INTERNATIONAL SEVEN JOURNAL
OF MULTIDISCIPLINARY
ISSN: 2764-9547

Naval carpentry and mathematical knowledge: A sociocultural study in the Amazônia Tocantina – PA

Carpintaria naval e saberes matemáticos: Um estudo sociocultural na Amazônia Tocantina – PA

DOI: 10.56238/isevmjv2n4-007
Receipt of originals: 20/06/2023
Accepted for publication: 10/07/2023

Robson do Carmo Dutra Dias
Master's student in the Graduate Program in Science and Mathematics Education (PPGECM)
Institution: Federal University of Pará (UFPA)
E-mail: binho87dias@gmail.com

João Claudio Brandemberg
PhD in Education from the Federal University of Rio Grande do Norte (UFRN)
Institution: Federal University of Pará (UFPA)
E-mail: brand@ufpa.br

ABSTRACT
The text discusses the mathematical knowledge present in the socio-cultural activities of naval carpenters in the Tocantina Amazon region, in the state of Pará. It seeks to understand how this knowledge is acquired and applied in the construction of vessels and what relationship it has with school mathematics. Using an ethnomathematical approach, the work is theoretically based on authors such as: D'Ambrósio (2022); Knijnik (2004); Lucena and Fossa (2000); Pantoja (2015), Mendes and Farias (2014), among others. The work also highlights the geography and history of the research site and the Amazonian-riverine peoples. The data was collected through observation and interviews with naval carpenters, holders of unique and valuable knowledge for the research. The results indicate that the carpenters have diverse knowledge about their culture, profession and the place where they live, acquired empirically over time, through experience, mistakes and successes. The more experienced carpenters have a greater amount of knowledge, due to their prolonged contact and experience with the profession. By analyzing the mathematical knowledge involved in naval carpentry, the study shows applications of mathematical concepts in the field of Geometry, Algebra and Arithmetic, used empirically and passed on to apprentices over the years. This knowledge is fundamental for the construction of stable, safe and quality vessels, and its transmission is essential for the continuity of this socio-cultural practice.

Keywords: Naval carpentry, Mathematical knowledge, Socio-cultural practices, Tocantina Amazon.

1 INTRODUCTION

When we approach and analyze the terms "Shipbuilding" and "Ship Carpentry", we can identify some differences and these will be extremely important for the theoretical approach of the research. The concept of Naval Carpentry is closely linked to the work of carpenters throughout the manufacturing process of a vessel, and is characterized by artisanal work. On the other hand,

the term Shipbuilding covers the entire process of building a boat, going beyond the work of carpenters, involving other activities carried out by professionals such as caulkers[1] , painters, electricians, mechanics, among others.

Naval carpentry, therefore, represents only a specific and essential part of the broad scope of shipbuilding. While carpenters play a crucial role in creating wooden structures and incorporating handcrafted elements, Shipbuilding encompasses the entire set of steps required to build a vessel, including the processes of design, planning, hull construction, installation of electrical and mechanical systems, finishing and painting.

From a mathematical perspective, we can understand the relationship between the two terms as Ship Carpentry being a subset within the broader domain of Shipbuilding. Thus, Naval Carpentry represents an integral and specialized part of the overall shipbuilding process, contributing its artisanal skills to the creation of solid and durable structures.

With this approach, we understand that Shipbuilding and Naval Carpentry play a fundamental role in a region like the Amazon, which is interconnected by many rivers, where there are locations that can only be reached by boat. Therefore, navigating these rivers requires means of transportation that are peculiar and adaptable to this environment. In this way, boats are, in most Amazonian cities and their communities, the means of transportation most used by the people who live here, for the "coming, going and doing" of their social, economic, cultural and professional needs.

Until the mid-1980s, the Lower Tocantins region in the state of Pará, also known as the "Tocantins Amazon" (PINTO, 2010), played an important role as the state's shipbuilding center. During this period, several small, medium and large vessels were produced, and the shipyards were recognized as places of learning, functioning as veritable "schools". Both naval carpenters and people from other professions frequented these shipyards in order to acquire skills in naval carpentry or obtain a profession that would allow them to support their families.

In view of this, as we are part of a society that is undergoing constant transformations in various aspects, such as cultural, socio-economic and scientific, among others, and in the face of these changes, mathematics plays a significant role in contributing to the achievements of human knowledge. As well as being part of people's daily lives, it plays a fundamental role in providing the basis and being an essential part in the activities of various scientific areas.

Within this scenario in which mathematics is recognized as a tool for individuals to achieve autonomy and social inclusion, the construction of the boats used by Amazonian communities

[1] A professional in the shipbuilding industry who is responsible for sealing boats.

requires their builders, the carpenters, to have comprehensive and specific knowledge. This knowledge includes not only general and specific aspects of the region and culture, but also information about the type of wood to be used, precise measurements and the application of mathematical, physical and other concepts acquired over years of experience.

Given this context, the aim of this research is to highlight the mathematical knowledge present in boat building, and thus try to understand the following questions: how was/is mathematical knowledge acquired by carpenters? How are they applied in the construction of boats? What relationship can we establish between the socio-cultural practices of these subjects and school mathematics?

Methodologically, the research was based on exploratory research into shipbuilding in this region, followed by a bibliographic survey to build the theoretical framework. The data was collected by observing the carpenters' activities and interviewing the subjects to gain a better understanding of some issues related to mathematical knowledge, the carpentry profession and boats.

After the analysis, we saw that naval carpenters play a fundamental role in the region's activities, being responsible for building the boats that are used for fishing, transporting people and cargo, and for other day-to-day activities of the riverside dwellers[2] . In addition to the craft of carpentry, many of them also carry out other activities in parallel to naval carpentry, and are also fishermen, extractivists, farmers, small traders, etc.

It was also found that the carpenters have a lot of knowledge about their culture, their profession and the place where they live, and that the more experienced carpenters have a greater amount of knowledge than the younger ones, which can be understood from the fact that they have had more contact and experience with the profession. During this process, we observed various mathematical concepts involved in the carpenters' socio-cultural activities, such as: geometry knowledge, proportion, calculations, symmetry, etc.

As a result, we concluded that the mathematical knowledge applied in the construction of boats comes from the subjects' daily practices, that this knowledge is acquired by the carpenters through the observations and teachings of older and more experienced carpenters. In other words, empirical applications, without the use of formulas or specialized instruments, but with links to the knowledge learned at school.

[2] According to Pantoja et al (2016, p.189) "Ribeirinhos are people who live on the banks of rivers in the Amazon. They generally make a living from handicrafts, agriculture, hunting, plant extraction and, above all, fishing."

2 NAVAL CARPENTRY IN THE TOCANTINA AMAZON

According to Almeida (2010), "there are several Amazons in Brazil". The author also states that in the 'melting pot' of the Amazon there are various peoples. Native populations and those who came here in search of better days: internal migrants, with an emphasis on the northeast, and people from more distant lands, such as Europeans and Asians. They can be found on dry land, floodplains or islands.

The Amazon is, therefore, this agglomeration of people who came in search of "magical" wealth in the gold mines, and many others attracted by the dream of jobs in the big mining projects, railroads, steel mills and dams. Today they make up the constellation of faces of this land (ALMEIDA, 2010, p. 291).

In other words, when we talk about the Amazon, in the plural, we want to reaffirm and reinforce its diversity, heterogeneity, multiplicity, differentiations and internal particularities (MIRANDA, 2022, p. 31). Thus, geographer Carlos Walter Porto Gonçalves (2015) tells us that

> There is a symbolic-material debate and clash that reconstructs the meaning of Amazonia. There isn't one Amazon, but several. Consequently, there is no one true vision of what the Amazon is. However, the various social subjects elaborate a vision and their version of what the Amazon is, and try to propose/impose their vision of what the truth of the region is as the truth of the region. This truth game is part of the power game that takes place in and over the region (GONÇALVES, 2015, p. 17).

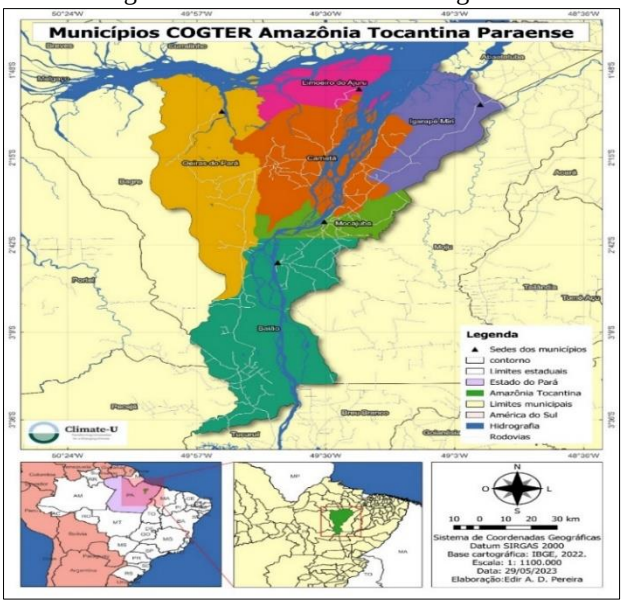
For the author, there is not just one Amazon, but several, and this is explained by the different visions that the subjects who are part of it develop. This statement is reinforced by geographer Edir Augusto Dias Pereira, who says that "This power game present in these articulations that are formed over it is asymmetrical, because not all of these subjects have the power to impose their discourses" (PEREIRA, 2012). This implies that we cannot measure the Amazon based on its exclusively economic value, but rather understand that there are Amazons within the Amazon and this is a way of perceiving its pluralities and heterogeneities.

In this context of multiple Amazons, the region known as the Tocantina Amazon, located in the northeast of the state of Pará, played an important role in shipbuilding in the state until the mid-1980s. According to Pinto (2010), the designation of this term emerged from the 1970s and 1980s when

> The population of the Lower Tocantins Microregion, through its hardships, resistance and struggles in opposition to the actions of the system, gave it a feminine name, the Tocantins Region. As it is located in the Amazon Region, it usually appeared in the speech of members of the working classes organized in the Basic Ecclesial Communities, as another derivation: Amazônia Tocantina (PINTO, 2010).

Figure 1 below shows the geographical location of the Tocantina Amazon region:

Figure 1 – Tocantins Amazon Region a



Source: Pereira (2023)

In addition, we know that these regions are interconnected by many rivers and, because of this, there are places that can only be reached by boat. Thus, in the view of Pantoja *et al* (2016, p.189), "shipbuilding is a cultural symbol of the Amazon. This cultural activity arose from the indigenous and riverside population's need to move around the rivers, streams and boreholes of the Amazon". Pantoja (2015, p.74) says that,

> The geography of the rivers cutting through the forest is one of the main natural characteristics of the physical aspects of the Amazon region and constitutes a large part of its fluvial extension. This natural aspect of the Amazon's regional geography inspired the subjects to develop knowledge of work so that they could improve their transportation dynamics, which was necessary for them to travel the length and breadth of the most distant river courses, as well as making it possible to intensify the forms of social relationships between indigenous communities (PANTOJA, 2015, p.74).

In other words, the author points out that this geographical aspect of the Amazon region is something that is striking and that extends over a large part of it. This somehow ended up inspiring the development of work knowledge on the part of the people who live here, with the aim of improving both the dynamics of transportation and enabling a greater intensification of the forms of social relationship between communities.

In view of this, Formigosa, Lucena and Farias (2017, p. 3) state that

> to navigate the rivers, streams and boreholes that "cut through" this region is to enter a universe of sociocultural diversity that is renewed according to the geography of these

> rivers, streams and boreholes, or with each riverside community that appears along their banks, or with each bend the river takes, when an isolated house or some other natural element appears, or even with the coming and going of the people who cross these "waterways" as they go about their lives. (FORMIGOSA; LUCENA; FARIAS, 2017, p. 3)

The authors show that navigating the rivers of the Amazon requires means of transportation that are peculiar and adaptable to this environment. In most Amazonian cities and communities, boats are the means of transportation most used by the people who live here to "come, go and do" their social, economic, cultural and professional needs, etc.

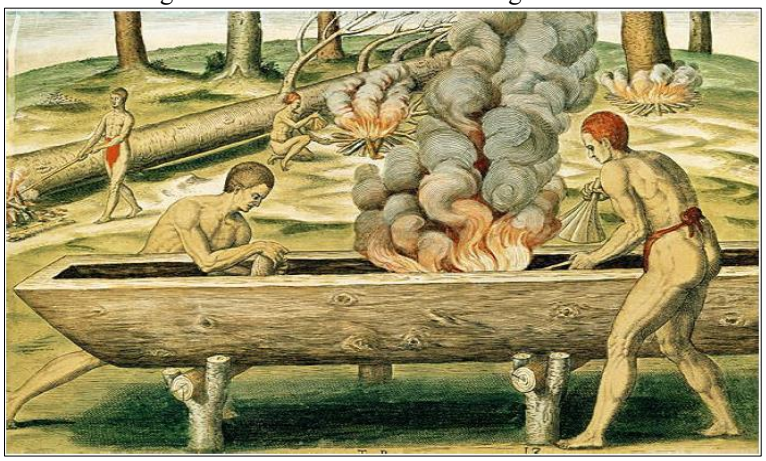
Almeida (2010) states that the hulls (canoes), the rabetas[3] , the voadeiras[4] and the popopôs (the name of the boat acquired because of the noise of the engine) are the main form of transportation and channel for commercial relations between farmers, fishermen and extractivists and the urban environment. The author also states that journeys between Amazonian cities and their communities, which often last hours, are moments of contemplation, solidarity, exchange of information, *storytelling*, gossip and various banter between acquaintances.

Historically, shipbuilding in the Amazon was developed by riverside and indigenous communities, who mastered the techniques of building canoes and other types of boats adapted to the conditions of the Amazonian environment. The natural geographical conditions of the Amazon region allowed the people of this region to exploit the natural resources available, as well as to create objects from these resources, such as shaping the trunk of a tree into an *ubá* or *igarité (a* boat shaped from a tree trunk) (GUALBERTO, 2009).

In this way, the people of the region developed river transport to move to other areas, either to find food for their tribes or to resist colonization. According to Gualberto (2009), trees were initially felled with fire and then technical processes were carried out on the extracted wood, such as burning the trunk to make it easier to scrape off the burnt part and then forming a concave cavity with a certain depth. This process resulted in a vessel known by the Amazon Indians as an *ubá*.

[3] A small boat, similar to a canoe, but motorized, making the journey faster.
[4] Small and medium-sized motorized boats, usually made of metal (iron or aluminium).

Figure 2 - Illustration of the making of an ubá



Source: Gualberto (2009, p. 74)

According to Lins (2010, p. 21), from the 16th century onwards, during Portuguese colonization, shipbuilding became an important factor in regional development, along with extractivism, agriculture and the manufacturing industry. As a result, shipbuilding gained momentum and was improved.

This cultural activity of the region's inhabitants merged with European culture, resulting in the production of more agile and durable vessels, capable of successfully dealing with the peculiarities of the region. These vessels were used as fundamental tools for colonization and the expansion of the Amazon frontier, but mainly to transport export cargo such as rubber and timber.

As such, this socio-cultural activity plays an important social and economic role for the region. The construction of boats is responsible for generating direct and indirect jobs, boosting the local economy. In addition, river transportation is essential for supplying many cities in the Amazon region and for distributing agricultural, livestock and extractive products, etc.

When it comes to the cultural aspect, shipbuilding is also of great importance, as it represents traditional knowledge passed down from generation to generation. The techniques used to build Amazonian boats have their own particularities, which take into account the characteristics of the rivers and the needs of the riverside dwellers. This knowledge is valued and preserved by local communities, who often maintain small boatbuilding yards as a way of keeping their traditions alive.

3 NAVAL CARPENTRY, SOCIOCULTURAL PRACTICES AND MATHEMATICAL KNOWLEDGE: SOME REFLECTIONS AND RESULTS

Naval carpentry is an activity that dates back centuries and is one of the oldest forms of trade and transportation. Since then, naval carpenters have been perfecting their techniques and

knowledge in the construction of boats, ships and other vessels. This is because as well as requiring practical and manual skills, it also requires basic and advanced mathematical knowledge, even if this is sometimes imperceptible to the eyes of these professionals.

With this in mind, based on reading the works of D'Ambrósio (2022), Milrroy (1992), Knijnik (2004), Vergani (2007), Gerdes (2012), Mendes and Farias (2014), Lucena (2002) and others, we understand that socio-cultural practices are activities, behaviors, beliefs and values shared by groups of people who are influenced by their culture, society and the environment in which they live.

These practices can include religious rituals, celebrations, traditions, customs, forms of language and communication, among other activities that reflect the identity and values of these social groups. They can vary greatly between different social groups, depending on factors such as age, gender, religion, ethnicity, social class, among others. These practices can be passed down from generation to generation and can be influenced by social and historical changes over time.

Ethnomathematical practices refer to different forms of mathematical knowledge that are found in different cultures around the world. They are based on mathematical systems and methods that have evolved in specific cultural and historical contexts, and which reflect the way people from different cultures understand and use mathematics. These include, for example, the numbering systems, measurement techniques, ways of solving problems and geometric patterns found in different cultures. They can be quite different from traditional Western mathematical practices, and can include, for example, non-decimal numbering systems, measurement techniques based on parts of the human body or everyday objects, and problem-solving methods that involve narratives and stories.

In this context, D'Ambrósio (2022) states that

> All knowledge is the result of a long cumulative process, in which stages are identified, which are naturally not dichotomous, when knowledge is generated, organized intellectually, organized socially and disseminated. These stages are, respectively, the subject of cognitive theory, epistemology, history and sociology, and education and politics. As a whole, this process is extremely dynamic and never finished, and is obviously subject to very specific conditions of stimulation and subordination to the natural, cultural and social context. This is the cycle of individual and social acquisition of knowledge (D'AMBRÓSIO, 2022, p. 52).

In line with this, naval carpenters are, in most cases, self-taught and learn to build boats based on the experience they have acquired over the years, passing on this knowledge from generation to generation. However, mathematics is a fundamental part of shipbuilding, and much

of the mathematical knowledge needed to build a boat is acquired through practice and the knowledge passed on from others.

These professionals use empirical knowledge of mathematics to measure, calculate and design the dimensions of each part of a boat. In their socio-cultural activities, they end up using knowledge in the field of geometry, trigonometry, algebra, calculus and other fields of mathematics to deal with concepts such as angles, proportions, areas, volumes, weights and balance. All these mathematical concepts are necessary to create a boat that is safe, functional and efficient.

In view of this, the activities carried out by professional Amazonian naval carpenters have a wealth of knowledge embedded in their socio-cultural practices. When we look at the practices developed by these carpenters to build the boats, we notice that "the level of schooling of the master craftsmen, when there is any, only reaches the first grades of elementary school" (LUCENA; FOSSA, 2000).

Although they have received little formal education, the carpenters demonstrate varied knowledge of geometry, including plane figures and solids, as well as concepts such as angles, density and thrust. They are able to apply this knowledge when building the boats, despite not having learned these concepts in traditional school, only with empirical knowledge and/or passed down from their ancestors.

Lucena and Fossa (2000) also state that when they begin the process of building the boats,

> Carpenters dispense with the use of blueprints as a means of guiding construction practice. When necessary, they make a sketch of the boat's design to give the buyer an idea of the final product. The most commonly used units of measurement are palms when referring to the dimensions of the parts of the boat or the names of the parts (stern, deck, keel, etc.) and tons when referring to capacity (LUCENA; FOSSA, 2000).

This makes us think, to try to understand the mental activities involved in the carpenters' "gaze", since, despite applying the concepts of academic mathematics, many don't even use tools, they just use this gaze to fit the pieces of wood together and check that they are in position, which allows us to infer that possibly years of experience mean that older people can use these strategies and pass them on to their apprentices.

The socio-cultural practices exercised by naval carpenters in the Tocantina Amazon, in the view of Pantoja *et al* (2016, p.8) "bring with them tradition and culture through knowledge and doing". According to Gualberto (2009, p. 20), this knowledge embedded in cultural practices, even if sometimes imperceptible, consists of "knowledge in the fields of mathematics, chemistry, physics, geometry, education, administration, economics, ethics, art, history", in short, areas of

knowledge taught at school that are developed and practiced by carpenters in their daily work without them having had contact with such knowledge at school.

For Mendes and Farias (2014), "mathematical knowledge is considered a fundamental skill in the teaching of practically all subjects, as it requires logic, precision, rigor, the exercise of abstraction and structured formal thinking". Mendes (2016) also states that the mathematics we are referring to is "mathematical culture, i.e. mathematics constructed socioculturally", which is a culture of practices that are thought about, experimented with and reflected on socially and which consequently give rise to explanatory models of such mathematics, among which are the models that are incorporated into academic mathematics.

Throughout the research, it was observed that shipbuilding is an activity that involves diverse socio-cultural practices. Naval carpenters play a fundamental role in the region's activities, being responsible for building the boats that are used for fishing, transporting people and cargo, and other day-to-day activities. In addition to the craft of carpentry, many of them also carry out other activities in parallel to naval carpentry, and are also fishermen, extractivists, farmers, small traders, etc.

In line with this, Mendes and Farias (2014) state that these subjects are, at the same time, bearers and producers of culture and knowledge, becoming unique individuals, even though they are in a diverse cultural context, they differ from others because they have their own individual and family history. In other words, they are subjects capable of creating and acquiring knowledge. This form of relationship between individuals, D'Ambrósio (2022) characterizes as culture, for him

> The symbiotic association of shared knowledge and compatible behavior constitutes what is known as culture. Culture manifests itself in the complex of knowledge/doings, communication and values agreed upon by a group, a community or a people. Culture is what makes life in society possible (D'AMBRÓSIO, 2022, p. 61).

In this context, mathematics plays a crucial role in our daily lives, allowing us to understand and analyze the constant flow of information we receive from the media and the social interactions resulting from human activities. Many of these activities involve practical actions that can be modeled mathematically to provide us with a better understanding and structure of the phenomena involved.

In line with what we are discussing, Mendes and Farias (2014) state that

> mathematics as socially produced knowledge is characterized by social interactions and imaginary constructions manifested in culture, as one of the multiple explanatory forms for socio-cultural experiences. This characterization shows us ways of reading,

> understanding and explaining how human culture creates its methods and codes for reading the mathematics of socio-cultural realities (MENDES; FARIAS, 2014, p. 38).

Santos and Silva (2008), in turn, tell us that mathematics teaching is often criticized for failing to establish a clear connection between the knowledge taught at school and the reality experienced by students. However, the ethnomathematics approach seeks to bridge this gap by introducing cultural aspects of mathematics and other areas of knowledge into school activities.

With this approach, students have the opportunity to learn about the contribution of other cultures to the development of mathematics, while at the same time strengthening their own cultural roots. In other words, "reconciling the need to teach dominant mathematics while at the same time giving recognition to the ethnomathematics of their traditions" (D'AMBRÓSIO, 2022, p. 61).

This mathematical knowledge of social groups is often shaped by their needs and interests, and passed down from generation to generation to other members of the group, through memories and alternative ways of solving everyday situations that require mathematical skills, such as measuring, classifying and sorting.

Thus, in addition to socio-cultural practices, artisanal naval carpentry involves a series of mathematical skills that are fundamental to the construction of vessels. The research showed us that various mathematical concepts involved in this process were identified, such as geometry, proportion, calculation, symmetry, etc. Some concepts may be used more frequently than others, but all are important for building a boat.

In line with this, it is important to recognize that the sociocultural practices of carpenters are an important part of their cultural and social identity, valuing their ethnomathematical practices, which in turn have the capacity to promote a broader and more inclusive understanding of mathematics, recognizing that different cultures have different forms of mathematical knowledge that are valuable and important. They can be used in mathematics education as a way of promoting cultural diversity and making mathematics more accessible and meaningful to students from different cultural backgrounds.

4 FINAL CONSIDERATIONS

The Amazon is characterized by its ethnic, social and cultural diversity, home to both native peoples and migrants in search of opportunities. The region is marked by its extensive river network, which drives shipbuilding as a cultural symbol and essential means of transportation for

the region. Navigating the Amazon rivers reveals a universe of socio-cultural diversity, connecting communities and fostering the exchange of information and experiences.

Shipbuilding in the Amazon has a rich and diverse history. Initially developed by riverside and indigenous communities, boatbuilding techniques adapted to Amazonian conditions were improved over time, mainly under the influence of European culture, resulting in the production of more agile and durable vessels.

In this context, the Amazon as a whole is home to a variety of boats with different characteristics and purposes. From small handmade canoes powered by oars to large cargo ships used to transport goods on a large scale, each vessel is designed to meet the specific needs of the people who use the rivers as a means of transportation. Whether for daily commuting, local commerce or tourism, these vessels contribute to connecting, supplying and economically developing the region.

According to the literature studied, the sociocultural activities of naval carpenters in the Tocantina Amazon are characterized as ethnomathematical and sociocultural practices, i.e. knowledge spread through experience and passed down from generation to generation, and which explores the relationship between academic mathematics and the social and cultural practices of different ethnic and cultural groups.

As a result, we understand that artisanal naval carpentry involves the empirical application of various mathematical concepts to boats. Naval carpenters, through their practical experience, use mathematical notions such as: proportion, measurements, various calculations, geometry, logical and spatial reasoning, etc. to build and size the different parts of boats.

This mathematical knowledge is transmitted within a socio-cultural context in the Master-Apprentice relationship, constituting a form of traditional and cultural knowledge. And by recognizing and valuing this empirical application of mathematics in naval carpentry, we can promote a richer approach to teaching mathematics, demonstrating its relevance and application in the daily lives of urban and riverside communities.

An interesting feature of this professional activity is that carpenters' mathematical knowledge, although applied in a practical and efficient way, is often unrelated to formal scientific knowledge. They acquire their mathematical knowledge through experience and oral and/or visual transmission, without resorting to complex formulas or academic theories.

This disconnection between the carpenters' empirical mathematical knowledge and scientific mathematical knowledge makes room for reflection on the importance of recognizing and valuing different forms of mathematical knowledge. When we relate this idea to the discussion

of ethnomathematics and sociocultural practices, we realize the need to broaden our conception of mathematics and value the diversity of mathematical approaches and knowledge present in different cultures. This recognizes and values mathematical knowledge acquired through practice and tradition, enriching the teaching and learning of this subject.

In line with this approach, we believe that the findings on the mathematical knowledge of carpenters in boat building have significant practical and theoretical implications. From a practical point of view, the study can contribute to valuing traditional techniques, improving their practices and developing this naval activity in a sustainable way. Theoretically, the research advances the understanding of the interaction between academic mathematics and socio-cultural practices, promoting mathematics education based on ethnomathematics. In addition, the results can strengthen the cultural identity of the subjects involved, influence educational policies and promote more relevant and contextualized mathematics teaching and learning.

Delving into the subject revealed the importance of the relationship between ethnomathematics, socio-cultural practices and education, highlighting the richness of the mathematical knowledge passed on in naval carpentry. The perception of their disconnection from traditional scientific knowledge raised questions about their appreciation and integration into the educational process. The research also provided a broader understanding of cultural perspectives and emphasized the importance of respecting diversity.

Based on the analysis, discussions and results presented, it can be concluded that the ethnomathematics approach and valuing the socio-cultural practices of naval carpenters in education are extremely important. Understanding and integrating the mathematical knowledge that has been passed down for decades, especially in the context of naval carpentry, highlights the importance of recognizing and valuing the diversity of knowledge. This approach enriches the teaching of mathematics, promotes inclusion and prepares students for critical and conscious participation in a plural society.

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