Capítulo 96

Different Ways Of Feeling And Interpreting Physical Phenomena In The Ceramist Practices In Cuéra Village In Bragança (PA)

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ABSTRACT
The present work is part of a doctoral research under development in the Graduate Program in Education in Science and Mathematics at the Federal University of Pará. One of the themes addressed is the teaching of Physics through the process of making clay pots relating traditional knowledge to academic knowledge. The research has as empirical locus the traditional community Vila Cuéra, located on the banks of the Caeté River, in the rural area of the municipality of Bragança, state of Pará, Brazil. Among the objectives of the research, we intend to record the empirical knowledge of ceramic artisans about their production and main techniques. The methodological procedure chosen privileges ethnographic techniques in order to facilitate the understanding of the relationship between Physics and the production of ceramics in the chosen community, especially pots, seeking to establish ties that assist the process of construction of the observed ethnophysical knowledge.

Keywords: Knowledge of tradition, Sensitive Science, Ceramics, Ethnophysics, Physics Teaching.

1 INTRODUCTION

Everyday life in traditional communities is a space full of knowledge that serves as a guide for the emergence of new ways of understanding particular notions of thinking and representing their own existence in these places, as well as contributing to the understanding of how these communities organize themselves in society, their relations with the environment and their daily practices.

By establishing relationships between local knowledge, present in communities of traditional characteristics of the Amazon,[1] with contents studied in Physics, new possibilities arise and a new environment is created from new perspectives that seek to reconnect the science of the concreteness of real life, distancing its abstractionism.

This new configuration of contemporary science has distanced itself from people's day-to-day lives, like physics, which commonly frightens those who are unaware of its applications and concepts. This distancing was provoked by years of discrimination in relation to the knowledge developed in daily life, distancing that prevents the common individual from seeing the moments of production and application of knowledge in his daily life.

According to Maturana (2001),science is based on two assumptions: first, that there is an objective reality independent of observers and, second , that the validity of explanations is based on this objective reality. Thus, scientific knowledge rises to a level from which all other forms or systems of knowledge are subjugated, making traditional knowledge far from scientific reality.

Diegues (2008) points out that populations considered traditional develop a unique way of life, as they are in constant interdependence with nature, respecting natural cycles, using renewable natural resources from which they build a way of life by developing sustainable management systems. They are populations that cultivate the importance of family, domestic or communal unity for the exercise of economic, social and cultural activities. The author also points out that the symbologies, myths and rituals associated with hunting, fishing and extractive activities are important to subsistence in these communities. These populations maintain a direct relationship with the natural environment in which they are inserted; they use this environment in order to ensure the use of resources for successive generations, in which the knowledge and practices important for the existence of the community are transmitted by orality.

In this perspective, Almeida (2010) states that, unlike common sense, "knowledge of tradition" architects understandings based on systematic methods, controlled experiences and systematizations reorganized continuously. This knowledge represents the manifestation of knowledge that is commonly not recorded in academic or school books (Bastos, 2013).

But this other way of thinking has aroused curiosity and interest on the part of researchers, since this knowledge does not follow the formal scientific logic and is based on other ways of thinking practical actions of daily life (Lévi-Strauss, 2008). According to Silva & Fraxe (2013), ethnoscience is presented precisely to seek to understand these other knowledge stemming from traditional populations. Knowledge that is not codified by scientists, because the knowledge of traditional populations changes according to the place in which they live, both in the social and cultural aspects. In this sense, Radford (2014, p. 52) argues that "en otras palabras, las culturas producen saberes que no solamente son diferente de cultura en cultura sino que dichos saberes afectan (directly and indirectly) differently to sus individuals".[2]

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[1] Science that studies the laws and properties of matter and energy that control the phenomena of nature (Houaiss Concise Dictionary, 2011).

[2] "In other words, cultures produce knowledge that is not only different from culture to culture, but that this knowledge affects (directly and indirectly) their individuals differently" (Our Translation).

Alongside scientific knowledge, traditional populations, throughout their histories, have developed and systematized diverse knowledge that allow them to respond to material and utilitarian problems. Although they use the same cognitive attributes that constitute the unity of human thought, these two forms of knowledge (scientific and knowledge of tradition) are guided by different strategies of thought, one closer to the logic of the sensitive, the other, more distant (LÉVI-STRAUSS, 2008; ALMEIDA, 2010).

The registration and dissemination of other rationalities present in a society constitute an expansion of its cultural elements. This understanding of how the subjects of a culture construct their knowledge opens possibilities that seek to reconnect scientific knowledge and knowledge of tradition within a studied sociocultural reality (ALMEIDA, 2010; MENDES & FARIAS, 2014).

Thus, through this work, we seek to establish some relationships between the knowledge of tradition and the scientific knowledge derived from Physical Science, present in the ceramista caeteuara production of the Vila Cuéra community with the objective of contributing to the teaching-learning process of some concepts of Science and, especially, physics.

2 METHODOLOGY

The study was carried out through a qualitative approach (OLIVEIRA, 2016), of ethnographic nature, with the aim of bringing physics closer to the production of ceramics, especially with regard to pots, seeking to establish bonds that help the process of construction of the ethnophysical knowledge observed. This approach is based on the perspective that knowledge is a process socially constructed by the subjects in their daily interactions, in fact, transforming it and being transformed. Our study also points out some characteristics of qualitative research, such as concern about understanding the totality of the phenomenon studied and intense interpretation of the collected data, characteristics that are in full connection with ethnographic research (PEREIRA ET AL., 2018; PERINELLI, 2019).

It is notepoint that researchers who make use of ethnographic methods systematically and reconstruct, in as much detail as possible, the characteristics of the variables that constitute an observed phenomenon, with the purpose of organizing conceptual categories, comparing the constructions and postulates generated from the events in different scenarios. Therefore, we used readings by anthropology authors who describe approach experiences such as Malinowski (1978) and Geertz (2008).

In order to achieve the proposed objectives, four instruments were used to record the empiria: the first one was used in the **participant observation**. Through field observation, the researcher can interact with the researched context, establishing a direct relationship with groups or people, because this modality of research is an instrument that enhances knowledge and knowledge directed to traditional communities and minority groups (OLIVEIRA, 2016; FAERMAM, 2014).

The second instrument was based on **interviews** with the ceramists at different moments of the investigation. According to Oliveira (2016, p. 86) these oral records constitute an "excellent research tool for allowing interaction between researcher and interviewee and obtaining detailed descriptions about what is being researched" and make up an effective means of information recording (POUPART, 2014). At the same time, photographic (ROCHA & ECKERT, 2014) and filmic (REYNA, 2014) photographic and filmic (REYNA, 2014) photographic observations of the ceramist's work and their daily life in the community were made.

3 ETHNOPHYSICS

The program called Ethnomathematics establishes relationships between the knowledge of each community and the contents studied in mathematical science, that although the discipline takes such a name, in essence it ends up studying various forms of knowledge. Ethnomathematics is not only restricted to mathematical studies, but to every culture that surrounds the environment of science. D'Ambrosio (2005) introduces the idea that the Ethnomathematics program is part of the studies of the sciences, arts, history, religions and local cultures to demonstrate how the Exact Sciences were developed within a sociocultural context. Once instituted and over the years, the program now serves as a subsidy for the study of new areas related to Ethnoscience.

In this line of thought, Ethnophysics appropriates Ethnomathematics to discuss the possibility of an analysis of knowledge in different environments, based on the contextualization (by the social group that composes it) of the physical phenomenon studied under an inclusive paradigm, seeking to revalue the meanings of knowledge observed in each community in a harmonic movement with scientific physics.

Thus, ethnophysics becomes a field of study, which at first emerged based on the contributions of Ethnomathematics. Because it is a relatively new field of science at the national level, the concept of Ethnophysics is still under construction[34]. However, we can create points of intersection (BARROS, 2016) with the concept of Ethnomathematics to point out clues that help us think about what would become Ethnophysics. According to Barros (2016, p. 50) an important relationship that can occur between two concepts is that of intersection that "corresponds to the property of the concepts of sharing certain characteristic notes with each other".

In view of the concepts of Ethnomathematics, it is possible to perceive that, from the definitions of the term, we can create a relationship of traditional knowledge present in each community with the various mathematical rationalities. In relation to Ethnophysics, such relationships are not different, so thinking about Ethnophysics is considering all other existing rationalities that approach and relate to physical phenomena in the various realities. In the search to conceptualize ethnophysics, Santos (2002) states that:

> The physics we know, in a sense, is also an Ethnophysics because it emerged from a subculture within European society, from the exchange of various cultures [...] that each student lives and coexists with various cultures identified by nation, language, sex, social class, religion, etc., and that

[3] Some of its first authors nationally highlighted are Santos (2002) and Anacleto (2007).

[4] Conceptualizing is not only a scientific operation, but also an art. The invention or discovery of the characteristic notes that will be part of the composition of a conceptual chord, as well as the adoption of existing or unpublished concepts, will be used to entertain the theoretical tessitura on which the work will be supported (...) (BARROS, 2016, P. 190).

> their cultural identity can shock to a varying degree with the culture of Western Science (SANTOS, 2002, p. 4).

Following this logic in order to understand Ethnophysics, Anacleto (2007) investigated the physics used by rural workers in rice cultivation at Granja Bins, in Palmares do Sul, State of Rio Grande do Sul, Brazil. The text excels in the characterization of the place of study, physics teaching, ethnomathematics, ethnophysics and ethnographic method. According to the author, Ethnophysics allows scientific knowledge to be taught from real situations impregnated with intuitive knowledge. This methodology can make physics teaching more contextualized. Within this perspective, Anacleto (2007) points out that individuals who have ethnophysical knowledge in a given community cannot link this knowledge to physical science.

> In practice, they seem to use and know many principles used by physics, for the explanation of reality, but they are not aware of the scientific or academic jargon proper to this Science, sometimes because they have not had enough time of schooling, sometimes because they have not found necessary links so that, both physics and mathematics, could be revealed as an integral part of their experiences (ANACLETO, 2007, p. 80).

In this line of thought, we can understand Ethnophysics as a reference to traditional knowledge about physical knowledge (PRUDENTE, 2010; ALMEIDA, 2010), ontologically considering the way of sharing the natural phenomena of each community and by each individual belonging to a specific social group. As D'Ambrosio emphasizes:

> The focus of our study is man, as an integrated individual, immersed in a natural and social reality, which means in permanent interaction with the natural and sociocultural environment (D'AMBROSIO, 2015, p. 50).

In this perspective, Sousa (2013) assures that an ethnophysical look means to consider ontologically the way of seeing, interpreting, understanding, explaining, sharing, working, dealing, feeling physical phenomena. Thus, working with Ethnophysics requires the appropriation of the cultural memory of the subject researched, its codes and symbols. Souza & Silveira (2015) advocate that, for a research in Ethnophysics to obtain the expected results contemplated, it is necessary the help of:

> [...] a true master of craft, that is, [a professional who] has a lot of practice in his profession. This is because masters of craft have refined meanings over the years and, by hypothesis, such models tend to approach scientific models. This means that masons, carpenters, mechanics, fishermen, cooks, seamstresses, shoemakers, drivers, among others, are great candidates for a survey in Ethnophysics (SOUZA & SILVEIRA, 2015, p. 115).

In this same logic Rosario (2017) approaches that, through the conceptions of ethnophysics constructed in the search to reconnect the science of knowledge present in traditional communities, it is possible to:

> establish relationships and interconnections between physical phenomena and traditional knowledge-making present in the daily life of the community studied, because daily life is impregnated with its own ways of thinking, organizing and expressing knowledge of culture, which express physical ideas in its most varied forms, because it is noticeable that the daily life of traditional peoples is impregnated with their own ways of thinking, organizing and realizing

> existence, transforming nature and, consequently, manipulating physical phenomena in their most varied forms (ROSARIO, 2017, p. 1).

Thus, according to the theoretical approaches mentioned above, we conceive Ethnophysics as the science of skills and knowledge that sociocultural groups use to observe, experiment, understand, use and manipulate physical phenomena in their daily lives.

4 ETHNOPHYSICAL KNOWLEDGE PRESENT IN THE PROCESS OF CONSTRUCTION OF CAETEUARA CERAMICS

The production of pottery from the Vila Cuéra community is carried out by the Furtado family, [5]which uses various knowledge for the development of this officio. Some were passed down by family members, generation by generation, who developed this knowledge from their daily practices, others were constructed from the experiments of the ceramists themselves. The process of construction of a part usually has the following steps: clay collection, part modeling, drying and burning of the parts. Within each of these stages, there are substeps that are also very important for the production of caeteuara ceramics, but will not be treated in this part of the work. Now, we will focus specifically on the drying and burning steps of the piece. Each of these steps is performed in different environments and express ethnophysical knowledge at various times.

The ceramist Josias Furtado explained to us, during the interviews and the observations that[6], when learning this craft with his mother, Dona Maria, there were many losses during the drying and burning period and this came to be one of the motivations for the development of new ways to perform these steps, in order to develop the final product:

> We had difficulty in this burning, because we did not dominate the fire of the oven, burned the pots only at the campfire. Then I was able to adjust this burning time, this drying, which was our difficulty, so that's it, we managed to reach almost 100%. Because in the old place we lost in drying and burning and it was only injury (Interview, Jul. 2019).

Josias' explanation allows us to understand that the difficulties of finding the right drying and burning point already existed and, through experimentation, the ceramist developed new ways to perform drying and burning of his parts to obtain a better quality of the final product.

We emphasize that the drying process is one of the stages of great importance in the manufacture of the parts, because, after modeling, the part can stay one or more days outdoors, depending on its thickness (Image 1 and 2). Thus, part of the water contained in the clay is eliminated in the evaporation process and the most resistant part of the material goes to the oven, a knowledge developed by the experiments of the ceramist (Lévi-Strauss, 2008).

5 In this work, Dona Maria and Josias Furtado were consulted.
6 In qualitative research, among the most important research instruments or techniques that help to unravel phenomena and facts, the Observations and Interviews (Oliveira, 2016).

Image 1 and 2: Parts in drying process

Source: Samuel Rosário Collection, 2019.

For Baccelli (2010) drying:

> it is one of the most important phases of the whole process, along with burning, because it is drying that we will reach the final product, and the drying process is responsible for removing liquid through transport through pores and evaporation to the environment. The air of the environment, which is not saturated, tends to absorb the moisture of the parts until the balance occurs (Baccelli, 2010, p. 128).

Climatic conditions are relevant factors in this process, as the evaporation of the moisture of the material will occur. Depending on the air currents, there may be a good aid in evaporation and the guarantee of a correct homogeneity of the parts, because the liquid that disappears from the parts becomes water vapor . "Evaporation is a change from the liquid phase to the gas phase that occurs on the surface of the liquid" (Hewitt, 2011, p. 304).

After the drying period, the ceramist begins the stage of burning the caeteuaura ceramic. He proudly reports that after several tests, he was able to improve his production.

> In the old days, the piece was in the oven for a long time and we did not have much control of the burning time of the piece, so I thought and decided to leave heating the oven in the late afternoon, all night to burn the pieces the other day. Then yes it worked and today I earn a day or two less in the burning time and I can work with the right temperature just keeping the fire lit, then it is quickly that the pieces are at the same temperature, because the oven is already all hot (Interview, Jul. 2019).

In this daily experimentation, the ceramist always seeks to improve the practices of his craft. Even without many tools, he developed ways to use physical phenomena to his advantage. By using his knowledge and senses (Lévi-Strauss, 2008), as vision and touch, he manages to establish precious bases for his cultural practice. From this perspective, it is notorious that the concepts of temperature, heat and thermal balance are well established for the ceramist, who has developed ways to find the ideal temperature for burning his pieces even without the knowledge of academic physics.

The ceramist comments that he developed other ways to use natural phenomena to his advantage and explains how he improved his burning process:

> Generally, I burn three types of materials, with different thicknesses and burns. I've learned that the pieces that are below heat up first than the ones on top, so they stay at the fastest point. So I calculate more or less and such, (...) because the fire comes from below, so I put the thickest ones below and the thinner ones on top (Interview, Jul. 2019).

Josias explains that his oven was built based on what he designed in his mind. The oven is capable of providing heat transfer in various ways , besides allowing an equal burning: "I put all the pieces together, pot, vase, dish, canister, sculpture and everything else, but always in the same idea, thicker pieces underneath even the thinnest ones on top" (Field Diary, Jul. 2019) . As the oven is usually closed during burning, we will exemplify how would be the organization of these pieces according to the explanation given in the field by Josias.

The ceramist exemplified what would be the models of each piece according to his organization in the oven: "I consider thin pieces, the ones that burn faster, the ones that are on top in the oven, the dishes, for example" (Interview, Jul. 2019)

"Already the pieces that go in the middle, are pieces of the width of my finger and that has a bottom that is not very thick. Just by looking, I already know the ones that can be in the middle. In this part, I usually put the small pots, cliques and their lids" (Interview, Jul. 2019).

"And at the bottom are the pieces that take longer to burn, are those with the thick bottom. The cliques, ways to serve food, large pots and others there" (Interview, Jul. 2019).

In this context, it is evident that the ceramist has developed differentiated physical rationalities to use heat transfers in favor of his craft, because the organization system inside the oven helps heat transfer by conduction, convection and radiation. According to Josias:

> The time in the oven is according to the piece. I look at her thickness and I already have a idea of how long she's going to be there. Because the fire comes from the bottom up and then the fire begins to come into contact with the pieces, heating up the material that is closer to the fire. Then, then, the quentura goes to the other pieces that are on top, until the point that the pieces are at the same temperature (Field diary, Jul. 2019).

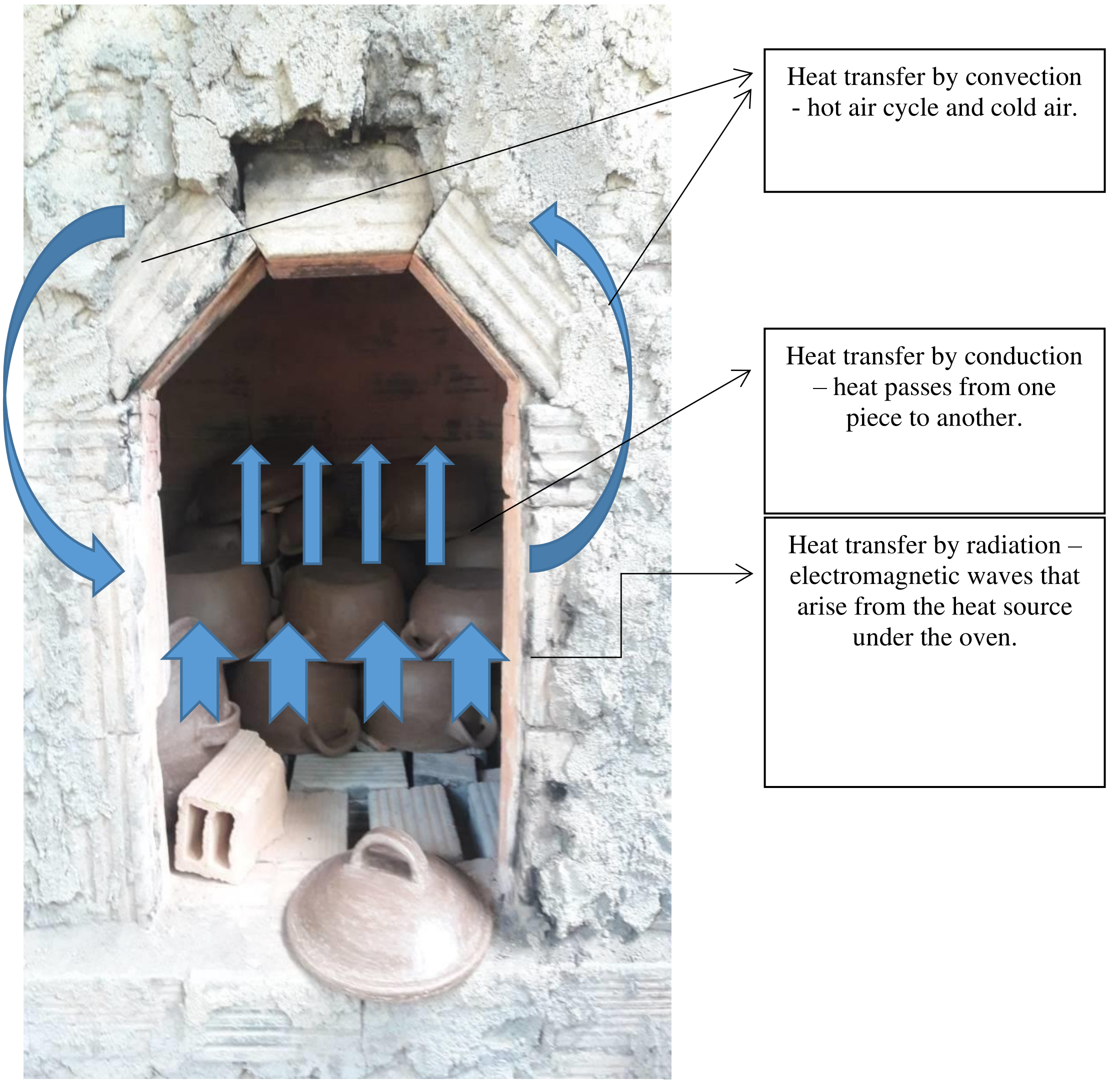
Thus, we realize that Josias exemplifies that the pieces that are closest to the fire (heat source) heat first, stirring their molecules and, later, pass the thermal energy to the other parts by heat transfer, by conduction.

About the organization of the pieces, Josias puts it: "I always try to leave a space between the pieces, I never fill the whole oven, you have to let the air run to carry the fire all over the oven" (Field Diary, Jul. 2019). Thus, we can relate the ethnophysical knowledge, expressed by it, with the convection currents that cause the hot air to change places with cold air in a repetitive movement, so that the system warms more and more.

The ceramist also comments that he puts the firewood in the oven constantly, so that the fire is always enough to burn all the pieces: "I just put enough, not much and not much, I already know head, I look and already know if you need more firewood [...], the important thing is that the fire does not go out before the pieces are all burned" (Field diary, Jul. 2019). In this context, we have a heat source that allows the burning of the pieces (in this case, the abrasive wood), right after the generation of this heat source. We can observe the light rays emanating from the flames all over the inside of the oven in the form of electromagnetic waves, transferred by radiation. We notice the importance of firewood and fire in Josias' speech.

We can then realize that, even without academic knowledge about physical phenomena, the ceramists were able to develop reasoning strategies to use the various forms of heat transfer in their favor, when making use of the senses, according to Lévi-Strauss (2008). In addition, they stipulate the limits of temperature, heat and thermal balance. In this follow-up, we outlined a scheme that exemplifies the heat transfers that occur in the oven, according to the explanations of the ceramist (Figure 3).

Figure 3: Front of the oven with organized parts



Source: Samuel Rosario Collection, 2019.

During our research, we observed that artisans have, yes, an abstract conception of heat transfer, which academic science calls conduction, convection or radiation. It is noteworthy that the lack of mastery of academic concepts on these topics did not prevent them from performing the efficient cooking of the pieces, since they use traditional knowledge, in an elaborate way, linked to natural phenomena. The rationalities related to the study of heat are expressed by them intuitively at the moment they build their pieces, because they use the various forms of heat transfer, as well as perceptions of temperature and thermal balance, to transform the raw clay into a well-prepared and resistant piece.

5 FINAL CONSIDERATIONS

The physical rationalities related to the study of heat are intuitively expressed at the moment when the ceramists produce their pieces. To transform the raw clay into an elaborate and resistant piece, they use the various forms of heat transfer, as well as the definitions of temperature and thermal balance. The ceramist uses only vision and touch, arising from his extensive experience, to determine the amount of energy source needed to keep his oven warm, the burning time of each piece and the best place for each one inside the oven, taking into account daily trials. This shows that their traditional knowledge, referred to here as ethnophysicists, goes beyond the knowledge about thermodynamics such as heat and temperature. Other concepts from physical science are also observed, such as work, strength and physical transformations of matter.

Thus, we infer that this research can guide new possibilities of approximations between the area of Physics and the practices performed in different sociocultural contexts, emphasizing the different physical rationalities explained in the daily life of the communities, extolling how much sociocultural richness exists outside the intellectual and academic perimeters.

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