

Calculation strategies of sugarcane workers regarding their work journeys

Abstract: This study analyzed the strategies used by a sugarcane worker to determine the remuneration of a sugarcane cutter, considering his roles as cutter, overseer, and inspector. The objective was to understand and explain his perceptions through cell phone-recorded interviews about his professional trajectory, which characterizes a qualitative case study. As a result, the adoption of unusual methods was observed, such as transforming triangles into rectangles and decomposing the area of land with elevations, without resorting to procedures taught in school. The interaction between the overseer, the inspector, and the cutters in measuring the areas reveals conflicts related to benefits and losses, demonstrating an awareness of the need to avoid social injustices.

Keywords: Sugarcane Cutter. Daily Wage Calculation. Ethnomathematics.

Estrategias del cálculo de los trabajadores cañeros sobre sus jornadas laborales

Resumen: El estudio analizó las estrategias empleadas por un trabajador de caña de azúcar para determinar la remuneración de un cortador de caña, considerando sus roles de cortador, inspector e inspector. El objetivo fue comprender y explicar sus percepciones mediante entrevistas grabadas por teléfono celular sobre su trayectoria profesional, lo cual caracteriza un estudio de caso cualitativo. Como resultado, se observó la adopción de métodos inusuales, como la transformación de triángulos en rectángulos y la descomposición del área de terreno con elevaciones, sin recurrir a los procedimientos enseñados en la escuela. La interacción entre el inspector, el inspector y los cortadores al medir las áreas revela conflictos relacionados con beneficios y pérdidas, lo que pone de relieve la necesidad de evitar injusticias sociales.

Palabras clave: Cortador de Caña de Azúcar. Cálculo de la Diaria. Etnomatemática.

Estratégias de cálculo dos canavieiros sobre suas jornadas de trabalho

Resumo: O estudo analisou as estratégias utilizadas por um trabalhador canavieiro para definir a remuneração de um cortador de cana-de-açúcar, considerando suas funções como cortador, cabo e fiscal. O objetivo foi compreender e explicar suas percepções por meio de entrevistas gravadas em celular sobre sua trajetória profissional, o que caracteriza um estudo de caso qualitativo. Como resultado, observou-se a adoção de métodos inusitados, como a transformação de triângulos em retângulos e a decomposição da área de terrenos com elevações, sem recorrer aos procedimentos ensinados na escola. A interação entre o cabo, o fiscal e os cortadores na medição das áreas revelam conflitos relacionados a benefícios e prejuízos, evidenciando a consciência da necessidade de evitar injustiças sociais.

Palavras-chave: Cortador de Cana-de-açúcar. Cálculo de Diária. Etnomatemática.

1 Introduction

In Elementary, Middle and High School, one can experience various work activities

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related to the rural environment that, in some way, require scientific knowledge, such as a first formal contract as a sugarcane cutter. However, despite the *acceptance without questioning* of this form of knowledge, it only began to be recognized in the face of the need to understand whether the remuneration corresponding to the work activities experienced in the field was compatible with task fulfillment.

In turn, the complexity of the tasks experienced is also ignored since they involve negotiations over payment for the services provided, the values of which are based on land measurements to calculate production during a day's work. Given the difficulties faced in knowing whether the wages were correct or not through the calculation of areas of flat figures learned at school, we became interested in making connections between this form of knowledge and what was carried out in the practices of measuring areas within the scope of a worker's social group.

Sugarcane cutting allows us to associate mathematical knowledge with procedures like calculating agricultural measurements, daily rates, etc. This may spark the interest of those involved in this context in learning at school the knowledge that may help them to discuss the numbers related to their work practices properly. We have no intention of being original, as many works in the literature share this view. Wenger (1998), for example, presents what he calls the social theory of learning. In this approach, the primary unit of analysis corresponds to the *communities of practice*, not the individuals alone and/or social institutions, showing that something produced this way approaches the development of a theory of social scope. The author sets out four premises to support this approach: community, knowledge, knowing and meaning, consecutively, corresponding to people as social beings, the acquisition of something valuable in terms of competency, the means to actively engage with the world, and the result of learning as a product.

In this context, to justify the existence of other theoretical perspectives, as stated above, it is worth bringing the theoretical epistemological focus of this research which, despite sharing sources with Sociology, Anthropology, etc., has distinct characteristics, which becomes clear given the need to theorize and/or define Ethnomathematics, as Sebastiani Ferreira (2002, p. 3) points out in the following section:

D'Ambrosio proposed an Ethnomathematical Program. For him, it is a program in the sense of Lakatos; that is, as he described it, the methodology of the program of dissemination of knowledge, and it is in dissemination that the educational part comes in. These four branches correspond to what is usually studied as cognition, epistemology, history, and sociology of knowledge, including education.

It is also essential to remember that formal knowledge also had contributions from common sense since, as Campos (2012) states, citing D'Ambrosio (2005)¹ and referring to elementary manifestations of mathematical thought, "Mathematics has always developed in parallel with that of the people or professions, that is, with ethnomathematics. Thus, different peoples developed ways of measuring land, differently from other peoples, and therefore created relatively different geometries (measurements of the land)" (p. 3).

Incorporating these assumptions into teaching can influence classroom practice, allowing the acquisition of scientific knowledge associated with values such as the notions of dignity and social justice. Despite the fruitful possibility of relationships between the intentions of this research and decolonization, such as the problematization of a compensatory-decolonial

¹ D'AMBROSIO, Ubiratan. Volta ao Mundo em 80 Matemáticas. *Scientific American Brasil*, n. 11, p. 6-9, 2005.

way to denaturalize the unique and fixed way of understanding the world in light of a decolonial action carried out by Conceição and Souza (2024), this research section describes a sugarcane worker's strategies to calculate the daily wages of a sugarcane cutter based on his experiences as such, as a foreman, and as an inspector/administrator.

2 The context of the study

Instead of promoting a debate in an attempt to outline a definition of Ethnomathematics, the option chosen was to resort to something that would highlight that the purposes of this study are situated within this field. This was done in two directions, the first of which addresses Ethnomathematics in terms of non-academic mathematical knowledge, according to Fiorentini (1994, p. 59),

it meant non-academic and non-systematized mathematics, that is, oral, informal, “spontaneous” and, sometimes, hidden or frozen mathematics, produced and applied by specific cultural groups (indigenous people, favela dwellers, illiterate people, farmers...). That is, it would be a very particular way for specific cultural groups to perform classifying, ordering, inferring, and modeling tasks.

The second approach has pedagogical intentions based on the exploration of power between mathematical knowledge acquired at school and outside, as highlighted by Knijnik (1993, p. 35-36),

the investigation of the mathematical conceptions, traditions, and practices of a subordinate social group and the pedagogical work that develops from the perspective that the group interprets and decodes its knowledge; acquires the knowledge produced by academic mathematics, using, when faced with real situations, the knowledge that seems most appropriate to it.

A frequent characterization in works that address ethnomathematics has been the etymological approach highlighted by Ubiratan D'Ambrosio, one of the creators of this field of study, who made an etymological approach to the word. Regarding this, Fiorentini (1994, p. 59) adds that “D'Ambrosio expands the meaning of Ethnomathematics by defining it as “the art or technique of explaining, of knowing, of understanding in diverse cultural contexts”.

Some research in Ethnomathematics in recent years has analyzed issues related to decoloniality, as Silva, Gomes, and Capecci (2023) reported in their systematic review. In this regard, the authors highlight the existence of distinct theories. In their analysis, they found nine studies involving Ethnomathematics and interculturality. The purpose of bringing something that allows us to understand decoloniality can come from a variety of perspectives, as highlighted by Matos, Giraldo, and Quintaneiro (2021, p. 897),

Walsh (2017)² challenges us to unlearn thinking from a hegemonic perspective and to act in its surroundings, in its fissures, in its cracks. “It is in the cracks that processes, practices, and possibilities of the intercultural and the decolonial begin to intertwine and sow, undoubtedly, not as fixed nouns, but as ‘verbalities’ that awaken their active action, their engagement

² WALSH, Catherine. ¿Interculturalidad y (de)colonialidad? Gritos, grietas y siembras desde Abya Yala. In: DINIZ, Alai Garcia; PEREIRA, Diana Araujo; ALVES, Lourdes Kaminski. (Coord.). *Poéticas y políticas da linguagem em vias de descolonização*. Foz do Iguaçu: Unila, 2017, p. 19-53.

(WALSH, 2017, p. 44, our translation)”.

In all these idealizations, culture occupies a central place. Regarding pedagogical interests and their peculiarities, it is worth remembering that,

The pedagogical proposal of ethnomathematics is to make mathematics alive, dealing with real situations in time [now] and space [here]. And through criticism, question the here and now. By doing this, we delve into cultural roots and practice cultural dynamics. We are effectively recognizing in education the importance of various cultures and traditions in forming a new, transcultural, and transdisciplinary civilization. (D’Ambrosio, 2019, p. 46).

In the case of sugarcane cultivation in Brazil, the object of interest of this research, since its beginning, labor has generated problems from several perspectives, as observed below:

At the beginning of colonization, however, sugar mill owners suffered from a shortage of African labor, as the slave system in the Atlantic was still in the early stages of formation. Only at the turn of the 16th to the 17th century were the distribution networks for captives consolidated, driven, above all, by the significant expansion of the sugar economy. (Nascimento, 2014, p. 28)

Slave labor was unpaid, but the end of slavery in Brazil established sugarcane cutting as a paid activity. So, the working day began to be paid per day of work or daily production. Thus, establishing ways to define payment became necessary, including the daily rate, which, over time, to reach fair values for employers and employees, led to different ways of calculating working hours based on hours of services rendered. Over the last fifty years, for example, there are records that these values could have been settled based on the experiences of workers, who were responsible for measuring the area cut through loose, burnt, and/or raw cane, the weight per hectare, and the cane tied in bundles that weighed ten kilos on average. However, adopting the smallest bundle as the basis for determining workers’ production illustrates traits of Colonialism. It is worth adding that, in measurement practices, the fathom is often used to calculate workers’ earnings.

Therefore, some places in the country’s south began using tape measures. In other regions, such as the northeast region, compasses were employed to improve measurements and, in some way, avoid social conflicts between sugar cane workers. Finally, the measurement by weight is currently close to the *exact* value. However, the method used by workers, who measure working hours directly in the field, is very intuitive, resulting from the experience acquired throughout their lives.

The interest in debating sugarcane workers’ social issues aims to minimize union interventions in their defense by adopting Ethnomathematics as part of the field of study of Mathematics Education. This could certainly be explored through decoloniality, from Conceição and Souza’s (2024) perspective, as mentioned above, in the line of research on transcomplex decolonial Mathematics Education (Rodríguez, 2022) or others. However, in this research, the calculation of the working day is investigated through the area covered by the sugarcane plantation to be cut, seeking to describe the measurement procedures to reveal the source of problems due to errors caused by the lack and/or excess resulting from how the farmer measures, highlighting how these practices directly impact labor remuneration, working conditions, and the emergence of conflicts between workers and employers within the productive process.

3 Methodology: typology, locus, participants, and instruments

Debates involving methodological approaches focus on two paradigms: a former, qualitative paradigm based on Positivism as a philosophical stance and a more recent, qualitative one based on Constructivism. Quantitative research is objective and adopts inferential statistical procedures to transform its data, while qualitative research is subjective and interpretative.

Gerhardt and Silveira (2009, p. 31) state, “qualitative research is not concerned with numerical representation, but rather with deepening the understanding of a social group, an organization, etc.” In addition, within the scope of qualitative research types, reference is made to case studies because this approach meets the purposes of this investigation; it is enough to observe the three conditions pointed out by Yin (2001)³ and cited by André (2008, p. 30):

(1) the research questions are of the “how” and “why” type; (2) the researcher has little control over what happens or might happen; (3) the focus of interest is a contemporary phenomenon that is occurring in a real-life situation.

In turn, an ethnographic case study, according to André (2008), requires the existence of an emphasis on singular knowledge in which the requirements of ethnography are present. The author adds: “Generally, the case focuses on a particular instance, be it a person, an institution, an innovative program, or a social group” (André, 2008, p. 24).

This study is unique because it is based on the accumulated experience of a sugarcane worker who performed as a sugarcane cutter, foreman, and inspector/administrator. Thus, we seek to map the procedures involving land measurements used to calculate the daily production of a sugarcane cutter within the scope of each of these three forms of activity and compare them with each other and with classroom mathematics.

In this context, we chose interviews for data collection partly due to the assumption that “the use of the interview method becomes the most appropriate strategy to ‘construct’ descriptive data in the subject’s own language during the interview” (Zanette, 2017, p. 162). The analysis involves examining the strategies presented in the sugarcane worker’s statements about calculating the daily wages of a sugarcane cutter considering each of these three forms of experienced action.

3.1 The Research Locus and Participants

The study was conducted in the municipality of Timbaúba, located in Zona da Mata, north of Pernambuco, in the Brazilian Northeast region. This municipality has five district zones: Timbaúba, Cruangi, Livramento do Tiúma, Catucá, and Queimadas. In addition to the villages, the territory is 292.3 km²; in 2013, the population was 53,825.

At first, we thought four workers would participate: a foreman, an inspector, an administrator, and a sugarcane cutter, all from the municipality of Timbaúba, in the state of Pernambuco, Brazil. We would not have trouble finding those workers, as many work in this municipality and other regions of Pernambuco and neighboring states, such as Paraíba and Alagoas. However, the fear of omitting and exposing workers’ information led us to choose only one worker from this municipality with experience in the three functions required, because, as he is retired, much of the fear could be circumvented. The worker was taught to read and write in field schools and began working in sugarcane cultivation at twelve. Forty-eight of his

³ Yin, Robert Robert Kuo-zuir. *Estudo de caso: planejamento e métodos*. Tradução de Daniel Grassi. 2.ed. Porto Alegre: Bookman, 2001.

sixty-four years were dedicated to this area. He worked twenty years as a sugarcane cutter, twenty-three years as a foreman, and five years as an inspector/administrator.

3.2 Collection Instrument

The data were obtained through a semi-structured interview recorded on a cell phone, based on the following question: How can the working hours of a sugarcane cutter be calculated based on the daily rate per area of sugarcane cutting? After the interview, the retired sugarcane worker's speech was transcribed, and the data collected gave us the means to identify how a sugarcane cutter, a foreman, and an inspector/administrator calculate a sugarcane cutter's daily wages.

4 Discussion of the Results

The answers given by the sugarcane worker from the municipality of Timbaúba when in the position of a sugarcane cutter, foreman, and inspector/administrator show that determining the calculation of a worker's daily wage when cutting sugarcane depends on the area in terms of geometric shape, the quality/type of sugarcane to be cut and terrain conditions. The characteristics of the protocols arising from this worker's answers from the standpoint of a sugarcane cutter, a foreman, and an inspector/administrator, respectively, consider the quantity and quality of sugarcane planted per area, the topography of the terrain, weather conditions, among other aspects, which were analyzed and systematically organized and are presented as follows:

Sugarcane cutter — When asked how to calculate a sugarcane cutter's daily wage, he replied: *"It's very easy, right? Calculating a daily wage, let's say, depends on the sugarcane, let's say one hundred cubes"*. We can see that the worker does not use the international system of measurements since he refers to the cube (note that a cube represents a unit of area in square fathoms, and each fathom corresponds linearly to two meters and twenty centimeters). In this regard, it is important to highlight that the worker claims that the fathom is the measurement sugarcane workers use the most; in other regions, measuring tapes or even compasses are used to avoid errors when measuring land.

Furthermore, the worker stated that the quantity/quality of the sugarcane interferes with the calculation. In his report, when asked if the quantity/quality of the sugarcane influences the calculation of the daily rate, he said: *"Of course, because if the sugarcane is strong [forte] or even very full [cheia] sugarcane [little space between one sugarcane and another], then eighty cubes would be enough for a daily rate. Therefore, for him, the space between one sugarcane and another indicates whether the sugarcane will be stronger or weaker. Here, my daily allowance is ten fathoms in length and eight in advancement [width]"*. These are the dimensions placed by the worker, according to his experiences, to delimit the perimeter to be worked or the area intended for that day, stating that it is eighty square cubes or fathoms.

The adjectives *forte* and *cheia* as spaces between one cane and another interfere in the volume and weight of cane calculated per cube, but the quality is related to the size, diameter, and spacing that change with the number of harvests, in which the first has better quality than the second and this one than the third. In addition to management during planting, care must be taken when harvesting the new sugarcane ratoon — the regrowth of sugarcane after cutting the sugarcane plant, which corresponds to the first cycle of the plant. The possibility of being destroyed during cutting or by agricultural machinery when removing the cut sugarcane or its straw, as phases in the harvesting process, can interfere with the quality of the ratoon and, consequently, with the new sugarcane harvest. Thus, we observe that, with the increase in the number of harvests, there is a decrease in the quality of the sugarcane and, consequently, in the volume per cube, which is why the ratooning often ends in the second cycle, where the area is

replanted.

The worker's speech about cutting sugarcane makes clear his concern about reducing the area worked and the need to produce enough to meet his minimum target, which is essential for him to continue working and to support his family. Each worker sets their own productivity goal, in line with their financial needs and those of their families. To guarantee a minimum wage at the end of the month, a worker must cut at least three tons of sugarcane daily. However, this salary is not enough to cover their expenses and guarantee their subsistence during harvest, increasing their need in the off-season, as at that time they are unemployed, with no savings from their accumulated production, and cannot generate a necessary financial residue.

In this regard, it is worth noting that many workers begin the sugarcane harvest after months without working, in debt, and are unable to support their families. Hence, a type of self-demand becomes a reality. In search of an income that provides a better quality of life, these workers need to double their production to six tons per day, corresponding to an income of two minimum wages per day. However, overwork can result in physical exhaustion, when some faint and a weakened state is experienced, known in this context as *motor batido* [engine failure]. Certain attitudes are necessary to overcome these inadequacies: a period of physical readaptation at the beginning of the harvest, adequate nutrition, and rest, which are generally not followed in the off-season.

Sugarcane cutters constantly monitor the area/perimeter worked to avoid measurement losses that compromise the real value of their workday. Therefore, they observe the type of cane to be cut — smaller, upright canes with greater spacing between them —, as this makes cutting easier and requires less effort to handle on the mats, while large/tall canes, with less spacing between them or lying down, require greater care and labor force. In turn, whereas the thicker diameter of the cane requires a different practice in cutting and care in gripping the cane and the machete, the canes of smaller diameter can be collected in one go, which is why workers with large hands and long arms are considered to be better sugar cane cutters — known as *badeiros* — while cane cutters without these attributes have less productive strength and are called *orelhas secas* [dry ears].

The soil type can also affect the worker's performance during sugarcane cutting, reducing production, such as rocky soils, which break the machete blade, forcing the worker to interrupt the workday to sharpen it or continue with the tool in a precarious state, compromising production. A blunt blade requires hitting the cane or a bunch of canes several times, delaying the cut and exhausting the worker. The difficulty increases given that the sugarcane must be cut deep into the ground, closer to the root, as instructed by those responsible for cutting, arguing that the sucrose is in the lowest part of the sugarcane.

Very humid soil gets muddy, hindering the worker's movement and making it difficult to manually remove the sugarcane, which may lie in the mud and be rooted, increasing the risk of accidents because the bark leaves sharp stems when broken. Furthermore, the uneven topography requires great leg strength from workers to climb and descend very steep slopes, reducing the pace of production and increasing physical wear and tear during harvesting.

Foreman — When asked as a foreman: How do you calculate the daily wage of a worker in an area where sugar cane is cut? He replied: *"It will depend on the sugarcane, too. I arrive in the morning, see the type of cane, and tell the worker, you are going to cut this cane ten fathoms long by twelve fathoms long"*. His position as a foreman is based on his experience as a sugarcane cutter and as a foreman, as he aims to ensure that there will be no loss for the company, which is why he suggests considering, as a calculation for a cane cutter's daily wage, ten fathoms wide by twelve fathoms long. The foreman's implicit negotiation in this proposition regarding the sugarcane cutter's perspective, i.e., from one hundred twenty to eighty cubes,

implies forty cubes more, which, through an agreement between the foreman and the cutter, ends up in one hundred ten cubes. There are ongoing talks: even though the foreman had formerly been a sugarcane cutter, he cannot find a fair balance between the company and the worker because his fear of losing his job prevails. So, he imposes a much larger area for the sugarcane cutter to work in during a working day.

Now, as a foreman, when asked if the quality of the cane interferes in the calculation of the daily wage for a work area cut from sugar cane, the respondent argued: *“Let’s say that a cane that is a meter eighty high, if you cut one hundred forty-four cubes, after calculating, it only gave two thousand eight hundred kilos of cane, the boss will quick me out because I have to base myself on three tons, and this depends on the type of cane. I don’t want to exploit the worker, nor do I want the boss to get less than he should. In this case, the quality of the sugarcane has a big impact”*. He talks about the height and weight of the cane, probably in the first harvest, to give an example of a volume per area cut that is smaller than the basic area that should be eliminated in a day. By adopting three tons as a reference, he justifies that this does not compromise his work as a foreman or the volume of sugarcane to be given to the cutter for his daily wage. It is important to remember that three tons represent the minimum daily production of a sugarcane cutter to guarantee the lowest monthly salary.

The foreman’s role in the sugar cane harvest is to control the workers’ production process, acting in the measurement of land to calculate the income of the sugar cane cutters. He cannot make mistakes because, on the one hand, it is about the production of sugarcane cut for the worker’s subsistence as a source of income to support their families; therefore, he must be fair with his measurements to avoid conflicts with the workers and try to keep them motivated to produce even more. On the other hand, there is concern about his own job, so he knows that his incorrect measurements can cause losses for the company, which can culminate in his dismissal if the weight of the sugarcane projected on the harvesting ground is not equivalent to the same weight weighed at the mill — called sugarcane breakage. However, if there is a surplus value in the calculation of the workers’ production, this part will not be divided among the cutters in proportion to their production in that lot. Given this characterization, the complexity that permeates the foreman’s activity becomes clear. However, many who occupy this position are roughly literate and have learned to measure land from their experience as sugarcane cutters during the rise of their careers.

Parallel to the discussion about the foreman’s difficulties in monitoring the sugarcane cut by each worker, we see that he intends to avoid possible conflicts with the cutters or among the cutters due to monitoring the harvested area. Such hardships can be observed when lots are invaded, i.e., the formation of *buchos* [belly-curves] instead of rectilinear borders between the lots worked by two workers, which benefits one and fouls the other, which sometimes occurs intentionally, in which case, the foreman advises them to open a path between the blocks to avoid injustice.

In this context, the foreman also needs to be aware of the type of cane to be cut since, if all the canes in a particular area have a smaller diameter, the spacing between them is greater, indicating that he must increase the worked area, otherwise, the weight will be lower than projected. If this information goes unnoticed, it will be detected during weighing at the mill, and the foreman may be penalized.

Soil conditions are generally not considered in the foreman’s decisions, even though all know that such conditions can reduce the work pace of the cane cutter and that the cane weight projected for that area at harvest must be met. However, due to his case knowledge, the foreman can promote negotiations to facilitate work in areas such as those, highlighting his importance in maintaining the quality of work and efficiency in the harvesting process.

Inspector/administrator — We asked: In this role, how do you check whether the daily rate that the worker will receive for the area cut is correct? He answers: *“I pass by on the road on a motorbike or horseback, I see if the sugarcane is good or bad (weak or strong). If it’s weak, I say: Foreman, this cane can be cut at ten fathoms by fifteen. Sometimes, you measure ten fathoms by fifteen in the weak cane, but inside, the cane is strong. Or when the cane is strong, I say: Give a hundred fathoms here, but inside, there is room for a hundred and twenty”*. The inspector again uses the quality of the sugarcane as a reference variable for calculating the daily rate. They make assumptions based on their experiences that allow them, even from a distance, to make inferences about the task to be performed by a sugarcane cutter corresponding to his daily wage. However, he admits he can miscalculate the weakest or strongest cane.

In carrying out his duties, the inspector, in the same way as the foreman in relation to the cutter, has the role of mediating conflicts between the foreman and the cane cutter and between the foreman and the manager of the sugar mill. He tries to avoid possible union interventions, which would cause problems for the sugarcane mill manager. The inspector is responsible for supervising the entire production process, from burning the sugarcane to transporting workers, cutting, and removing the sugarcane — manual process and/or harvesting by agricultural machinery —; he is also responsible for not allowing the destruction of the ratoons and for seeking to reduce waste during the straw harvest.

The inspector is also responsible for the administration of mills or *zones*, a popular name in this context representing a group of mills, which requires him to have a higher level of schooling than that required from foremen and cutters. However, in our study, even without an educational level, the experience throughout the career enabled the worker to rise to the role of inspector. The privileged knowledge of the territory of the sugar mills under his administration, involving the variety of species of sugarcane planted, irrigation conditions, and ability to assess the weight of the sugarcane to be harvested, underpins the development of criteria for dealing with negotiations with the mill manager, with the foreman and, when necessary, with the cutters, including the interest in increasing the company’s productivity/profits, which is also important for avoiding/minimizing conflicts between workers.

In his answers, the worker uses mathematical knowledge related to measuring the areas of flat figures without, at any time, referring to a given type of geometric shapes of this nature. In the speeches of the three characters brought — sugar cane cutter, foreman, and inspector/administrator —, different values were presented, but the reasoning used is coherent in all the answers, since they involve lateral measurements of unidentified flat geometric shapes that refer to the calculation of their areas.

Another aspect of mathematical knowledge immersed in the characters’ speech is the measurement of the weight of sugarcane harvested per area in tons. Somehow, this volume of sugarcane, conceived through experience based on observable characteristics, such as height, thickness, and quantity per area, interferes as an attribute to typify what was called quality from the perspective of measuring the weight of the harvest in a given plantation.

In the worker’s speech, putting himself in the place of a cutter, a foreman, and an inspector, the calculation of the daily rate was estimated by area cut in square fathoms (cubes) and measured in weight per ton of sugarcane also estimated through measurements in cubes. Thus, a sugarcane cutter’s daily wage was estimated at an average of one hundred cubes or three tons.

As already highlighted in the answers presented in the calculations of the sugarcane cutter’s daily wages, even when the worker refers to the measurement of the sides of flat geometric shapes, he does not mention it. This led to the need to place the interviewed in some situations related to this concern. In the first one, he was asked to represent, on a piece of paper,

the figure of a square and calculate its area, illustrated in Figure 1.

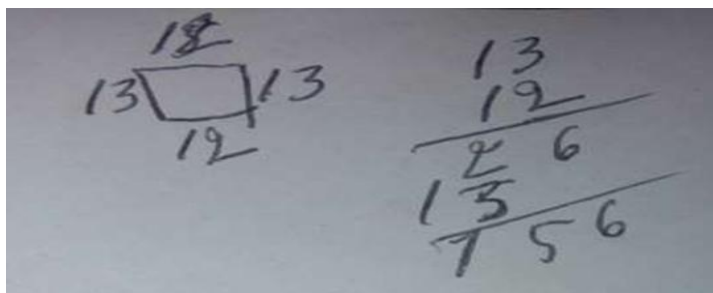


Figure 1: The worker's sketch of a square and his calculation of its area (Research Collection)

The geometric shape the worker sketched alludes to a quadrilateral, but not to the square requested to be represented. For this worker, having opposite, parallel, and equal sides is enough for it to be a square. As for calculating its area and that of other quadrilaterals, he obtains the sum of these opposite measurements, divides each by two, and multiplies these results to represent the area in question.

To understand how the worker proceeded when faced with situations where it was more challenging to calculate the area, Figure 2 was presented, indicating the lateral measurements in fathoms.

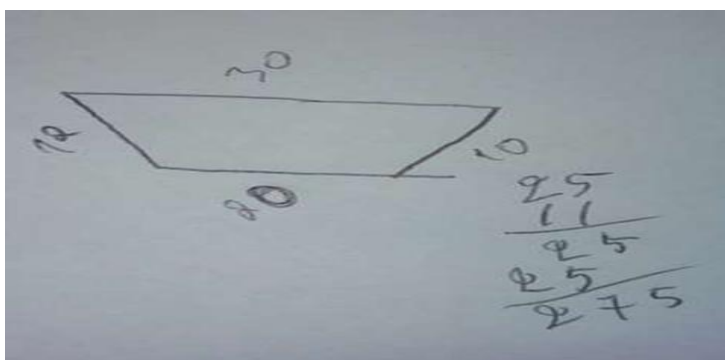


Figure 2: The worker's sketch of a trapezoid and calculation of its area (Research Collection)

Figure 2 is also a quadrilateral called a trapezoid, where the measurements of all sides are different. To measure the square — area of cut cane —, the worker first adds the opposite sides and divides them by two, finding the arithmetic mean of these dimensions, then multiplies these results together, obtaining the value of the area requested in square fathoms, that is, in cubes. However, the procedure adopted to calculate the area and result differs from the Euclidean Geometry learned at school.

The third situation deals with triangular geometric shapes, i.e., the geometric shape and its corresponding dimensions. The measurements of the sides in fathoms taken by the worker are indicated in Figure 3.

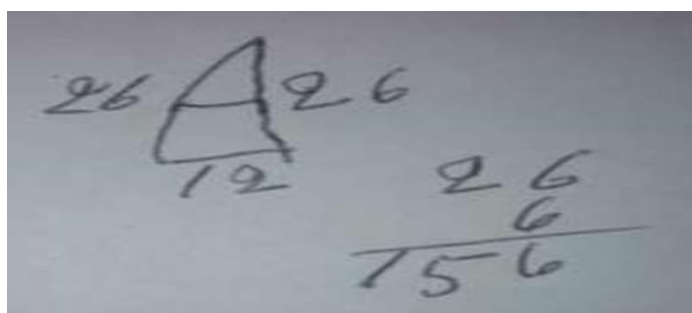


Figure 3: The worker's sketch of a triangle and calculation of its area (Research Collection)

In Figure 3, the worker roughly outlines a triangle with two sides measuring, in fathoms, twenty-six, and the third measuring twelve. The procedure adopted to calculate the area of the triangle is analogous to that carried out in the situations discussed in Figures 1 and 2. He adds the two sides with the same measurement and divides them by two, obtaining twenty-six fathoms. As for the third side, with a measurement equivalent to twelve, the worker adds zero using the expression *morre zero* [zero dies] dividing twelve by two and obtaining six. The area of the triangle presents fifty-six square fathoms as the product of multiplying twenty-six times six.

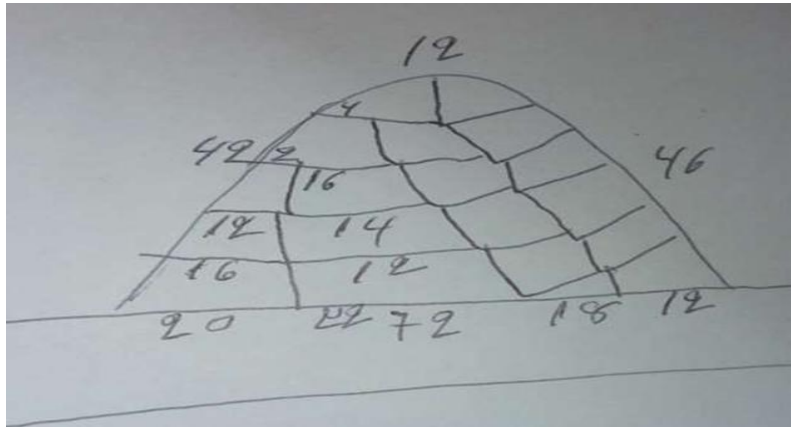


Figure 4: The worker's sketch of a hill and calculation of its area (Research Collection)

In the third situation, in Figure 4, the worker sketches a surface with an elevation shaped like a hill/mountain. Subsequently, the worker is asked to show his procedure for calculating the area of this uneven surface. In Figure 4, the dimensions and subdivisions of the larger area indicated were assigned by the worker, with the justification that it would be important to better explain what he was doing.

On the left side of Figure 4 (hill), the worker attributes forty-nine fathoms to the measurement of the surface that gives origin to an imaginary line, corresponding to the measurement from the bottom to the highest point of the elevation (the summit). The same was done in the demarcation of the right side of this figure, which corresponds to the value of forty-six fathoms. Then, he subdivides the total surface area into subareas by mapping it; however, it is worth highlighting that the results achieved do not really represent polygons. Therefore, no matter how carefully the measurements are taken, there are differences, whether in comparing the three situations or analogous procedures in the school environment.

To avoid problems in accounting with the overseers, for example, the foreman, the area that represents the daily journey in fathoms, instead of ten wide by ten long for the cutter, is represented by ten square fathoms, which correspond to ten wide by twelve long, and for the inspector, ten wide by fifteen long. To facilitate an understanding of the values of the daily wages paid to a sugarcane cutter, Figure 5 presents proof of his payment receipts.

When asked what cubes mean, the worker, playing the role of a sugarcane cutter, answers: "*One hundred cubes means one conta⁴, one daily rate*". Then he states: "*I measure ten square fathoms*". Therefore, it is understood that an area ten fathoms wide by ten fathoms long is equivalent to one hundred cubes, the same as one *conta*.

An important aspect that occurred with the inquiry about how to take measurements on elevated terrain needs to be highlighted. The worker stated that a stake is placed at the top of the elevation, and ropes/lines are extended downhill, dividing the region into triangles. Thus,

⁴ *Conta*, *tarefa*, and *braça* [account, task, and fathom, respectively] are, among others, forms of agrarian measures used by local traditions in informal contexts.

the area that constitutes the elevation is obtained by determining the area of each triangle and adding them all together.

PERIOD:		NIRVALDO SERAFIM DA SILVA		\$1.600.	
FUNÇAO:		02/02/2004 To 07/02/2004		SALARY BASE:	
DAYS	#	DESCRIPTION	REP/TAR/PRODUT		AMOUNT \$
1	18	MANUAL CUT OPEN	* 159	93	\$25.50
2	9	MANUAL CUT OPEN	93	83	13.50
3	5	MANUAL CUT TIED	* 340	50	\$45.00
4	3	MANUAL CUT TIED	* 166	166	18.00
5	1	REMUNERATED REST 100%	1	100%	\$9.03
6	1	ACCOMMODATION	1		\$10.00
7	3	MANUAL CUT OPEN	71	88	\$9.03
3	3	MANUAL CUT OPEN	71	88	\$9.03
3	3	MANUAL CUT OPEN	71	88	\$9.03
7	1	DEBT/PERSONAL LOAN	1		\$3.00
7	1	PREVIOUS BALANCE	1	B.2	\$8.20
12	1	DEBT/IN.S.S.	\$	10.13	\$10.13
TOTAL GROSS \$			TOTAL DEDUCTIONS \$		
Field Base Gross Total			Base Base		
\$1,485.00			\$10.55		
Total Base Contr. I.N.S.S.			Total Base Deductions		
\$1,600.00			\$10.13		
TOTAL GROSS \$			NET \$		
Total Base Gross Field			\$1,103.00		
Base Contr. I.N.S.S.					
\$1,600.00					
TOTAL DEDUCTIONS \$					
Base Base					
Total Base Deductions					
RECEIVED THE CONSTANT NET AMOUNT					
Nirvaldo Serafim da Silva					
EMPLOYEE SIGNATURE					
ALCOHOL: WORK IN THE FIELD & HEALTH IN THE CITY.					

Figure 5: Payment statement, 1st author of this article when working as a sugarcane cutter (Research Collection)

Some data was omitted to preserve the workplace in the statement. The document corresponds to the biweekly payment of the first author of this study when he worked as a sugarcane cutter in the first quarter of 2004. Therefore, the statement does not belong to the sugarcane worker but to his father, who shared the knowledge acquired about sugarcane culture during the interviews with his son.

The information in the first lines of the statement includes the employee's full name, company registration number, and the period during which he performed this activity. Just below, on the left, is the function and, on the right, the financial value of the minimum daily rate, nine reais and three cents, referring to the cutting of three tons of sugarcane, that is, one block/*conta*, which means three reais and one cent paid for each ton produced. To understand the financial value received in 2004, one can remember that in this year, the minimum wage was R\$240,00, and in May of the same year, it was readjusted to R\$ 260,00.

Next, from left to right, are the days, the indication of typicality, whether manual cut, loose, or tied, the quantity of daily production in *contas*/tasks measured by weight in tons, and its corresponding value in the current currency, the real. Manual cutting of sugarcane tied in bundles, without going through the burning process, is generally carried out in areas that are difficult to access. The bundles weigh approximately ten kilos, each equivalent to twenty units of cane, approximately one meter long.

This process involves the so-called *sugarcane pushing*, also known by growers as *sugarcane balling*. This is an important and necessary activity during the rainy season, lasting one or more days. It certainly makes it challenging to remove straw and sugarcane using agricultural machinery. In carrying out this activity, round wood measuring approximately ten centimeters in diameter and just over two meters in length is used. The poles are inserted underneath the mat of the already cut sugarcane, then lifted several times until an avalanche effect is formed, so they roll down the slope to the closest point for truck removal, a process that demands significant physical effort from workers, increases exposure to occupational risks, and reveals the embodied knowledge mobilized to overcome environmental and logistical

constraints in the harvesting process.

5 Educational Considerations

Regarding the foreman's commitment to his function, it is worth highlighting the care taken in calculating the measurement of the cane cut in the field compared to the weight reference established by the industry/mill. This means, for example, that the calculation of the measurement by a foreman responsible for fifty workers, in which each cutter, on average, produces five tons of cane per batch, must guarantee that the quantity transported to the industry/mill is at least 250 tons. This control is essential to ensure production accuracy, avoiding discrepancies that could impact logistics and harvest yield.

In this form of production control, loss is more likely for the worker than the mill; that is, the error may be *welcome* for the worker, but its implication as a loss for the company is unacceptable. Losses and gains between the worker and the company are not entirely inevitable. This can lead to other discussions, such as investigating labor conflicts according to union interventions involving daily wages, production, profits, losses, and subservience. This aims to provide opportunities for people in rural areas to develop awareness of social values through research related to decoloniality.

In Brazil, many mills harvest sugarcane mechanically, and some harvesting machines can replace the work of eighty people and increase the production of sugar and ethanol. However, in addition to the reduction in employment opportunities and the demand for this work activity being confirmed in several regions, it is important to remember that workers are still necessary for manual sugarcane cutting since machines cannot move through certain sugarcane plantations. However, other opportunities end up happening for these workers. In the case of the first author of this article, he left the sugarcane cultivation activity and entered the urban job market. As a result, he worked in industry, commerce, and the service sector, which required several skills that he had acquired in and outside school. Along the way, the first author of this research recognized the need to resume his studies and prepare himself to have more autonomy and increase his possibilities for subsistence, which resulted in his enrollment in the Mathematics degree at a public Higher Education institution, the University of Pernambuco (UPE). After completing the course and working as a teacher for three years, he passed a public exam and is currently a full-time professor in the public school system in Pernambuco.

Assuming the positions of a cane cutter, foreman, and inspector, the worker highlighted two fundamental reflections. The first refers to the fact that knowledge about the measurement process to arrive at the daily value, among other aspects in the sugarcane sector, is related to his experiences with the weight of the sugarcane. The other consideration is social since the answers imply recognition of the advancement of the position assumed by the worker throughout his professional career through the knowledge acquired in the calculation of the daily rate involving notions of Geometry (area, volume, unit transformations), Arithmetic (numbers, fundamental operations) and social attributes in determining the minimum production of three tons of sugar cane.

In Basic Education, the use of mathematical knowledge in applications in carrying out formal and/or informal activities in commerce, provision of public and/or private services, civil construction, etc., has not been adequately related by teachers and students in and outside the context. A fruitful path to foster the adequacy of this form of knowledge and its countless possibilities for applications can be, for example, through *Programa Etnomatemática*, according to its core, using the generation, organization, and dissemination of knowledge from the D'Ambrosian perspective of education.

The second author of this article has adopted this path since 2007. Combined with

elements of the Ausubelian theoretical contribution, he intends to provide significant learning of Mathematics for Basic Education students. With the approval of the first author of this study in the Postgraduate Program in Education at the University of Pernambuco, the research carried out in the undergraduate program evolved with the necessary modifications for his master's qualification project, which articulates elements of the theoretical approaches of Ethnomathematics and the theory of meaningful learning for students with experience in the rural labor market of sugarcane mills in the teaching modality of Youth and Adult Education (YAE).

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The first author would like to thank his father for his help, from his initiation into the role of sugarcane cutter, through home and school education in Basic Education, until the culmination through contributions to the completion of the monograph for the conclusion of the Mathematics degree. In particular, although late, he now recognizes the value of his availability and teaching provided carefully and pedagogically about the activities of the cutter, foreman, and inspector, twenty years after the end of the period in which he worked as a sugarcane cutter.

Conflicts of Interest

The authors declare that there are no conflicts of interest that could influence the results of the research presented in this paper.

Data Availability Statement

The data produced and analyzed in the paper will be made available upon request to the authors.

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