10.46551/emd.v9n16a21 2526-6136

Decolonial ethnomathematics and the ethnographic education of Mathematics teachers

Abstract: The study is justified by offering guidelines that help teachers understand the cultural and social challenges and demands of students, integrating them into the teaching of Mathematics. To this end, a theoretical foundation was developed based on Ethnomathematics, teacher education, Decoloniality and decolonial Ethnomathematics, to develop concepts that lead to on-demand ethnography as a possibility of affective/methodological education of Mathematics teachers through decolonial Ethnomathematics. The study, of a theoretical nature, is configured as an essay. In the end, three aspects for the affective/methodological education of teachers were identified: *i*) allowing oneself to be affected through a sentipensante attitude; *ii*) knowing the environment inserted by the precepts of on-demand ethnography and liberating pedagogy; *iii*) decoding of signs based on emic ethnomodeling.

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Received • 31/10/2024
Accepted • 12/02/2025
Published • 23/05/2025

Dossier — Anthropology and Mathematical Education

Keywords: Ethnomathematics. Decoloniality. Teachers Education. Anthropology.

Etnomatemática decolonial y la formación etnográfica de profesores de Matemáticas

Resumen: El artículo tiene como propósito ofrecer directrices para que los profesores comprendan y afronten los desafíos culturales y sociales de los estudiantes, integrándolos en la enseñanza de las matemáticas. Basándonos en los fundamentos de las Etnomatemáticas, la Decolonialidad y la formación docente, proponemos la etnografía por demanda como una metodología para la formación afectiva y metodológica de profesores, a través de las Etnomatemáticas decoloniales. Este estudio teórico, elaborado como ensayo, identifica tres aspectos clave: *i*) adoptar una actitud sentipensante que permita ser afectado; *ii*) conocer el contexto mediante la etnografía por demanda y la pedagogía liberadora; *iii*) decodificar los signos culturales utilizando la etnomodelización émica.

Palabras clave: Etnomatemáticas. Decolonialidad. Formación de Profesores. Antropología.

Etnomatemática decolonial e a formação etnográfica de professores de Matemática

Resumo: O estudo se justifica por oferecer orientações que auxiliam os professores a compreender os desafios e demandas culturais e sociais dos estudantes, integrando-os ao ensino de Matemática. Para isso, desenvolveu-se uma fundamentação teórica baseada na Etnomatemática, formação de professores, Decolonialidade e Etnomatemática decolonial, para elaborar conceitos que conduzam à etnografia por demanda como possibilidade de formação afetiva/metodológica de professores de Matemática pela Etnomatemática decolonial. O estudo, de natureza teórica, configura-se como um ensaio. Ao final, foram identificados três aspectos para a formação afetiva/metodológica de professores: *i*) permitir-se ser afetado por meio de uma atitude sentipensante; *ii*) conhecer o ambiente inserido pelos preceitos da etnografia por demanda e da pedagogia libertadora; *iii*) decodificação dos signos com base na etnomodelagem êmica.

Palavras-chave: Etnomatemática. Decolonialidade. Formação de Professores. Antropologia.

Educação Matemática Debate
v. 9, n. 16, p. 1-18, may. 2025

1 Introduction

Ethnography can be understood in different ways: for some, it is a research method; for others, it goes beyond this notion (Peirano, 2014). This work proposes a new vision for Ethnography amidst its multiplicity: considering it as a tool for future Mathematics teachers to understand the cultural, social and gnosiological aspects of Basic Education students, incorporating them into Mathematics Education.

Thus, this article aims to shed light on possibilities for the field of Anthropology and Education, whose theoretical repertoires can contribute as theory and practice to the development of themes and teaching procedures based on knowledge revealed by students and observed, but often unnoticed, by teachers. Such possibilities are revealed to us by decolonial Ethnomathematics (Dias, 2024) — a new theory that articulates the episteme of the Ethnomathematics Program in light of the post-paradigm of *critical interculturality* —, which has recently emerged and points to the importance of the demand of the oppressed as a perspective for the construction of new knowledge.

These elements are the result of the author's doctoral research. This approach seeks to prevent research and practice from incurring in the hierarchization of knowledge or epistemic racism in relation to the prior knowledge of students from historically subalternized contexts (Dias, 2024). In this sense, guidance for an educational practice that does not hierarchize knowledge in Basic Education requires the training of professionals capable of articulating the mathematical knowledge that they must teach — even within an increasingly restrictive curriculum — with the knowledge brought by students from their family, social and cultural contexts.

It is important to note that the terms *context*, *culture* and *social* are used throughout this work. However, it is recognized that these terms have become more flexible with the advent of new digital technologies and social networks, since a student inserted in a certain context may share and operate under different demands than those of his/her fellow countrymen, given his/her presence in virtual environments.

Ethnomathematics contributes greatly to a Mathematics Education based on the characteristics and demands of the students who are the target audience of Basic Education, offering conceptual and modeling tools for adapting the content that must be taught. Relevant examples include the contributions of professors Daniel Clark Orey and Milton Rosa (2012), who stand out with Ethnomodeling. Ethnomathematics has always been concerned with the way mathematics is taught and with the role of the teacher in the educational process (D'Ambrosio, 1996), especially with regard to their training.

However, the decolonial movement provides special conditions and the necessary tact to work with the demands and cultural aspects of historically subalternized societies and cultures. Among these conditions, we highlight the following: *sentipensar* (Fals Borda, 2015) and Anthropology on demand (Segato, 2015), which, mediated by decolonial Ethnomathematics, can serve as valuable tools and attitudes to be explored in Mathematics teacher education courses. These approaches aim to enable future teachers to value knowledge from different contexts, incorporating it into the teaching of Mathematics, even in scenarios with limitations on action.

Therefore, this article is justified by its contribution to the field of Anthropology in Education, as already mentioned, as well as by the need to go beyond the development of content and methodologies for teaching Mathematics. There is also a need to develop tools and guidelines so that teachers can understand the challenges and cultural and social demands of their students, adapting them to a Mathematics teaching that goes beyond mere contextualization, becoming a builder of knowledge based on the reality of each student.

Educação Matemática Debate
v. 9, n. 16, p. 1-18, may. 2025

Therefore, it is also justified to look at the training of Mathematics teachers, whose intention should be focused on a Mathematics Education that also includes the cultural demands of students, beyond merely satisfying neoliberal interests.

We will develop the ideas presented here in a theoretical manner, which can be classified as a brief essay, since it combines objective and subjective analyses (Larrosa, 2003). Thus, this work adopts a language considered *impure* or *insubordinate* by academia, when juxtaposed with the purity of the dogmas of systematic philosophy and technical-scientific reason widely accepted by academic centers in the Global North (Larrosa, 2003). The objective of the study presented in this article is, therefore, *to develop concepts that lead to on-demand ethnography as a possibility for the affective/methodological training of Mathematics teachers, in order to qualify them for a Mathematics Education that values the cultural demands of their students*. The objective should be explored through the sections: Ethnomathematics and teacher training; Decoloniality and Mathematics Teaching; Decolonial ethnomathematics, feelingthinking and on-demand ethnography.

In the first section, we will understand how Ethnomathematics approaches the teaching of Mathematics in the context of teacher training in teacher education courses. It is at this point that we will shed light on the following questions: what tools should be provided to future teachers for the contextualization of ethnomathematics in Basic Education? How can we ensure that teachers will be able to learn, reflect on, and act with and based on the knowledge brought by their students? These questions are answered in the final stages of this essay.

2 Ethnomathematics and teacher education

Ethnomathematics is a growing field in Mathematics Education. Its perspectives reach researchers and influence the teaching of Mathematics in various locations. However, its emergence is older than one might think. Ethnomathematics emerges with the need for human beings, as a species, to survive and transcend the environment in which they live (D'Ambrosio, 2022).

Its academic and educational potential began to be explored in the 20th century, when authors from different areas of knowledge, such as Georges-Henri Luquet (Psychology), Otto Raum (Anthropology), Leslie White (Anthropology), Raymond Louis Wilder (educator and mathematician), among others (Gerdes, 1996), took the initial step by becoming concerned with the cultural implications of mathematics and its teaching.

Although research already points to mathematics linked to culture, Ethnomathematics has been consolidated as an area of study since its delimitation and composition by Ubiratan D'Ambrosio in the 1960s and 1970s of the last century (D'Ambrosio, 1995). Since then, the field has expanded considerably, giving rise to diverse perspectives and ramifications, among which its connection to teacher training stands out.

Ubiratan D'Ambrosio develops the Ethnomathematics Program, a research program that understands Mathematics as a body of knowledge beyond its academic aspect, including knowledge/practices of cultural groups that have historically had their knowledge denied and silenced (D'Ambrosio, 2022). In this sense, the very idea of school and academic mathematics is surpassed by Ethnomathematics. According to Ubiratan D'Ambrosio (2022), Ethnomathematics, in the view of the Ethnomathematics Program, is constituted as techniques, arts, sciences, behaviors and knowledge shared and compartmentalized by a specific social and cultural group.

In Mathematics undergraduate courses, from the perspective of Ethnomathematics, the central point should be the development of problematization as a means of overcoming the adversities faced by students at different levels and teaching contexts (Costa, 2019). In this

sense, “to contemplate the ideas of the ethnomathematics program, methodologically the teacher needs to assume the position of an ethnomathematical educator” (Costa, 2019, p. 145).

For Mathematics teaching to be consolidated from this perspective, it is essential that teacher training includes, in addition to specific and pedagogical knowledge, the development of sociocultural knowledge. The importance of articulating this knowledge during initial training comes from the difficulties that many teachers face when working based on the context of their students. These challenges will be attributed to the way in which future professionals learn mathematics during their initial training (Lenzi, 2019).

To reflect on the connection between traditional initial training and cultural knowledge, it is necessary to consider the structure of undergraduate courses in Mathematics from the perspective of Ethnomathematics. This connection should be designed with the aim of offering Mathematics teachers skills that enable them to deal with the cultural diversity they will encounter in their teaching. It is understood that undergraduate courses in Mathematics are structured in three distinct ways, as described below.

a) *Strong* mathematical training: some courses have very little or no presence of didactic-pedagogical subjects, emphasizing mainly the mathematical training of the teacher (Fiorentini and Oliveira, 2013).

b) Focus on specific knowledge: this is one in which there are subjects within the scope of Mathematics Education, but the main focus is still on specific knowledge of mathematics (Soares and Fantinato, 2021).

c) Training with an emphasis on Education: involves courses that offer classical training in Mathematics, but with a significant presence of subjects related to Education and Mathematics Education (Gatti and Nunes, 2009).

The third perspective is similar to the vision defended by Ethnomathematics regarding initial teacher training courses, approaching the ideal by developing and reflecting on issues of education, curriculum, and teaching and learning methodologies. However, the Ethnomathematics Program presents its own vision of Mathematics teacher education courses. According to this perspective, there are three fundamental traits to be explored in the Mathematics Degree: emotional and affective knowledge, political knowledge, and specific knowledge (D’Ambrosio, 1996).

Emotional/affective training is based on the idea that a good teacher not only understands the reality of students, but also incorporates aspects of their own experience into the Mathematics they teach. Emotional and affective training plays a crucial role in this process. The act of educating is, in essence, an act of love (D’Ambrosio, 1996), despite the tensions inherent in the educational environment. From the perspective of the Ethnomathematics Program, the sensitive teacher listens to students and creates a space in which different types of knowledge intertwine, generating something new in the teaching and learning process.

The teacher, aware of these issues in his/her initial training, has the opportunity to understand the obstacles of the physical, emotional, mental and sociocultural environment of the students, transforming them into tools for teaching mathematics that has the characteristics of these individuals, thus becoming truly their own. Affective training must return again when discussing teacher training from the perspective of decolonial Ethnomathematics.

The second aspect, of a political nature, is based on the principle that “educating is a political act” (D’Ambrosio, 1996, p. 85). When a teacher remains politically neutral, he or she finds no incentives or reasons to constantly reconcile the student’s Ethnomathematics with that present in his or her daily practice at school. A mathematics teacher, when adopting the perspective of Ethnomathematics, must have a political stance and be aware of promoting

Educação Matemática Debate
v. 9, n. 16, p. 1-18, may. 2025

citizenship. Understanding the sociocultural aspects of students' reality requires this political notion. A "'aware' educator needs to be trained in 'another way'; we believe that Ethnomathematics, due to its liberating nature, can bring countless contributions to future Mathematics teachers" (Soares and Fantinato, 2021, p. 6).

As for the teacher's training in Mathematics, it is unanimous among Ethnomathematics researchers that cultural knowledge must also be present in their specific training. This occurs because the everyday knowledge that students bring with them, both during Basic Education and in mathematics teacher training courses, is often not valued. This is an aspect that concerns researchers in the field of Ethnomathematics. According to Fiorentini (2004), teachers who train future teachers who will teach Mathematics do not

> aware that they participate in this dual — and I would say multiple — training of the future teacher. This fact leads us to defend that this dual/multiple function of the trainer be recognized by everyone and assumed as a fundamental function in the training of the future teacher. This, in a certain way, obliges us, as Mathematics teacher trainers — mathematicians or mathematics educators — to develop studies, both in relation to the didactic-pedagogical processes of teaching and learning Mathematics, and in relation to the expansion of their mathematical culture from a comprehensive perspective, involving historical and epistemological aspects of this field of knowledge (p. 113-114).

Ethnomathematics in teacher training is therefore not limited to the inclusion of a subject with the name of the field in the curriculum. It is a new perspective on those that would deal exclusively with academic Mathematics, offering them a cultural perspective.

The values to be used in the specific training of future Mathematics teachers are directly aligned with the assumptions highlighted by Ubiratan D'Ambrosio (2022) in the *educational dimension* of Ethnomathematics. These assumptions seek to answer the fundamental question: how to educate mathematically to promote peace? (D'Ambrosio, 2022).

Educating mathematically to promote peace begins with individual peace, of the person with themselves. The student who belongs to a specific social stratum who goes to school constantly sees his or her knowledge being stripped of its validity. This knowledge, rooted in their reality outside of school, because it is not considered in the teaching process, causes a rupture and an internal contradiction, leading the individual to face an identity conflict (D'Ambrosio, 1996) because he or she sees himself or herself in a process that often understands his or her knowledge as invalid or mythical.

Children learn a lot from their guardians, who teach them their first lessons. The daily coexistence between them, their family, friends and neighbors is a space for sharing knowledge. However, when they arrive at school, the knowledge they bring with them, including mathematical knowledge, is erased and replaced by knowledge more aligned with Western and modern culture. Furthermore, teachers need to be trained to understand young people's culture, their language and fluidity (D'Ambrosio, 2022), modifying and rethinking their educational process.

The answer to the question: How can we educate mathematically with the aim of promoting peace? lies in understanding and overcoming the social and cultural inequalities present in the school curriculum. This implies training teachers who are capable of understanding the desires of young people and teaching in a contextualized manner, respecting all views and mediating the cultures present in the classroom. This is why thinking about peace must be the root of educational concerns in the 21st century, where what we see is the takeover

Educação Matemática Debate
v. 9, n. 16, p. 1-18, may. 2025

of the entire educational process by neoliberal and non-collective demands.

In this scenario, Ethnomathematics resembles intercultural pedagogy. By integrating this perspective with Lenzi's (2019) vision, it is concluded that the aspirations of an Education that prioritizes cultural knowledge in the mathematical education of students are directly linked to the way in which this knowledge is connected to the specific knowledge of Mathematics teachers from their initial training.

A question arises based on the perspectives of Ethnomathematics, which we intend to shed light on: what tools should be provided to future teachers so that they can appropriate ethnomathematics in Basic Education? Familiarity with culturally contextualized mathematics in initial training is undoubtedly an essential step. However, how can we ensure that teachers will be able to learn, reflect on, and act with and based on the knowledge brought by their students?

Before moving forward, it is important to highlight ethnomodeling as a valuable tool for Mathematics Education based on Ethnomathematics. Ethnomodeling reflects the knowledge/practices of different social groups, sometimes forming a bridge with Western mathematics, in which signs and meanings are united to construct new knowledge.

> [...] ethnomodeling can be considered as the study of mathematical practices developed by members of distinct cultural groups through modeling. Therefore, ethnomodeling procedures involve mathematical practices developed and used in various problem situations faced in the daily lives of members of these groups (Rosa and Orey, 2012, p. 868).

Further highlighted by the authors:

> [...] the Ethnomathematics Program promotes the strengthening of the cultural roots present in these groups, while mathematical modeling techniques provide the contextualization of academic Mathematics, providing equal conditions so that individuals can act in the globalized world (Rosa and Orey, 2003, p. 2).

From this perspective, Ethnomodeling, by using mathematical modeling techniques in an emic sense, offers itself as a tool for teachers to highlight and value the cultural reality and demands of students, since they provide "descriptions and analyses expressed in terms of conceptual schemes that are meaningful and that have been appropriated by the members of the cultural group under study" (Rosa and Orey, 2012, p. 870).

We can conclude that Ethnomathematics, in its view of the initial training of Mathematics teachers, emerges as one of the perspectives with the potential to address these issues and direct Mathematics Education towards peace in the future, starting with individual, social and cultural peace — especially that which offers support for thinking about Mathematics Education from the perspective of *decolonial pedagogy*, decolonial Ethnomathematics. This view differs from the perspective of teacher training indicated by the Ethnomathematics Program in some aspects, which will be explored later in this text, but it can be incorporated into ethnomodeling as a possibility of understanding, describing and analyzing the conceptual schemes, symbols and signs that arise from the demands of other cultures for teaching Mathematics.

Before addressing decolonial Ethnomathematics and its perspective on teacher education, it is necessary to understand the main decolonial aspects that permeate this

Educação Matemática Debate
v. 9, n. 16, p. 1-18, may. 2025

discussion. The following section will address these aspects, reflecting on the decolonial movement, the colonialities of power, being and knowledge, the relationships that influence the homogenization of Mathematics teaching and how decoloniality can help to think, together with Ethnomathematics, about teacher training that breaks with the asymmetrical relationships that guide Mathematics teaching today.

3 Decoloniality and the teaching of Mathematics

Another fundamental field for the idea of decolonial Ethnomathematics is Decoloniality. To understand this concept, it is necessary, at least superficially, to reflect on its relationship with Ethnomathematics and, finally, on the new reflections of an emerging field in the education of mathematics teachers.

Decoloniality is a movement that emerged as a counterpoint to the relations established by modernity/coloniality. It is a natural response to the conditions imposed by a culture that acts imperatively on another (Mignolo, 2007).

The decolonial movement can present itself in different ways, such as documents, treaties, letters, songs, manifestos, images, films, videos, attitudes, social demonstrations, social groups and activism. In short, they are initiatives and demonstrations that oppose the colonial logic, which has historically erased memories, perpetuated domination, exploited, promoted violence, racism and even genocide against marginalized populations. These actions emerge mainly from voices that emerge from subjugated places of speech.

Therefore, the emergence of academic movements that position themselves as opposition to colonial relations would also be inevitable. The best known and most widely disseminated in Brazilian academic centers is the *Modernity/Coloniality Group*, which will provide tools for the dialogue between decolonial Ethnomathematics and the training of Mathematics teachers carried out in this article.

The Modernity/Coloniality Group differs from other academic movements that oppose Eurocentrism and colonial relations because of its disconnection from the European knowledge matrix. Its members also claim that the colonization of the Americas contributed to the development of the world power matrix, consolidating global capitalism and what is called modernity (Quintero, Figueira and Eliazade, 2019). In this way, the Modernity/Coloniality Group seeks to develop knowledge based on the Latin American reality, presenting a critique of the neoliberal capitalist model, which was established through domination, expropriation and violence established by Europe during and after colonization.

> The modern world-system was born in the long sixteenth century. The Americas as a geosocial entity of European construction were born in the long sixteenth century. The creation of this geosocial entity, the Americas, was the constitutive act of the modern world-system. The Americas were not incorporated into an already existing capitalist world economy. There could not have been a capitalist world economy without the Americas (Quijano and Wallerstein, 1992, p. 1).

Although the Modernity/Coloniality Group is not unanimously accepted among scholars from the Global South when it comes to decoloniality — because most of its authors work in the United States and are not involved in social movements — its references are considered indispensable for understanding the current situation of coloniality and its effects on politics, economy, culture, education, and people's lives.

Coloniality differs from the concepts of colonization and colonialism. Colonialism is

the historical process of establishment and control of colonies by European and Western powers, involving territorial expansion, economic exploitation, and cultural assimilation of distant territories. Modern colonialism, on the other hand, refers to the specific strategies with which these powers dominated vast parts of the world, often through the exploitation of natural resources and the imposition of their culture on local populations.

In the case of the Americas, colonization occurred when Europeans arrived in these lands to populate and exploit them. This process involved the assimilation of territories by foreign cultures, resulting in profound social, economic and cultural changes. Coloniality, in turn, is a global logic of dehumanization that persists even after the end of official colonies. It manifests itself in power structures, inequalities and prejudices that continue to influence relations between countries and social groups, even without the physical presence of colonies. It is an essential element in the maintenance of the global neoliberal logic, being the hidden face of modernity (Maldonado-Torres, 2018).

According to the group, Modernity/Coloniality is sustained by three main relations of coloniality: coloniality of power, coloniality of knowledge and coloniality of being (Ballestrin, 2013).

a) *Coloniality of power:* refers to the observation that colonial relations in the economic and political spheres did not end with the destruction of colonialism. Ballestrin (2013) argues that these relations persist, even after the formal end of colonial empires.

b) *Coloniality of being:* explores the effects of coloniality on people's lived experience. Maldonado-Torres (2007) highlights that it is not only about the structures of power and capital, but also about subjective and intersubjective relations.

c) *Coloniality of knowledge:* discusses how modern knowledge, especially in the social sciences, is intertwined with the colonial and imperial relations of power that characterize the contemporary world. Lander (2005) addresses this intersection between knowledge and coloniality. Lander (2005) explores this intersection between knowledge and coloniality, highlighting the implications of these dynamics in the production and reproduction of knowledge.

The tentacles of coloniality penetrate deeply into society, both regionally and globally. The *coloniality of power* acts on labor relations and authority, suppressing the peripheries (Quijano, 2005) through political and military influences. Capital in the Global North is isolated by conglomerates and international organizations, known in Brazil as the club of the rich. These organizations include the International Monetary Fund (IMF) and the World Bank (WB), as well as military institutions such as NATO, intelligence agencies, and the Pentagon — all of which emerged after World War II. This set of institutions sustains and promotes a new world-system characterized by the intersection of European, North American, capitalist, patriarchal, modern, and colonial elements (Grosfoguel, 2009).

In Dias (2020), we discussed how these same multilateral organizations, mainly the OECD, control education in the global periphery with external assessments and guidelines developed by and from Western countries. These assessments and guidelines cause the curriculum, teacher action, and school to act in a homogenizing manner, including in the teaching of Mathematics. These aspects characterize the influences of the coloniality of power in Education.

The coloniality of power was established mainly based on the idea of race at the beginning of colonization. The notion of race was fundamental to the definition of labor relations (slavery, servitude) and the accumulation of capital through natural resources extracted from the colonies, consolidating Europe as the center of global capitalism (Quijano,

Educação Matemática Debate
v. 9, n. 16, p. 1-18, may. 2025

2005). These aspects not only influenced, but also shaped relations with and between colonized peoples. All practices, knowledge, and cultures that diverged from the European model were subjected to a process of replacement by the beliefs and attitudes of the metropolis. This historical and political movement of erasing and replacing traditional knowledge with modern knowledge constitutes *epistemicide* (Gonçalves and Mucheroni, 2021).

Epistemicide is an ethnocentric practice that maintains the colonialities of power, being and knowledge through acculturation, initially supported by the idea of race and later maintained by coloniality, through the influence of international organizations in Basic and Higher Education.

The school plays a crucial role in the process of replacing the knowledge present in the conscious and subconscious of students with standardized knowledge, in a quest to achieve the goals established by international organizations, evidenced in the coloniality of power. In this sense, it is of mutual interest to Ethnomathematics and the decolonial movement to discuss practices that seek to break with colonialities and epistemicide in Brazilian schools, including in Mathematics Education.

Therefore, a collaboration between Ethnomathematics and decoloniality can contribute to a Mathematics Education that breaks with the multilateral relations that generate and maintain cultural homogenization through the teaching of Mathematics. In the movement to think about practices that do not evoke epistemicide, it is important to reflect on the hierarchy of knowledge and the role of Mathematics in this context. Hierarchy occurs when one knowledge overrides another, making it practically impossible to validate peoples who have been historically subalternized by the process of colonization and coloniality. This phenomenon occurs in the face of a knowledge that, due to hegemonic culture, overrides the others (Costa, 2020). This entire logic is also intrinsic to the coloniality of knowledge.

School and academic mathematics is permeated by hegemonic historical narratives that also constitute its practice. A common point among these narratives is the idea that true Mathematics would have emerged in Ancient Greece, while all the knowledge produced by other civilizations until then would be devoid of some aspect, which would distance it from the so-called real mathematics (Roque, 2012). This discourse, in addition to being unfair to the production of various peoples, especially Africans, constitutes a Mathematics that does not allow the approximation of knowledge from other knowledge matrices, considering that mathematical knowledge is only valid if it obeys a series of rules pre-established by a group of people linked to the hegemonic matrix.

This context, evidently, discourages the development of new discoveries by Mathematics itself and by academia, in addition to strengthening the narrative that knowledge from other cultures is just superstitions and legends. This type of discourse perpetuates asymmetrical relations between these cultures and the hegemonic culture.

The hegemonic narratives of academic Mathematics reproduce the logic of the coloniality of knowledge and being, perpetuating themselves both in mathematical productions and in its teaching, especially through teacher training. This occurs mainly in courses composed of disciplines that do not contemplate cultural aspects related to Education, as evidenced in the previous stage, in which teacher training and Ethnomathematics were discussed. This phenomenon becomes evident due to the fact pointed out by Lenzi (2008): the teacher reproduces the hegemonic narratives of Mathematics in his teaching because that was how he himself learned.

In short, decoloniality allows us to reflect on the antagonistic and asymmetrical relationships established by the producers of colonialities, which influence the teaching of Mathematics through homogenizing practices, including in teacher training. These practices

contribute to the maintenance and strengthening of cultural asymmetries and, as previously discussed, to the identity conflict of students in the public school system. In this context, one can idealize a decolonial Ethnomathematics that offers support for teaching Mathematics aimed at breaking these relationships, with a special focus on teacher training.

The next section explores the concept of decolonial Ethnomathematics and how it can contribute to teacher training, through ethnographic approaches in Mathematics undergraduate courses.

4 Decolonial ethnomathematics, sentipensar and ethnography on demand

Thinking about teacher training through the perspectives of Ethnomathematics and Decoloniality can lead to interesting and useful reflections on practices for teaching Mathematics, enabling future teachers to adopt the cultural perspective of students. In this way, acculturation and epistemic homogenization of the target audience of public education are avoided.

To this end, it is necessary to raise brief considerations regarding the relationship between Ethnomathematics and Decoloniality, and then delve into a specific perspective that casts a new light on teacher training, revealing ethnography as a possibility of acting and understanding the realities of the target audience of education. In order to think about a practice that evokes and values the cultural aspects of the most diverse contexts, it becomes essential to understand the contributions of the relationship between Ethnomathematics and Decoloniality to intercultural praxis in teaching Mathematics.

There is a movement of convergence between ethnomathematical and decolonial references, and this approach has strengthened intercultural dialogue in Mathematics. Tamayo and Mendes (2021) attribute to Ethnomathematics a character of *decolonial option*, since it allows breaking with the narrative of universality hegemonically attributed to academic mathematics. Monteiro and Mendes (2015) highlight Ethnomathematics as a counter-conduct movement to academic mathematics, enabling a break with the Eurocentric tradition in the production and teaching of mathematics. Cruz and Barbosa (2021) believe in Ethnomathematics as an alternative to breaking with and subverting authoritarianism and European epistemic hegemony.

There are several dialogues that contribute to the articulation between both fields. A new possibility in this sense is raised by Dias (2024), who justifies the birth of a new perspective, called decolonial Ethnomathematics. It makes sense to address it, since there are points at which the practices and visions between Ethnomathematics and Decoloniality may diverge, making it difficult, on some occasions, to articulate between references.

> The points of convergence, despite being present in each branch of Ethnomathematics, are not intrinsic to their research practice. From a branch of Ethnomathematics, a researcher can — even with the intention of adopting a decolonial stance — dignify the knowledge of a subalternized culture or hierarchize it in relation to Western Mathematics (Dias, 2024, p. 152).

Because it does not present a perspective that directly points to and guides an Ethnomathematical practice that does not hierarchize knowledge, Ethnomathematics, according to this view, cannot be considered intrinsically decolonial. Thus, it cannot be treated as a decolonial option in a natural way. In the context of teaching Mathematics, its application by teachers could

> end up hierarchizing knowledge, promoting an abstract universalism, (in)voluntarily committing *epistemic racism*, collaborating in maintaining the *status quo* of modern/colonial neoliberalism in schools and only satisfying academic demands. This is due to a gap in research that articulates ethnomathematical and decolonial references: the lack of orientation towards an ethnomathematical practice/research focused on the decolonial movement. (Dias, 2024, p. 152)

It should be noted that, at no time, should these aspects be changed in ethnomathematical practice solely due to the perspective of the decolonial movement. In fact, these are elements that hinder dialogue between fields and that promote the emergence of a new perspective, capable of improving this articulation without hierarchizing knowledge in the teaching of Mathematics. In the sense addressed in this article, this new vision should reflect on teacher training that favors intercultural dialogue in the teaching of Mathematics.

Regarding training in Mathematics undergraduate courses, Dias (2024) highlighted that, for Mathematics in schools to stimulate new knowledge and promote mutual respect between teachers and students, it is essential that the teacher prioritizes student learning through a decolonial ethnomathematics approach. In this sense, the initial training of Mathematics teachers, from this perspective, could be rethought on three fronts: *mathematical knowledge, critical knowledge*, and *affective/methodological knowledge*.

Mathematical knowledge would be transformed into teachers' *ethnomathematical knowledge*, directing specific training towards critical intercultural dialogue in different contexts. The teacher's *critical knowledge*, although already present in Mathematics Education disciplines, as pointed out at the beginning of this text. From the decolonial Ethnomathematics perspective, the teacher's critical training would encompass legislative, pedagogical and educational disciplines and knowledge, articulated with an intercultural critique that promotes equity between different cultures and social justice.

5 Affective/methodological knowledge of the Mathematics teacher

The latest proposal for teacher training through decolonial Ethnomathematics reveals the need to consider, in an affective, comprehensive and reflective manner, the reality of students, in order to then assimilate their context into the teaching of Mathematics. In this sense, decolonial Ethnomathematics calls for teacher training that provides epistemological, methodological and emotional tools, enabling them to have the ability and motivation to recognize and implement relevant aspects of the student's context in the educational process.

An epistemo-methodological and emotional training would include the understanding of the challenges and factors that permeate the most diverse contexts in which schools are inserted. Starting with the emotional dimension. D'Ambrosio (1996) states that

> no one can be a good teacher without dedication, concern for others, without love in a broad sense [...], the teacher is not the sun that illuminates everything. About many things, he knows much less than the students. It is necessary to make room for the students' knowledge to manifest itself. Hence the great importance of knowing the student, requiring the teacher to have the characteristics of a researcher. Of course, all of this has to do with the mental and emotional behavior of the teacher. Educating is an act of love (p. 84-85).

Considering affectivity and its importance in the teaching process, decoloniality, especially decolonial ethnomathematics, can offer interesting insights. The concept of

sentipensar can be adopted as an approach for the teacher-researcher, involving emotions and the heart in their daily practice.

Proposed by Fals Borda (2015), *sentipensar* is conceived as a research attitude, supporting the idea that researchers must be willing to completely deconstruct their knowledge systems in order to reconstruct them collectively. In this view, it is necessary to distance oneself from the assumptions of colonial/modern science in order to effectively generate knowledge from a decolonial alternative. One can then consider a reinterpretation of Fals Borda's (2015) proposal for the *sentipensar* training of Mathematics teachers.

Fals introduces the concept of being a sentipensante as part of his proposal. A sentipensante teacher must unite reason and emotion, unlike the aseptic rationalist view of knowledge production and reproduction through traditional means. It is a complete union of subject-object, far from the Cartesian separation, as a methodological epistemic disobedience. Or, according to the author, "an emerging paradigm for us would produce an articulation of science with consciousness and of the heart in rhythm with reason" (Fals Borda, 2015, p. 336).

Thus, a new path in the training of Mathematics teachers is pointed out, offering possibilities for a practice that unites the reason for knowledge, the central focus of the teaching and learning process, with the direct influence of the social, political, emotional and psychological nuances of each student and context. These elements can often only be understood through the emotional affects of the teacher himself.

In this sense, ethnography also gains relevance for the affective/methodological training of Mathematics teachers from the perspective of decolonial Ethnomathematics. According to the survey conducted by Dias (2024), ethnography is one of the research methods with the greatest impact in the field of Ethnomathematics. This relevance occurs because the field studies cultural aspects of different social groups, mainly linked to Ethnomathematics, in addition to being a tool for the study, understanding and application of pedagogical proposals based on Ethnomathematics, in schools with regular contexts or in subordinate cultures.

Due to its potential to develop educational praxis through a sentipensante process, Ethnography becomes an essential tool, method and field for teachers, particularly Mathematics teachers. Thus, affective/methodological training presents itself as an important path for the development of strategies through the correct tools, offered by ethnography, for teachers to get to know their students and think about teaching that takes into account the cultural and social aspects of their target audience. It is worth noting that, as discussed in Dias (2024), an ethnography based on Ethnomathematics could, even unintentionally, culminate in practices that hierarchize knowledge, due to a lack of guidance for critical intercultural action. Decolonial Ethnomathematics, pointed out in this work, highlights the proposal of Ethnography on demand as a possibility for the affective/methodological and intercultural education of the Mathematics teacher.

An example that can guide this training is presented in the research by Silva (2022), who developed an ethnography combined with an action research to describe and analyze the training processes of Mathematics teachers from two quilombola schools in Mato Grosso, Brazil. The study, based on the assumptions of Ethnomathematics and Decoloniality, investigated the impacts of this training on their pedagogical practices. The author spoke with the teachers to better understand their trajectories and conceptions, which revealed some of their demands. Then, she carried out readings, a type of training, in Ethnomathematics. Later, she encouraged the teachers — some of whom did not belong to quilombola communities — to learn about the cultural aspects of the context in which they worked, conducting research with an ethnographic approach within these quilombos. Based on this knowledge, the teachers should develop and implement teaching proposals compatible with the needs of the local

context. After implementing the teaching proposals, the teachers emphasized their intention to continue working with Ethnomathematics in this way. Silva's (2022) research, even unintentionally, reveals an ethnographic and ethnomathematical training approach for Mathematics teachers, based on local demands.

In this sense, taking ownership of students' demands can contribute to the development of a truly intercultural ethnomathematical practice, especially if it is considered from the initial training of future Mathematics teachers. In order for teachers to understand and act based on students' knowledge and their context in a *sentipensante*, one possibility is *Ethnography on demand*, a concept that we propose in Dias (2024) as a reinterpretation of Rita Segato's (2015) Anthropology on Demand. This approach, although practiced by academics, strives to listen to and meet the needs of those who have traditionally been the objects of Anthropology study.

In this context, undergraduate courses in Mathematics could consider Ethnography on Demand as part of teacher training, aiming to develop the ability to *feel(and)think* about teaching Mathematics under the demands and in the reality of students in public schools, using ethnographic tools. One should consider contextualizing the content based on practices or themes of the hegemonic culture, teaching procedures and the construction of notions based on the student's context, breaking with the view that their knowledge is not valid and undoing the internal conflict of the individual, who is confronted with the knowledge of the colonizing society (D'Ambrosio, 2005).

Some directions for Ethnography on demand for the affective/methodological training of Mathematics teachers could include:

a) guidance to allow yourself *to be affected* — allowing yourself to be affected, in an ethnographic practice, consists of getting rid of all your irreproachable certainties, even if scientific, and seeing your knowledge project unravel before your eyes, “because if the knowledge project is omnipresent, nothing happens” (Favret-Saada, 1990, p. 7-8). In other words, you continue to replicate the same vision regarding students and the content covered in Mathematics classes, without developing new knowledge from your *locus of enunciation*;

b) definition of learning objectives a posteriori, that is, after the initial contact between the teacher and the students and between the students and the teacher, in which the teacher, who arrives in his new environment, gets to know the culture in which the school is inserted and the main aspects regarding its students. The definition of learning objectives should occur based on the demands of subalternized social groups, discovered through tools of ethnography on demand and through a senti-thinking (Fals Borda, 2015) and affective (Favret-Saada, 1990) attitude. Something similar to what Paulo Freire (2021) suggests when, in his *Pedagogy of the Oppressed*, he denotes some phases of the elaboration of the generating themes and the programmatic content for teaching in oppressed contexts — first, one must focus on the dialogicity of the process, inviting and encouraging students to debate; then, “A series of information about life in the area, necessary for its understanding [...] always authentically, never forcibly, as sympathetic observers. For this very reason with understanding attitudes towards what they observe” (Freire, 2021, p. 144). Going further and saying that:

> The only dimension that researchers are supposed to have, in this framework in which they move, which is expected to be common to the men whose theme they seek to investigate, is that of the critical perception of their reality, which implies a correct method of approaching the concrete in order to reveal it. And this is not imposed (Freire, 2021, p. 144).

The author unintentionally (or not) and invariably affirms the need to employ ethnographic methods for teachers in their pedagogy, presenting a step-by-step guide to developing teaching proposals based on oppressed cultures, with prior understanding of the context being necessary for their development;

c) after understanding and reflecting on the context and demands of students, teachers must learn to transform this into information that can be used as a pedagogical proposal for teaching Mathematics, making it possible to use epistemological tools from the Ethnomathematics Program, as indicated by decolonial Ethnomathematics (Dias, 2024). Teaching content and procedures, based on dialogue, can be reinterpreted and rethought during the teaching and learning process, through the decoding of signs presented in the student's reality. A possible analytical tool for this task can be offered by Ethnomodeling, which, from the emic perspective, uses the idea of global and local to decode mathematical concepts, processes, and practices developed in diverse mathematical knowledge systems (Rosa, 2020). However, care must be taken when using ethnomodeling to purely translate concepts from the Ethnomathematics of a subalternized people into a Western language (Rosa, 2020), incurring, even unintentionally, in the hierarchization of traditional knowledge before academic knowledge.

In short, decolonial ethnomathematics reveals the possibility of using ethnography on demand in the affective/methodological training of future Mathematics teachers, aiming at teaching guided by critical interculturality, in which the knowledge and culture of students are not only used, but are the center of the educational process. To this end, the teacher, the focus of this training, must listen to the demands of students and the local community, allowing themselves to be affected by contextual nuances. After this, they must know and understand the reality of the student, so that they can then formulate class themes and teaching procedures based on ethnomathematics, decolonial ethnomathematics, liberating pedagogy and ethnomodeling.

In this scenario, considering the objectives of this work, for decolonial ethnomathematics, Anthropology, especially ethnography on demand, becomes not only important for scientific research, but also for teacher training. After all, these future teachers will need to work in a diversity of contexts throughout their trajectory in teaching Mathematics.

6 Final considerations

This article presents one of the results of the author's doctoral research, but is based on the purpose of contributing to the field of Anthropology in Education. It thus seeks to approach the ethnography of teaching practice, articulating itself with the diary of the Mathematics teacher through affective/methodological training in Mathematics undergraduate courses.

In addition, its justification arises from the need for analytical and theoretical tools that guide the Mathematics teacher to work based on the knowledge of their students and their demands for the construction of ethno(mathematical) knowledge. In this context, ethnography on demand presents itself as a promising option. Thus, the objective of this work was to develop concepts that lead to ethnography on demand as a possibility of affective/methodological training of Mathematics teachers mediated by decolonial Ethnomathematics. Objectives that were worked on in the sections: *Ethnomathematics and teacher education; Decoloniality and the teaching of Mathematics; Decolonial ethnomathematics, sentipensar and ethnography on demand.*

In the first section, it was seen that the Mathematics undergraduate courses are divided into three categories, according to the vision of the Ethnomathematics Program: from those that

least appropriate disciplines of Mathematics Education and Education to those that most incorporate this knowledge into pedagogical or educational training. Following this line, the Ethnomathematics Program's vision of teacher training emphasizes the importance of three fundamental knowledges: emotional and affective knowledge, political knowledge and specific knowledge (D'Ambrosio, 1996). This perspective differs, in one aspect, from the decolonial Ethnomathematics vision for teacher education, which, in turn, incorporates the affective/methodological training of Mathematics teachers.

The affective/methodological training of Mathematics teachers is organized into three initial aspects: highlighting the importance of an affective and *sentipensante* attitude at the beginning of their teaching practice; promote the recognition of cultural aspects through ethnographic tools, especially those offered by on-demand ethnography and liberating pedagogy (Freire, 2021); and guide the use of Ethnomodeling as a tool for interpreting and decoding concepts and practices (Rosa, 2020), aiming at teaching Mathematics based on the cultural and social demands of students.

In this sense, decolonial Ethnomathematics offers possible answers to the questions raised in the first stage of this work: what tools should be provided to future teachers for the contextualization of Ethnomathematics in Basic Education? How can we ensure that teachers will be able to learn, reflect on, and act with and based on the knowledge brought by their students? These answers are based on the precepts mentioned above for teacher training that allow for the real production of knowledge based on the student's reality.

An education that prioritizes and builds knowledge based on the student's reality contributes to breaking the logic of cultural homogenization, reinforced by the paradigm of functional interculturality and maintained by the colonialities of power, being, and knowledge. Valuing the knowledge brought by students, equating it with Western knowledge, and developing and validating new knowledge based on it (Costa, 2020) are fundamental aspects for the post-paradigmatic construction of critical interculturality.

These aspects contribute to thinking of decolonial Ethnomathematics as a true option to break with colonialities and the hierarchy of knowledge in education from the initial training of teachers. However, in addition to teacher training, this new field looks at the reality and demands of teachers, based on their increasingly precarious living and working conditions. A decolonial ethnomathematical education can only occur through these professionals who, once precarious, see as impractical not only the principles of Ethnomathematics, but also research in Education as a whole. Their demands are relevant and should be the focus of research in the field of Mathematics Education. Thus, this article highlighted the importance of also looking at the psycho-socio-emotional and structural working conditions of education professionals.

Future research can be based on decolonial ethnomathematics to develop knowledge based on the reality of individuals, cultures and historically subalternized contexts, promoting dialogue and contributions to the fields of Anthropology, Education, Ethnomathematics and Decoloniality. Future research can seek to understand or act on different realities, whether in the context of teaching or research, in regular or non-regular classrooms, especially in subalternized cultures that have often had their voices silenced and have been used only as objects of hegemonic academic research.

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