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Inspirations from ethnomathematics for the pedagogical practice of teaching geometry

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ABSTRACT
We present some ideas that we obtained while developing doctoral research, in which we realized that numerous concepts related to geometry were developed, empirically and self-taught, by subjects who work professionally in different places, even if they do not have formal studies or professors who instruct them in these activities. To analyze and understand this scenario, we take ethnomathematics, understood as an approach that values the mathematical practices and knowledge of cultures and subjects who use it empirically to deal with their daily lives. We illustrate the report with examples that describe how a subject of the timber industry uses his knowledge about geometric concepts in his professional daily life. We conclude by presenting clues so that mathematics teachers can take into account the cultural universe of their students, especially when it comes to ideas related to geometry, to think about their teaching performance, highlighting the importance of mathematics teachers understanding that mathematical reasoning is present beyond theoretical formalizations, and can often appear in languages different from those usual in formal education.

Keywords: Ethnomathematics, Geometry teaching, Cultural knowledge.

1 INTRODUCTION

When we analyze the construction of mathematical ideas from a historical perspective, we realize that mathematical knowledge, now systematized and organized, emerged, most of the time, from situations related to everyday life. According to Herodotus, geometry had its beginnings in ancient Egypt. According to him, the need to carry out measurements related to the size of land, which changed with each flood of the Nile, led to the first geometric concepts. In other words, due to the fact that every year the river overflowed, and the delimitations of the land were lost, it was necessary to carry out new demarcations of territories, giving rise to the need for measurements and systematized records.

In addition, other situations arose and demanded new mathematical ideas, such as the question of land measurements, which did not always fit into the whole of the object used to make the measurements, giving rise to the concepts of fractions and decimal values.

Corroborating this idea, Bueno *et. al.* (2018, p. 03) comment that: "Given the natural wealth of Egypt, such as the Nile River, the Egyptians' need to use mathematical resources was centered on seeking solutions to everyday problems, without much concern for mathematical theory". The same authors emphasize that:

> [...] mathematical development in Egypt was stimulated by everyday problems, so many geometric processes involved calculating the volume of grains, necessary for trade and agriculture, calculating the slope of the lateral face and the volume of the pyramid trunk, and calculating the land areas for the division of territory (BUENO *et. al.,* 2018, p. 07).

The process of systematizing and recording in an organized way the concepts that emerged gave rise to the concepts of geometry and also of other areas of mathematics. To Bueno *et. al.*, (2018, p. 14), it is worth emphasizing the

> [...] how rich and broad the Egyptian civilization is, and how its daily life and way of life contributed to the emergence and use of mathematics. It is also important to highlight that, although they used mathematics procedurally, without seeking the need to prove or demonstrate what was done, their knowledge and contribution to mathematical evolution should not be underestimated. All the procedures developed and used by them, especially in the area of geometry with the correct calculation of the volume of the pyramid trunk, were of great importance for the mathematical impulse in other civilizations, such as the Greek.

The scenario in which mathematical ideas began to be developed, in order to meet the demands of everyday and social situations, corroborates the concept of ethnomathematics.

Ethnomathematics refers to the cultural knowledge of the subjects, constructed by dealing with their daily experiences, in which the ideas related to Mathematics, such as calculating, measuring, organizing, deducing, arise in a format that is often different from that presented by institutionalized mathematics, following pre-established patterns or algorithms, but still being sufficient to solve problems and situations inherent to certain groups.

To Ubiratan D'Ambrosio:

> This view of the educational dimension is not intended to annul scientific mathematics, much less to belittle it. Ethnomathematics does not replace knowledge produced by generations of thinkers, but incorporates practical meanings into these values bequeathed to humanity. (D'AMBROSIO, 2004, p. 23)

Ethnomathematics aims to understand the forms of knowledge in all their dimensions and "originated in the search to understand the mathematical making and knowledge of marginalized cultures" (D'AMBROSIO, 2004, p. 44). By marginalized cultures, we mean groups that are often excluded from school benches, but that nevertheless practice mathematics on a daily basis and create strategies to do so, as we have seen many of our adult students perform in their daily professional lives.

In this sense, D'Esquivel (2007) emphasizes the cultural scope of ethnomathematics as a product of human needs:

> Research in Ethnomathematics is part of a multicultural and holistic conception of education that understands that mathematical knowledge, as well as all knowledge, is the result of the human search for survival and transcendence, and that there are in this perspective authentic manifestations of different cultures as answers to their being in the world. (D'ESQUIVEL, 2007, p.2)

Thus, we believe that ethnomathematics, which is a perspective of mathematics developed to meet the needs of certain subjects, can inspire teachers to take into account the cultural universe of their students, especially when it comes to ideas related to geometry, since, throughout history, many ideas related to this field of mathematics have originated in situations similar to the proposal of ethnomathematics.

Velho and Lara (2011, p. 10) mention that "(...) Ethnomathematics proposes the use of popular learning, with the strategy of interpreting how each person deals with and understands Mathematics, so that, based on these findings, knowledge can be improved and formalized at school". In this way, the ideas that students bring with them would be like bridges between what they already know and the knowledge to be built at school, in the exchanges and interactions between peers.

In this sense, Mendes (2009) comments that:

> In Ethnomathematics, we seek to recover the actions of each cultural group in order to be able to recover this knowledge and use it in the teaching and learning of the people of this group. In this way, the student starts his mathematical studies in a cognitive way that is already well constituted through his own coexistence in his culture. Mathematical knowledge is, therefore, contextualized for the student, helping him to give an intuitive sense to the concepts and procedures to be learned (MENDES, 2009, p. 67).

Professionals who work in different segments, such as the furniture, timber and construction industries, often perform many activities based on mathematical concepts, applied in practice. Thus, in a D'Ambrosian perspective of ethnomathematical education, the ethnomathematical knowledge already experienced by these subjects can be improved and expanded at school, as long as it is taken into account by the teacher.

To this end, it is necessary that the teacher is willing to be "the student of his student", listening to his methods, the paths he took to carry out his professional activities and the strategies he developed from his experiences, maintaining the fluid communication between the teacher and the student, with emphasis on a collaborative dialogue, in which the mutual exchanges that culminate in the construction of knowledge.

Thus, we present the course of the professional practice of subjects in the timber industry[1], where we identify some situations that illustrate the ideas we report. One of the interviewees is

1 These data were generated in a doctoral research. In this research, we follow the professional practices of some subjects who developed mathematical strategies to perform their work activities in a self-taught and empirical way, and we tried to use these ideas as inspirations for the creation of basic mathematics teaching practices.

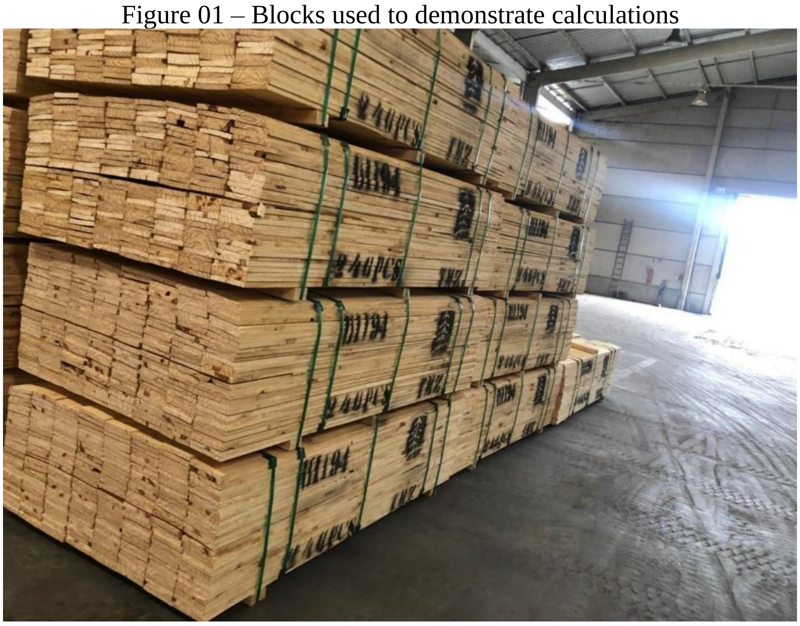
responsible for loading the wood into the company's truck, for making the measurements, calculating the volume of the load, the final value, in short, everything that is necessary for the verification and sale of the merchandise and that appears in the packing list. When we met him, he had stopped studying in the first cycle of elementary school, and therefore had not learned how to carry out these operations on the school benches.

To understand how he carried out his activities, we placed ourselves as his students, giving voice to the subject in question. We understand his processes, his ideas and how he went about building them.

An example given by the accompanied professional was how to make the volume of the wood load and the final value. He reported that each order called for a different thickness, commonly referred to as a gauge. He then explained the process he carries out to calculate the volume and final value of the cargo:

> I have to do the yardage of a package. I have to know how tall the package is, how many pieces it has, in this case it is 34 high. Okay, okay. Now you have to know the width of the package, it has 11 (showed and recounted). Now I'm going to do 11 times 34, in this case it's 374 pieces. Now I know how many pieces are in the package, now I'm going to do the footage to know how many meters[2] it's going to give. Now I'm going to take 36, which is the thickness, times 100 which is the width, times 2.30 which is the length of each piece. And that's all times 374, which is the amount of pieces. Then, in this case, it gives 3,096 meters each package. Now I do 3,096 times 24, it's going to be 74,198, because 24 is the amount of packages that fit inside the truck.

Figure 01 – Blocks used to demonstrate calculations



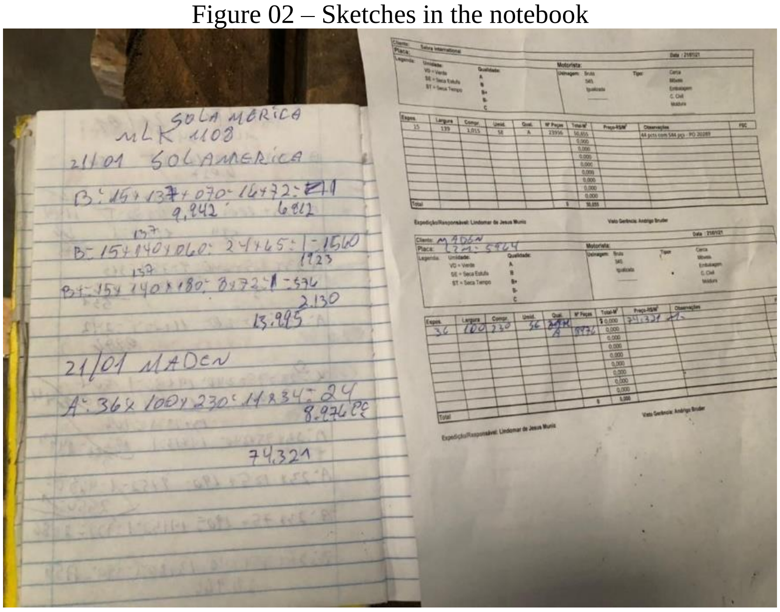
Source: Authors' record, 2021

After explaining it to us, he also showed how he puts it on paper. First, write everything down in a notebook and then transfer it to a printed sheet. And then it passes it on to the engineer in charge

2 Cubic meters, volume.

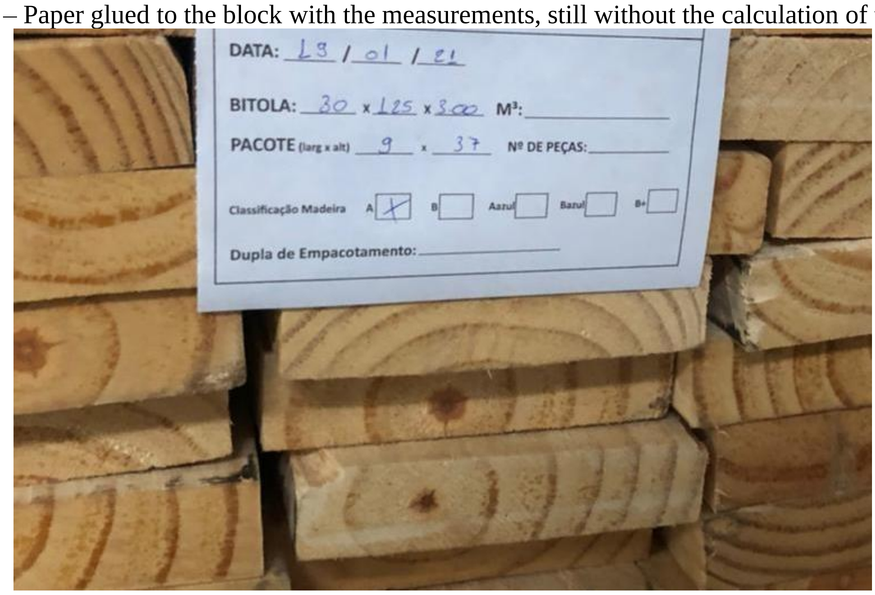
of the lumber company. According to him, the draft in the notebook helps him not to make mistakes when he goes to the page. We notice that all measurements are given in mm, indicating that it is the standard measurement used by him.

Figure 02 – Sketches in the notebook



Source: Authors' record, 2021

Figure 03 – Paper glued to the block with the measurements, still without the calculation of the volume



Source: Authors' record, 2021

Using examples from previous calculations and deduction, the subject was able to figure out how to calculate what he needed, autonomously and without instructions from a classmate or teacher. He also highlighted that the need for survival made him learn, but that he had the will and persistence to achieve his goals.

It is worth recalling here an excerpt from a text by D'Ambrosio (2018, p.13), in which the author discusses precisely the issue of developing mathematical skills for survival:

> Life is characterized by strategies for survival (all basic behaviors and actions aimed at "how" to survive), which is common to all species, and for transcending (understanding and explaining facts and phenomena, going beyond survival and asking "why"), which is a unique trait of homo species. The strategies of survival and transcendence are generated by each individual and, thanks to sociability and communication, are shared and socialized with others and constitute the culture of the group.

In this study, we count only a small portion of the geometry developed in a lumber company environment. The employees, who use different strategies to solve issues inherent to their daily lives, learned in different ways, some by trials, others with examples, ideas that can serve as inspirations for the teaching of mathematics.

From attentive listening and dialogue with our students, we can understand their place in the world, their perspectives, ideas, goals, and we will have subsidies to contextualize learning from their background.

As D'Ambrosio (2002, p. 11) cites, in order for us to work on ethnomathematics as a pedagogical action, it is essential "(...) to free oneself from the Eurocentric pattern and seek to understand, within the individual's own cultural context, their thought processes and their ways of explaining, understanding and performing in their reality."

These ideas propose the unveiling of new methods and models created by the cultural man, with the aim of promoting this knowledge and legitimizing it as a culturally and socially constructed knowledge, seeking sociocultural elements in force in the context to be explored, in order to attribute meaning to the teaching-learning process.

We believe that it is not enough for us to recognize the prior knowledge and context of our students. It is not enough to identify the ethnomathematics present in the daily life of a community. It is necessary to use it as inspiration, as an element as present in the classroom as the methodology to be used, as a link between what they already know and the knowledge they will build.

In this way, we make it possible, as education professionals, for students to understand mathematics beyond the school curriculum, far beyond reproductions disconnected from the reality that surrounds them. As D'Ambrosio (2009) cites, the idea of working from the perspective of ethnomathematics is to make Mathematics something alive, passing through real situations in the present time. Thus, we emphasize the relevance of mathematics teachers recognizing that mathematical reasoning precedes the formalization of theories.

In addition, this reasoning can manifest itself in languages different from those usual in formal education, characterized by symbols and notations. By understanding this, teachers will be able to take the previous and cultural knowledge of their students and the examples where it appears in a contextualized way, as a starting point to create teaching situations for the learning of formal mathematics.

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