated with the understanding of what Bhabha (2014) calls hybridity, particularly cultural hybridity, in which "[...] the social articulation of difference, from the minority perspective, is a complex, ongoing negotiation that seeks to confer authority on cultural hybrids that emerge at moments of historical transformation" (Bhabha, 2014, p. 20-21). In this situation, the circulation of knowledge occurs, leading to small ruptures in both non-indigenous knowledge and the knowledge of the Mura people. However, these ruptures, even though they are influenced by power relations and constructed by discursive scenarios, do not drastically break with foundational knowledge, as seen in the process of hull production.

Mr. Flavio dos Santos da Silva[2], a resident of Josefa Community, was a hull maker who built many hulls for the villagers every year. When he had orders, he would produce up to four hulls of twenty palms (4 meters in length) per week. He used split logs (wood trunk divided in half), where two logs would yield four hulls.

It was not a task that Mr. Silva undertook alone; the family actively participated in the entire manufacturing process, learning together. It was a lesson where Mura's mathematical knowledge was present, even though, he was illiterate, i.e., he could not read or write. He mastered this knowledge well and referred to it as a science learned through practice. He used to say, "Pay attention, so you do not get it wrong!"

Regarding this issue, it is pertinent to comment on the concept of Ethnomathematics proposed by D'Ambrosio (2009). According to the author, Ethnomathematics aims to explain, understand, and comprehend the knowledge and practices of different peoples. In this sense, these groups move away from the schooled perspective, thinking beyond the official and academic viewpoint. Their knowledge, or the logic they use for production, construction, and validation, is partially built upon historical necessities, independent of Euro-American-centric mathematical thought. This means that "official" knowledge is not required to build, measure, count, and perform other activities essential for survival. From this perspective, research by Souza (2019) and Diogenes and Almeida (2023) outlines how Ethnomathematics can enhance traditional knowledge while creating pathways for dialogue between traditional mathematics and academic mathematics.

When Mr. Flavio mentions, "pay attention, so you do not do it wrong," we are engaging with a historical and traditional process of this people, certainly realized out of the necessity to transcend and handle everyday situations essential for survival. This is especially true of the mathematical knowledge generated by the Mura. The concept of Indigenous Mathematics is articulated with Santos (2020, p. 27) when he understands that...

> the term Indigenous Mathematics is not idealized from Western mathematics but rather from an understanding that Indigenous peoples [...] before and after contact with non-Indigenous people, have been producing cognitive tools to establish rules and patterns in response to the needs of planting, harvesting, hunting, and existing in a space where it has always been necessary to interact with nature and through it.

In this understanding, the concept of Indigenous Mathematics is decentralized from the naturalization of the concept of 'mathematics,' in the emergence of visualizing other

[2] Mr. Flavio dos Santos da Silva is the grandfather of Jonatha Daniel dos Santos, the main author of this paper.

epistemologies that subvert some Cartesian logics, producing alternative pedagogies, other epistemic pedagogies. In this case, when the hull comes into production, at some point in history, it was made by knowledge constituted within the scope of its culture without being linked to non-Indigenous knowledge, especially disarticulated from any principle of Western mathematics[3]. Such an assertion highlights the validity of Ethnomathematics and enhances the perspective of verifying the mathematics generated from particular problems and specific situations of different social groups, thus, a Mura Mathematics or a Mura Mathematical Education.

The understandings presented in this research are generated through a methodological approach that seeks to validate the production of the hull by its builder, articulated through Autoethnography. Thus, the proposal aims to engage with the process of boat construction while incorporating aspects that can be discussed in relation to the production and articulation between Indigenous and non-Indigenous mathematical knowledge.

Autoethnography is conceived through Ethnography. According to Santos (2017, p. 221)

> In 1975, Karl Heider (1975) used the term Autoethnography to describe a study where members of particular cultures referred to their own culture. In 1977, Walter Goldschmidt (1977) observed that "every Ethnography" is Autoethnography to the extent that it reveals personal investments, interpretations, and analyses. In 1979, David Hayano (1979) used the term Autoethnography to describe anthropologists who conduct and write ethnographies of themselves and who choose a location or field (of research) to link or "tie" one of their identities or group affiliations.

The following proposal proves valid as an indigenous person becomes the author of a " study about their own people, from the perspective of their own community" (Guisso; Bernardi, 2017, p. 11). This perspective is also evident in the work of Barbosa; Bernardi; Souza (2021) when they present the results of an investigation that focused on time as a theme of study, guided by listening to and recording the stories of the *Kofa ag Kaingang* from the Xapecó Indigenous Land, aiming to understand their conception of Time as expressed through stories.

In this premise, the indigenous author[4] constructs their research through their experiences within the context of their village, their land, their cosmologies, and traditions—elements that may not be perceived in the same way by a non-indigenous observer. Santos (2020), in his work with the Tupari people, an indigenous group in the state of Rondônia, emphasized the validity and necessity of having indigenous people themselves narrate their own history. The author argues that presenting facts from the indigenous perspective allows "[...] (non-indigenous) researchers to hear from people who experienced the initial contacts with other social groups, while also offering insights from those who live the daily life in/from the villages" (Santos, 2020, p. 102).

The writings of Scribano and De Sena (2009) support this discussion by noting that autoethnography as a qualitative research method involves working with "privileged information." Such information, especially conveyed through oral language, cannot be fully observed and comprehended by an external observer.

Moving forward in the textual production, the next section will detail the construction of a

[3] Western mathematics is understood as the one which was established within academic spaces and school curricula, characterized by representational processes dictated by symbolisms, abstractions, axioms, postulates, among others. This model of mathematics acquired its rigid stance in the 19th century with an emphasis on pure and applied mathematics.

[4] The 'indigenous author' refers to Jonatha Daniel dos Santos, a descendent from Mura ethnical group.

boat hull at Josefa Idigenous Community. Based on this contextualization, the following topics are presented in the first person singular, considering it as an empirical discussion where the issues arose from moments during boat hull production, as well as the researcher's narration in this study.

3 Beginning of the construction of a Mura-style hull – a narrative by the author himself

My grandfather, like every native indigenous person who respects Mother Nature, always used to say: "we must ask permission from the forest to fell a tree," and this applied to everything, from a water spring, in rivers, lakes, *igarapés*, even when we went fishing he would say, "we have to ask nature for permission, that's how we are repaid." The belief in spirituality is part of our lives and in our daily lives, a deep respect for nature where our livelihood lies, and we must act with respect, taking care of what we have best, nature.

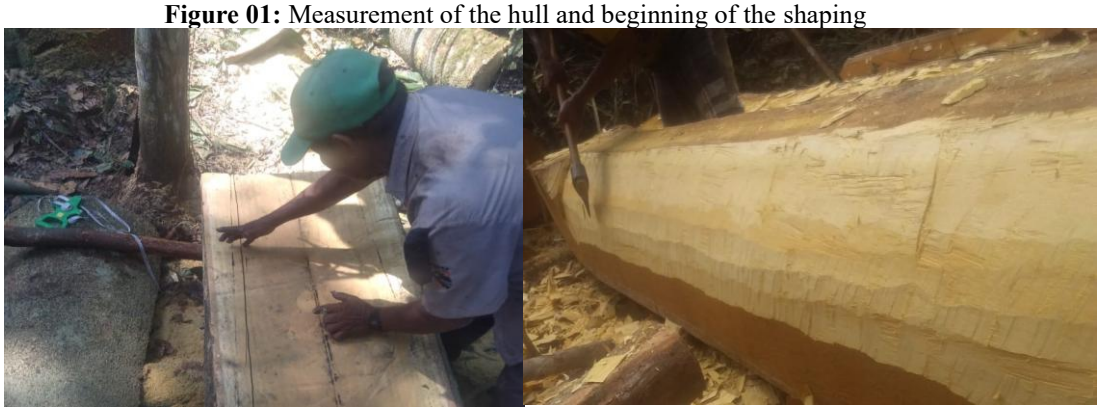
My grandfather explains some important points for choosing the wood. The choice of wood is essential considering its durability. For this, some criteria must be taken into account: 1) it must be wood that does not crack much; 2) it should not have holes and Y-shaped cracks; in this case, it only serves to make the hull if the crack is straight; 3) it should soften with fire. Fruit-bearing trees should not be cut down, as they need to be respected, standing they produce more, feed us, therefore, the tree, in addition to the three points mentioned above, must be male trees, which are those that do not produce fruit or are knocked down by nature, for example, storms.

The tree preferred for its durability and that softens well with fire is the *itaubeira*, but hulls are also made from *castanheira, piquiazeiro, uxizeiro, jacareubabeira, louros*, and others.

If the choice is to fell a standing tree, it is important to observe the moon phase; during the New Moon, the wood tends to split easily. My grandfather also observed the moon's position, which he referred to as its height in the sky according to the days of the month, as well as its alignment with the earth, noting various positions over the days. Through this, he could predict whether it would rain or be dry weather for the week, and determine if it was a good time for planting based on the moon phases.

According to him, during the time when the moon was very thin, known as the "strong" phase, it was not good for felling trees because the wood could split, and split wood is not suitable for making a hull. To prevent the wood from splitting during the New Moon phase, my grandfather had a few tricks, such as tying it with *taracuá* vine before felling the tree.

Figure 01: Measurement of the hull and beginning of the shaping



Source: Elaborated by the authors

Such lashing prevents the wood from splitting, and I confirmed this in practice, observing that it indeed remained intact. This was further confirmed when I did not tie the vine around another tree, and it split. Another thing my grandfather always taught us about being careful when felling trees is during the lunar phase known as 'borer's moon,' as borers are tiny

insects that attack wood, causing it to turn to powder and rendering it unusable. This typically occurs in low-quality wood. Everything must be rigorously observed for wood selection, a process my grandfather rigorously upheld. After a tree is felled, it undergoes a thorough check for any cracks to ensure the hull will not develop future problems, thus avoiding wasted effort.

My grandfather used to say that a span of *itaúba* heartwood one hand high is sufficient to make a half-log canoe. His techniques intertwined, forming a unique wisdom in the construction of these canoes, as can be seen in Figure 01. They are important for economic activity and carry tradition and culture through knowledge and practices.

3.1 The carving[5] of the hull

The process of making the hull is a Mura mathematical knowledge that can be compared to the four basic operations of non-indigenous Mathematics as well as Geometry, Angle Measures, and other subjects related to Western mathematical knowledge. The carving of the hull is done with perfect and ingenious measurements, stemming from those who know this reality. However, these measurements are "engraved in the mind" of these professionals, meaning that as the hull increases in size, all measurements are also adjusted accordingly to fit each specific size.

It is important that there are no errors in the measurements during its construction; otherwise, the hull may come out crooked, with the bow bent to the right and the stern to the left, with imperfections or even break due to execution errors, and also have unwanted twists. My father can spot small errors in the finishing made by other hull makers with just a glance and says, "the error was made during the carving." With good execution, there is efficient use of wood, minimizing waste.

A typical hull usually measures twenty spans (4,5 m) long. The hull may have a bow width of 8 cm at the front, opening into two lines of 80 cm with a 30-degree angle, then continuing parallel for 2.40 cm, closing with two lines of 80 cm each until reaching a vertical line of 8 cm. In total, there are 3 different measurements repeated 4 times and 2 identical ones, resulting in 14 sides, as shown in Figure 02.

Figure 02: A ready-to-be-shaped hull

Source: Elaborated by the authors

In this process, tools like axe, line, inkpot, and tape measure are used, but the old masters used splints, straw, sticks, and plumb line. The plumb line was self-made. Measurements are

[5] Carving is the art of shaping wood into various forms or reliefs

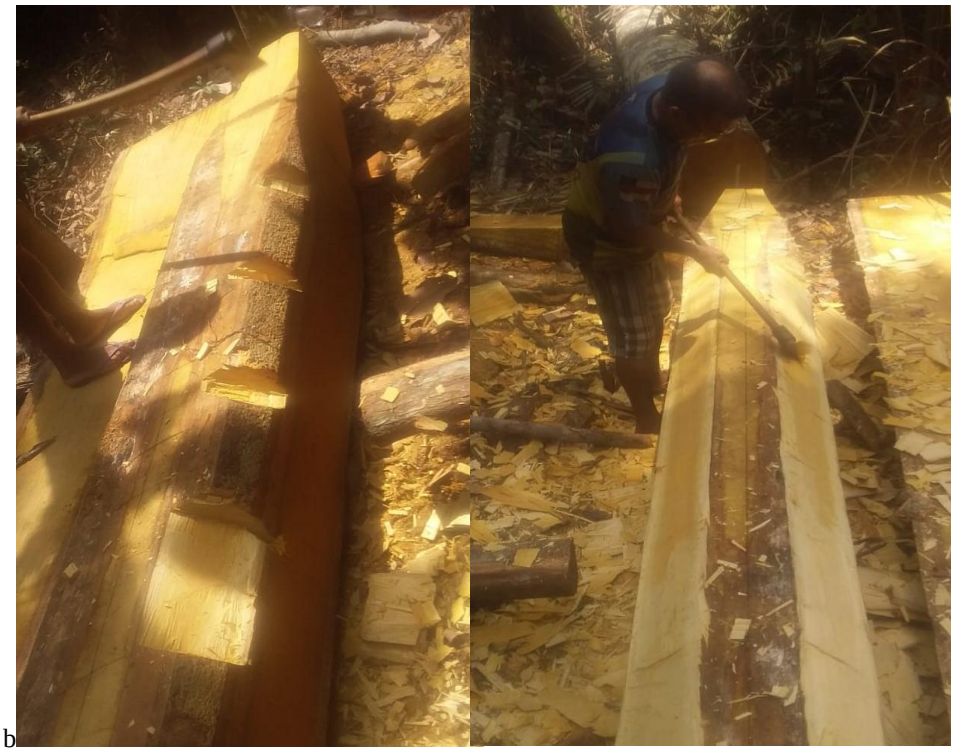
always presented in palms, but international decimal measures like meters, centimeters, and millimeters are also part of their daily life. However, they see their measurements as "our own way of measuring," and our calculations can also measure and verify correctness. Nowadays, chainsaws expedite this manufacturing process, partly replacing the axe, which is indispensable in hull construction.

In terms of mobilizing knowledge, the palm is most commonly used for measuring and dividing small measurements. By using this method along with straw or splints, plentiful in the forest, we can cover and encircle our houses, make sleeping mats, fans to wave over the *panacú* (a type of basket), carry cassava, and even make toys for children from straw. Thus, straw provides us comfort and wisdom.

3.2 Wood smoothing

The booliation process is very complex when worked in a concave parabola downward that changes and decreases the parabola through more precise cuts called "lavar." Our body stays in various crouched positions, becoming tiring. The hull must be plumb without movement or sway, and the curve must be perfect without flattening; otherwise, it will cause problems if the parabola is not perfectly adjusted in “tufas” (straight turns convex and cracks due to excessive force by bending in the opposite direction). If it remains imperfect, the greater the flattening or a small straight in the curve, the greater the cracking, and this hull may not even be useful, resulting in wasted work that cannot be used, as shown in Figure 03.

Figure 03: Hull booliation



b

Source: Elaborated by the authors

After the axe cuts are made perfectly without errors, it is time to use the plane for corrections and refinements to form a perfect curve. For this, polishing is performed, followed by drilling. Drilling involves making small perforations 3 cm deep all over the hull using a manual drill, with a spacing of 30 cm to 40 cm in a parabolic shape and in uniform straight lines. Then, the hull thickness is defined initially through carving and is done in a rectangular

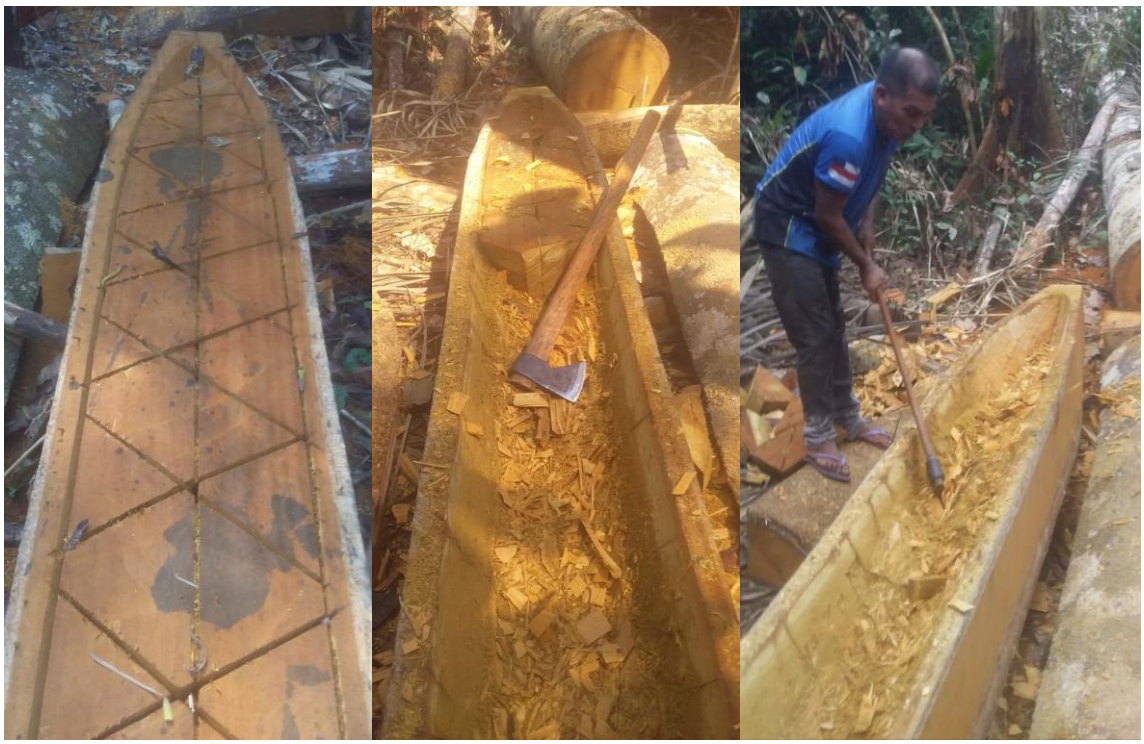
manner, following the curves and cuts of the hull.

After the process of booliation, the interior of the hull is cleaned until the drilling holes, which are around 3 to 4 cm, are revealed. Tools such as adze-gouge and iron-gouge are used, excavating with great care, taking into consideration the verification of thickness so that the excavation results in a parabolic shape, according to the hull's measurements. This process requires a lot of skill with sharp tools to avoid serious accidents.

Immediately after this process, the hull opening follows, which my grandfather called "esbarrar." This is a delicate and ingenious process where science, chemistry, and religion are present in this knowledge, and among the Mura people, beliefs are present in all areas. This is because spirituality and mysticism are part of our culture and our daily tasks.

3.3 Excavating the hull

Figure 04: Some steps of the hull excavation



Source: Elaborated by the authors

The excavation is done carefully to avoid puncturing the wood. One must have a keen sense of observation, and the tools used include: axe, adze-gouge, and adapted iron-gouge. The cutting requires great skill and must be done with a "light hand," as my father says, to avoid "aluir" (a small crack that cannot be seen until the hull is opened, leading to irreversible cracks). As one approaches the shoulder, the curve at the beginning of the bow and stern, the triangles become smaller right triangles, thus reducing the depth of the cuts, always feeling and calculating, and always reducing the parabolas, cutting until the hull's thickness is around 6 to 10 cm. There are other processes to further thin this thickness. Mura Indigenous mathematics has always been present in the daily lives and mastery of these craftsmen who, with just a glance, can execute this work, primarily due to their many years of experience. These masters, many times even not knowing conventional mathematical content, excel in their calculations due to the empirical knowledge passed down from generation to generation.

This process is time-consuming, and every day when the work is finished, the hull must be covered to prevent the sun from causing any cracks that could compromise other parts of the manufacturing process and finishing.

Under these circumstances, the hull must be upright and firm to avoid movement until it is flipped over to begin another manufacturing process. This next step, known as booliation, is the most complex and challenging, often causing difficulty for new apprentices.

3.4 Process of hull cleaning for the opening

After being cleaned, the hull is ready to be opened. According to my father, there are two ways to open the hull: one with fire and the other with water. The method most used by the masters at Josefa Indigenous Community is fire. This process involves flipping the hull onto four forks and two wooden crossbeams at a height of 30 to 40 cm. Several fires are then lit along the entire length of the hull. It is crucial not to let the heating cause a fire; it should be heated only until the wood softens, with careful attention to the wind direction to prevent any risk of fire.

Figure 05: Cleaning the hull opening

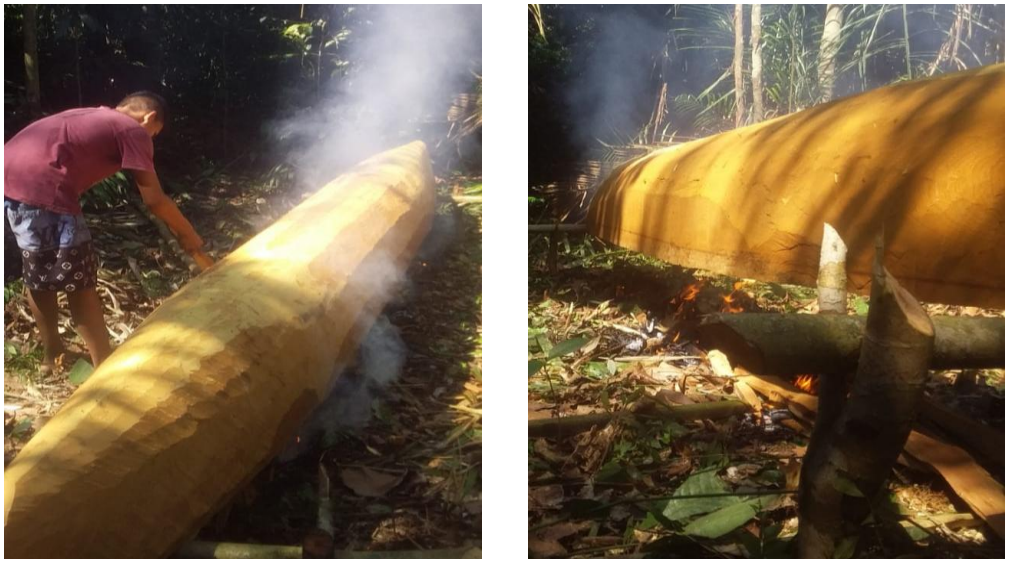
Source: Elaborated by the authors

To know if it is at the ideal point, we tap the warm wood with our index finger. If it sounds hollow and feels soft, it is ready to open.

To open the hull, it is necessary to bend it, which means immediately flipping it while still hot, extinguishing the fire to prevent a potential fire hazard. There is a technique to extinguish fire in places where water is not readily available. Right after removing it from the fire, the *pachiuba* scissors should be prepared, tied with *guariba* vine or *titica* vine, which are tools used to open the hull—similar to a large-mouthed forked stick made from *pachiuba*.

Wooden clamps, called engates, are also used to prevent the bow and stern from splitting during the hull opening. Lastly, a lever stick is used to move the piece with minimal effort.

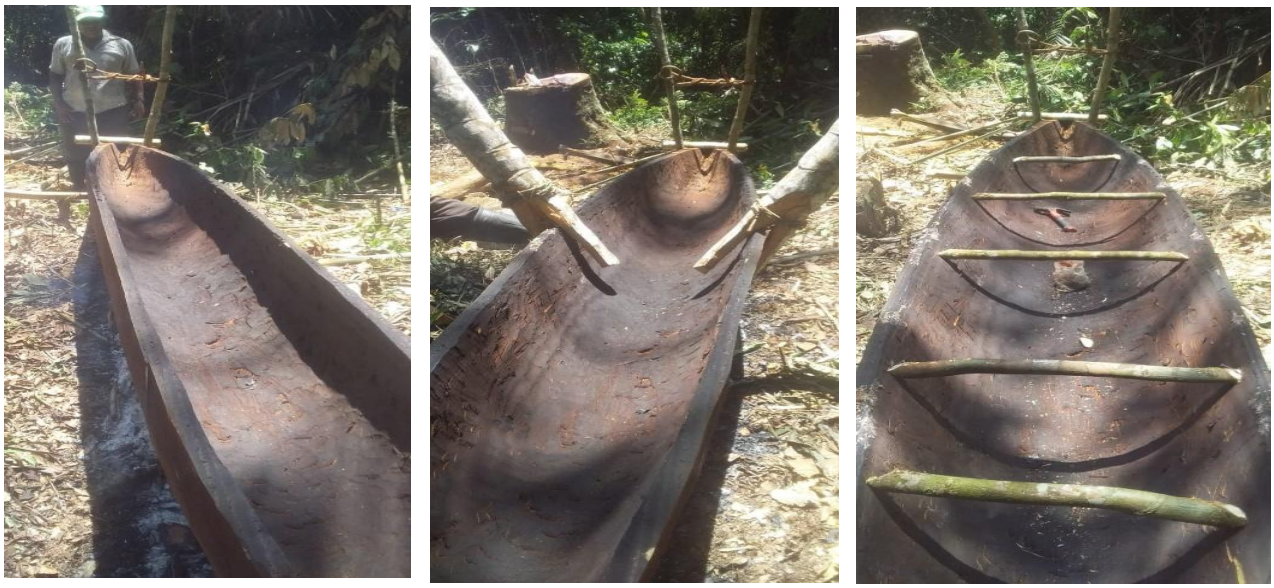
Figure 06: Fire for the hull opening



Source: Elaborated by the authors

After this stage, the process of opening the hull proceeds carefully, starting from the middle by placing the "pontaleites", which are wooden instruments, pointed on both sides in a V-shape, which are inserted into the softened wood that has been heated by the fire. They are driven into the inside of the hull, providing support to the new shape of the hull and ensuring the correct or ideal points of shaping and desired opening—whether fully open, partially open, and with an appropriate shape for navigating the waters. This last process, according to my father, has to do with the curve of the hull: the greater the curve, the better.

Figure 07: Hull opening (final process)



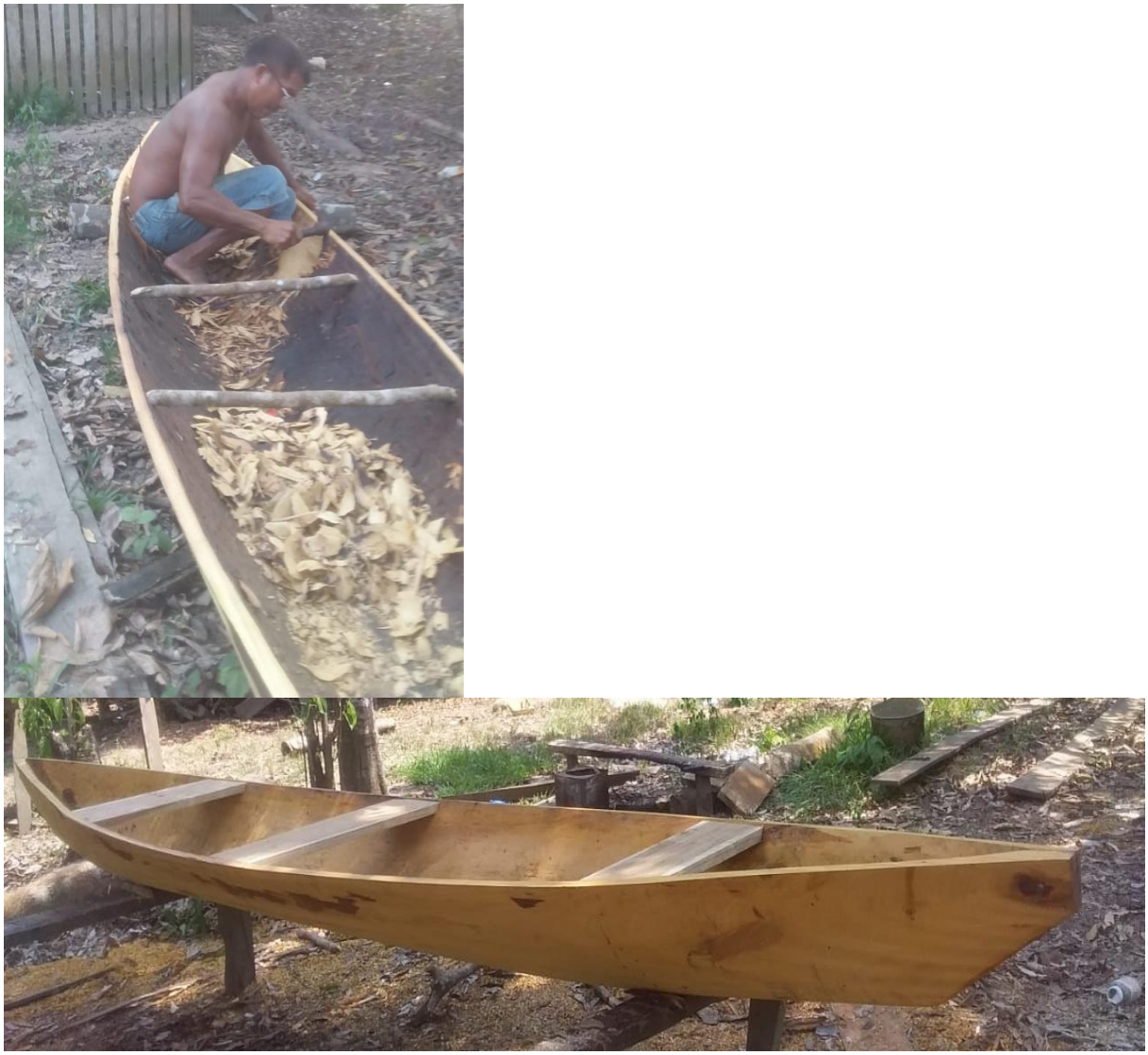
Source: Elaborated by the authors

According to my father, on the day before the opening of the hull, those who are involved in the opening should not have sexual relations the night before because, despite all

precautions, the hull may appear with cracks and will not result in a perfect hull.

After being opened, the hull is removed from the forest on frameworks of sticks called "jucurarú," pulled by vines pushed by poles, until near the residence where the final cleaning and finishing is done, as well as turning to seal the holes with the wood itself that was made with the auger to prevent any leakage, and finally, seats and keel are installed.

Figure 08: The last touches and final result



Source: Elaborated by the authors

Thus, the process of hull fabrication at Josefa Indigenous Community is concluded, and it is ready for use, fishing, and travel. Indeed, the hull has so many uses that even in its old age, it can still serve as a planter for onions, vegetables, or medicinal herbs.

Currently, at Josefa Indigenous Community, there are only two professional masters still active, both aging over 60 years old, and they are stopping building hulls. If there is no interest from the youth to continue hull construction, it will disappear, as there will be no one to carry on despite its usefulness and utility. Today's youth have other interests and have not sought to value our culture or show any interest in learning.

The knowledge and skills of these masters must be valued and passed down to future

generations so that the culture of hull construction does not become extinct. Today, in our villages, things are different; what should be learned is no longer taught, our heritage is undervalued, and worthless things have more value. What will be the future of our youth and our culture like?

4 Potentials and perceptions about hull production and Mura Mathematical Education

During hull production, there was a significant learning experience spanning three generations: my father, myself, and my son. It is expected that this knowledge will be passed down, ensuring the preservation of our culture. New participants will emerge, learning the craft of hull production, believing that this knowledge will extend to future generations and actively participate in the Mura way of life, contributing to the construction of our collective knowledge.

The culture needs to remain 'alive,' and the hull represents a tradition of our people. Despite centuries of subordination, it remains tangible; the hull is a sort of masterpiece crafted by artisans committed to achieving beauty. Therefore, it can be affirmed that a culture will remain vibrant among its people through dedication to preserving their traditions and cultural heritage.

The construction of the hull is not a simple task; rather, it requires effort, patience, and techniques guided by Mura mathematical teachings. Thus, it affirms that practical knowledge is our science. For instance, softening wood to reshape it into another form, creating defined curves—these are skills generated and passed down by our ancestors, refined over time in hull construction. The use of fire and hot water further exemplifies this, demonstrating that as techniques evolve, so do the Mura.

In the contemporary world, we utilize new tools; we do not stand still but rather evolve alongside humanity. In the construction of this hull, we incorporate tools like the chainsaw. This does not mean a loss of culture or imply that we are any less Mura; on the contrary, our craftsmanship remains as perfect as ever envisioned. It represents a cultural process carried out with new tools, maintaining the artistry of a people who have always lived on canoes. Thus, it illustrates intercultural processes shaped by the blending and articulation of knowledge. In this textual production, such implications are exposed, integrating Mura perspectives with teachings of non-indigenous mathematics—neither devaluing nor overvaluing, but fostering possibilities for intercultural dialogue.

Through this research, it became evident how it is still possible to construct and reconstruct objects that have been and continue to be part of our culture. Through autoethnographic processes and a theoretical framework that allows for different perspectives on Mura cultural situations, it was possible to establish comparisons in the hull production process, considering several aspects: a) production using traditional tools and knowledge; b) production integrating non-indigenous tools; c) production involving non-indigenous knowledge, such as non-indigenous mathematics; d) integration of cultural knowledge; e) creation of new hybridized and intercultural knowledge.

How enjoyable it is to roam, fish, and hunt in a hull produced by ourselves. It is immensely satisfying to have a hull to venture out at night and by dawn, our lunch and dinner are already assured at no cost, as this is a highly important tool for Mura families. With the hull, we have plenty of fish. With the lake, fish, flour, salt, and fire, the Mura people have plenty guaranteed food.

For our culture, it is important that children and youth actively participate in daily tasks to acquire knowledge. My son participated from the very beginning to completion, practicing

and honing basic skills, thereby safeguarding our culture, knowing it is a challenge for traditional peoples. Valuing what is ours, affirming our indigenous identity, promoting a sense of confidence that we are strong and resilient, and thus demonstrating that we stand tall in this century, seeking new knowledge and understanding, both our own and from non-indigenous society.

The use of Mura mathematics is constant in our daily tasks because without it, the execution of tasks would be impossible, and through the skills acquired in the process of constructing our identity. Observing the elderly villagers who lack knowledge of reading and writing, it is possible to see a mathematical knowledge with extensive experience, mainly through lived experience, for example, when measuring the bark of a tree for the quantity in liters of tea, or the quality of leaves, flowers, or grams of seeds for a specific remedy, among other situations that can be observed in the context of the village.

In this understanding, the construction of the boat hull also presents itself as a valuable learning opportunity for the Mura community and for strengthening the knowledge produced in the Amazon. In the field of Mathematics Education, the research highlights the vigor of Ethnomathematics, particularly in contributing to the understanding of mathematical production in different social contexts, providing strategies that break away from binary scenarios. That is to say, it is not about a singular knowledge or how its narrative is experienced; on the contrary, there is an urgent need for reflection on how these knowledges, by assessing their historical contexts, can be sufficient and contribute to our perception of what mathematics is.

Such perception can be discussed not with colonizing propositions or singular narratives, but with the possibility of intercultural dialogues through the articulation of knowledges, making them circulate between Mura cosmology and non-indigenous knowledges, between Amazonian Mathematics Educations and other forms of education, between the lived experiences of forest peoples and other subjects. This is an invitation for a reflection on movements that emphasize the centrality of culture in our production as human beings, starting from a decolonial principle.

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