Articles Section
2025, Volume 7, e2025014
Pages 1–21
10.33532/revemop.e2025014

revemop
ISSN 2596-0245

Beyond the undoubted and the algorithms: the philosophy of humanistic mathematics in initial teacher training

Além do indubitável e dos algoritmos: a filosofia humanista da matemática na formação inicial de professores

Más allá de lo indudable y los algoritmos: la filosofía humanista de las matemáticas en formación docente inicial

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Abstract
The objective of this article is to present an investigation into the approach of the philosophy of humanist mathematics in the context of an initial teacher training course, considering the need to promote discussions on the nature of mathematics and its teaching. It is a documentary research of a qualitative nature, in which the pedagogical project of the mathematics course offered by IFMG-SJE was analyzed through the lens of the discursive textual analysis (ATD). The humanistic principles of the philosophy of mathematics were considered as the theoretical foundation. The study showed that the foundations of the humanist philosophy of mathematics are present in the course syllabi, implicitly, through approaches that promote student-centered teaching or that explain its social contribution and its nature as a human construction.
Keywords: Humanistic mathematics. Philosophy of mathematics. Philosophy of mathematics education. Teacher training. Mathematics teachers.

Resumo
O objetivo do presente artigo é apresentar uma investigação acerca da abordagem da Filosofia Humanista da Matemática no contexto de um curso de formação inicial de professores, tendo em vista a necessidade em se promover discussões sobre a natureza da Matemática e do seu ensino. Trata-se de uma pesquisa documental, de natureza qualitativa, na qual foi analisado o ementário do Projeto Pedagógico de Curso da Licenciatura em Matemática, ofertada pelo IFMG-SJE, segundo a Análise Textual Discursiva (ATD). Como fundamentação teórica foram considerados os princípios humanistas da Filosofia da Matemática. O estudo evidenciou que fundamentos da Filosofia Humanista da Matemática estão presentes nas disciplinas do curso, implicitamente, por meio de abordagens que promovem o ensino centrado no aluno ou que explicitam sua contribuição social e sua natureza, enquanto construção humana.
Palavras-chave: Matemática Humanista. Filosofia da Matemática. Filosofia da Educação Matemática. Formação docente. Professores de Matemática.

Resumen
El objetivo del presente artículo es presentar una investigación sobre el enfoque de la Filosofía Humanista de las Matemáticas en el contexto de un curso de formación inicial de profesores, teniendo en cuenta la necesidad de promover discusiones sobre la naturaleza de las Matemáticas y su enseñanza. Se trata de una investigación documental, de naturaleza cualitativa, en la que se analizó el ementario del Proyecto Pedagógico de Curso de la Licenciatura en Matemáticas, ofrecido por el IFMG-SJE, según el Análisis Textual Discursivo (ATD). Como fundamentación teórica fueron considerados los principios humanistas de la Filosofía de la Matemática. El estudio evidenció que los fundamentos de

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la Filosofía Humanista de las Matemáticas están presentes en las disciplinas del curso, implícitamente, por medio de enfoques que promueven la enseñanza centrada en el alumno o que explicitan su contribución social y su naturaleza, como construcción humana.
Palabras clave: Matemáticas Humanistas. Filosofía de las Matemáticas. Filosofía de la Educación Matemática. Formación docente. Profesores de Matemáticas.

1. Introduction

Teaching degree programs in mathematics have sought to update their curricula in line with the practices and methodologies used in teaching (Mathias, 2013), which ultimately shape mathematics instruction in basic education.

> In many schools, radical changes have been taking place in mathematics classes. Traditional methodology has been threatened by thematic approach and project-based work to such an extent that it is no longer possible to distinguish a mathematics class from a class in another subject (Alrø; Skovsmose, 2021, p. 16).

However, the same space for updating is not open to discussions about the philosophies that underpin initial teacher education courses (Mathias, 2013). The most widespread philosophies of teaching and conception of mathematics throughout history are Platonism and Formalism. These philosophies, described in Section 2 of this article, tend to depersonalize the mathematical concepts studied in the classroom by distancing the subjects from the objects of study. This distancing contributes to difficulties in understanding such concepts and to the segregation of some students in mathematics learning. This segregation holds that the full study of mathematics is possible only for those able to transcend the ideal world envisioned by the great mathematicians of antiquity (Hersh, 1997).

In contrast to classical philosophies, the philosophy of humanistic mathematics argues that mathematics has a social and cultural character, is inseparable from human beings, and that its teaching process should be student-centered. Mathematics as a discipline is “a strategy developed by the human species throughout its history to explain, understand, manage, and coexist with sensible, perceptible reality and with its imagination, naturally within a natural and cultural context” (D’Ambrósio, 2005, p. 102). To foster more meaningful learning, the teaching of mathematics must be student-centered and grounded in students’ autonomy and self-realization (Santos; Oliveira; Saad, 2021).

Given the predominance of Platonist and Formalist philosophies in mathematics curricula, especially in initial teacher training courses for this subject, which is reflected in teaching practices in basic education, we must study the adoption of philosophies of mathematics, such as humanist philosophy, that reclaim the human aspect of teaching. In this sense, this article presents an investigation of the philosophical principles present in the pedagogical project of the mathematics teaching degree course at the Federal Institute of Education, Science and Technology of Minas Gerais — São João Evangelista campus (IFMG-SJE) and their possible relationships with the philosophy of humanistic mathematics.

2. Philosophies of Mathematics

The philosophy of mathematics constitutes "the branch of philosophy whose task is to reflect on and explain the nature of mathematics" (Ernest, 1991). For Ernest (1998), this field analyzes mathematical objects from a perspective outside mathematics and relates to other sciences such as history, sociology, psychology, and anthropology of mathematics. Therefore, the philosophy of mathematics is not restricted to mathematics, nor can it be treated as a subset of that area. Although mathematics and the philosophy of mathematics have been seen as distinct, throughout history, philosophical endeavors have focused on mathematical objects themselves, reducing the philosophy of mathematics to the science of mathematics (Ernest, 1998).

According to Hersh (1997), among the most widespread philosophies in the study of mathematics, Formalism and Platonism stand out at various educational levels. Other philosophies, such as Logicism (which draws on Platonist principles) and Intuitionism (the most prominent among constructivist philosophies), as well as the classics mentioned above, have their place. These philosophies, in general, privilege one aspect of mathematics, treating it as mathematics itself, thereby reducing the conception of the area of knowledge. Thus, if we consider one of these models to be correct, the others are automatically wrong (Hersh, 1997). These philosophical currents are called absolutists because they assume that mathematical knowledge is unquestionable and incorrigible (Ernest, 1998). It is important to highlight that such philosophies are imbued with the socio-historical-cultural context and period in which their principles were established.

In contrast to absolutist philosophies, other currents have emerged throughout history, among which those rooted in Humanism stand out. According to Hersh (1997), the term Humanism encompasses "all philosophies that see mathematics as a human activity, a product and a characteristic of human culture and society" (Hersh, 1997, p. xi). Thus, the socio-constructivist philosophy of mathematics, by Paul Ernest, the philosophy of humanistic mathematics, by Alvin White and Reuben Hersh, and ethnomathematics, by Ubiratan D'Ambrosio, are directly or indirectly based on Humanism by highlighting the importance of individuals (mathematicians, teachers, students), as social beings, for the construction of mathematics and its learning.

In this section, we will describe the fundamental concepts of some of these philosophies. Therefore, we have decided to discuss Platonism and Formalism, as they are the most widely used philosophies in teaching and practicing mathematics, and Humanism and the philosophy of humanistic mathematics, which constitute the focus of this work.

2.1. Platonism

Platonism is a philosophy that views mathematics as a component that has always existed in an ideal world, preceding humankind and being perfect and unquestionable. From this perspective, there are no unanswered questions, since mathematics is self-sufficient. Thus, any apparent gap would not be a flaw in mathematics, but rather humanity's inability to understand its patterns (Cornelli; Coelho, 2007).

Although different definitions exist, the standard model that describes Platonism "says that mathematical entities exist outside of space and time, outside of thought and matter, in an abstract realm independent of any consciousness, individual or social" (Hersh, 1997, p. 9). According to

Cornelli and Coelho (2007), the term Platonism is used in contemporary philosophy of mathematics to refer, in general terms, to "the belief that mathematical objects exist independently of us and that we have no causal interaction with them; we can discover them but not create them" (Cornelli; Coelho, 2007).

According to Hersh (1997), mathematicians and mathematics educators, in general, have Platonist ideals rooted in their conception of mathematics, which is reflected in the subjects in this area of knowledge. The activities proposed in the classrooms reverberate only to a limited extent because there is a consensus that there is only one correct answer. This answer, from this perspective, is independent of the people involved and the context in which teaching takes place, since it transcends human practices and the material world (Hersh, 1997).

According to Paul Ernest (1991), Platonism presents two important weaknesses: it fails to explain how great mathematicians discover mathematics, and it does not offer a satisfactory explanation of what mathematics is. The first weakness concerns the Platonist view that mathematical knowledge belongs to an ideal, transcendent world. If we take this as true, how can we explain how the most important mathematicians reached this ideal world of mathematics? It would probably be through some kind of intuition, but Platonism is based on logic and reason. Even so, there are no answers regarding the Platonist method for deciphering the supposed inhuman universe of mathematics. The second weakness, in turn, concerns the Platonists' limited view of mathematics. Internally, it is static, as it discards its constructive and computational aspects, which require "the representation of dynamic mathematical processes, such as iteration, recursive functions, proof theory, and so on" (Ernest, 1991, p. 30). From an external standpoint, this is unjustifiable, since it fails to define the usefulness of mathematics for humanity (Ernest, 1991).

2.2. Formalism

Formalism, whose leading representative is the mathematician David Hilbert (1862-1943), in turn, rewrites mathematics and transforms the way mathematical content is taught. Prioritizing the accuracy of science, which should be considered indubitable —unquestionable and perfect, admitting no errors—, formalist philosophy is rooted in irrefutable axioms and formulas that must be executed mechanically (Loureiro; Klüber, 2015).

According to Mathias (2013), Formalism is:

> The perception that mathematics is a game of manipulating the symbols of a specific formal language, through certain rules of inference, about which interpretations are considered irrelevant. For the formalist, intuition is external to mathematics and to the game that constitutes it. The adjective intuitive is considered a synonym for informal, outside the rules, and without rigor (Mathias, 2013, n.p).

Thus, any demonstration that uses a more intuitive approach, such as geometry or figures, is not accepted by the formalist view (Mathias, 2013). Furthermore, Mathias (2013) cites the Pythagorean theorem as an example, which, from a formalist point of view, is not constituted as a mathematical object but rather as a set of mathematical symbols that form a formula resulting from the manipulation of Euclid's axioms adopted *a priori*.

The formalist approach treats mathematics as a set of symbols and rules, described formally. According to Paul Ernest (1998), Formalism was based on two assertions:

> 1. Pure mathematics can be expressed as uninterpreted formal systems in which the truths of mathematics are represented by formal theorems. 2. The safety of these formal systems can be demonstrated in terms of their freedom from inconsistency, by means of metamathematics (Ernest, 1998, p. 18-19).

These statements describe one of the main processes that have occurred in mathematics throughout history. With Formalism, mathematics was shaped to become increasingly axiomatic and formal, since it was the language used to describe, demonstrate, and prove theories from the most diverse areas, and, therefore, should be exact.

In short, if Platonism errs by decharacterizing the importance of the human being in mathematics *a priori*, Formalism depersonalizes mathematics *a posteriori* (Matemática Humanista, 2023). In other words, Platonist ideals exclude human contributions to the construction of mathematics —which, in this conception, precedes the human being and is independent of him to exist— while the formalist view removes mathematics' social contribution, excluding the fact that much of mathematics was built to meet the needs of cultural groups.

2.3. Humanism and the Philosophy of Humanistic Mathematics

The term Humanism gained strength in Europe from the 15th century onward, in a movement that severed the ties between society and the ideals of the medieval era, emphasizing the importance of human beings and their capacity to make choices and bring about transformations in reality. Over the years, Humanism has become an important branch of psychology — even being called "the third force in psychology" — with works focused on the study of human subjectivity (Santos; Oliveira; Saad, 2021).

In the Humanism movement, the work of the American psychologist and professor Carl Rogers (1902-1987) stood out. He advocated client-centered therapy, which consisted of "an active, voluntary and responsible participation of the individual in therapeutic relationships" (Santos; Oliveira; Saad, 2021, p. 91). Rogers also developed the theory of meaningful learning and adapted the client-centered therapy approach to education, known as student-centered learning.

According to Santos, Oliveira, and Saad (2021):

> Rogers proposes a Humanistic Education with teachers (facilitators, leaders) who are self-assured, knowledgeable, and confident in their relationships, trusting in self-learning and in the students' capacity for thinking and feeling, which involves teachers who are attentive to student motivation and engagement in classroom activity planning, who offer appropriate teaching resources, who actively participate in learning, and who enable students to express their contributions in group learning programs, taking ownership of their interests, choices, and their consequences (Santos; Oliveira; Saad, 2021, p. 87).

In this sense, the student has autonomy in their learning process, taking an active stance not only in solving activities but also in planning. For Rogers (1978), "the only learning that significantly influences behavior is that which is self-directed and self-appropriated" (Rogers, 1978, p. 151 apud

Santos; Oliveira; Saad, 2021, p. 89). The teaching environment, from this perspective, is established as a society in which each member is important and contributes to the group's learning.

Inspired by Carl Rogers' theory, the New York mathematician and philosopher Alvin White (1925-2009) created, in the 1960s, the "student-centered mathematics teaching," which he applied in a seminar on Calculus of Variations that he offered in his living room. Alvin White began employing this approach in the courses he taught, in which he received students from diverse fields such as mathematics, arts, biology, linguistics, electrical engineering, computer science, and artificial intelligence (White; Keith, 2002).

Student-centered mathematics teaching promoted active participation in constructing the proposed knowledge, thereby developing student autonomy in this process. In a "course on the calculus of variations, he [Alvin White] introduced ten or twelve text books, and let the students find how best to use the different books for their own learning, and to give reports to the class" (Hersh, 2011, p. 56). In the offered classes, students were encouraged to modify and create problems, and challenge each other to solve them (Hersh, 2011). Another proposed activity was a cooperative exam, in which the group could discuss solutions, making the task more dynamic and interesting for those involved. Although students liked the format of this exam, some did not consider it adequate for assessing their individual progress (White; Keith, 2002).

With this humanistic approach, the group strengthened its bonds and grew through the active participation of its members:

> We became a community that cared for one another and learned from each other. Students invited other professors to participate. Visitors to MIT-DSRE [Massachusetts Institute of Technology (Harvard)–Division for Study and Research in Education] would ask permission to observe quietly, although they usually joined in the discussion. One student remarked that the popularity of our seminar among visitors was probably due to the openness, honest listening and caring that were evident (White; Keith, 2002, p. 66).

The success of the group's relationship was cultivated based on the freedom of individuals to express themselves, so that no one was forced to speak, but everyone had the opportunity to. With this premise, combined with the autonomy and active participation of the student in the teaching process —student-centered mathematics learning — Alvin White dedicated himself to "develop the concept of Humanistic Mathematics; to create an approach to teaching and learning mathematics that would be nonthreatening, but inviting to students, who would participate in a cooperative spirit with each other and with teachers" (White; Keith, 2002, p. 68). He convened a humanistic mathematics network by holding national meetings for 17 years and created a newsletter, which later became the *Humanistic Mathematics Network Journal* (White; Keith, 2002; Hersh, 2011).

Reuben Hersh (1927-2020), who was involved in Alvin White's humanistic mathematics network, dedicated himself to formalizing the philosophy of humanistic mathematics, based on White's proposals. Reuben Hersh's work, although also dealing with mathematics education, focused on the nature of mathematics. In this sense, the philosophy of humanistic mathematics understands mathematical objects as products of human constructions; that is, mathematics is understood as a socio-historical-cultural activity (Hersh, 1997).

According to Hersh (1997):

> Once created and communicated, mathematical objects detach themselves from their creator and become part of human culture. We apprehend them as external objects, some of whose properties are known and others unknown. Among the unknown properties, some we have managed to discover. Some, however, we cannot discover, even though such objects are our creations. Does this seem paradoxical? If so, it is because of a way of thinking that only recognizes two realities: the individual subject and the external physical world. The existence of Mathematics shows the inadequacy of such categories. The customs and institutions of our society are real, even if not internal to the subject or external to the inhuman world. They are a different reality, a sociocultural and historical reality. Mathematics is this third type of reality – internal to society as a whole and external to the individual, like you and me (Hersh, 1997 apud Mathias, 2013, n.p.).

Thus, for the philosophy of humanistic mathematics, mathematical knowledge is made by us and, therefore, becomes part of our culture, as it is conceived and disseminated socially. It is the result of human actions and feedback loops, in which social, psychological, and historical aspects actively interfere (Mathias, 2013).

Regarding the teaching-learning process, Hersh (1997) considers that:

> A philosophy that obscures the teachability of mathematics is unacceptable. Platonists and formalists ignore this question. If mathematical objects were an other-worldly, nonhuman reality (Platonism), or symbols and formulas whose meaning is irrelevant (formalism), it would be a mystery how we can teach it or learn it. Its teachability is the heart of the humanist conception of mathematics (Hersh, 1997, p. 237-238).

This critique by Reuben Hersh is directed at the fact that the absolutist philosophies cited, when applied to teaching practice and school organization, determine whether students have the capacity to see and understand mathematics. In practice, what is perceived is that such philosophies end up hindering students' understanding, as they distance the objects of study from the subjects involved (Hersh, 1997). Contrary to absolutist thinking, according to Hersh (1997, p. 60), "the purpose [...] of all teaching, is understanding," which is why mathematics is constituted by the capacities to teach and learn, inherent to the human species. Hersh (1997) thus assesses that the philosophy adopted by — or imbued in — the teacher greatly affects their teaching, is assimilated by students, and, depending on the philosophical current followed, can have devastating consequences.

Philosophy of humanistic mathematics, like other philosophies that value human practices and sociocultural interactions throughout history in the construction and reconstruction of mathematical knowledge, possesses the property that "pulls mathematics out of the sky and sets it on earth" (Hersh, 1997, p. 246). This refers to a genuine democratization of mathematical knowledge, which removes the signs of an elitist conception that this type of knowledge is for the few who manage to transcend to an ideal world of Platonism (Mathias, 2023). Putting mathematics on earth can also be understood as the effort to show the human work involved in the construction of this knowledge, which returns to society in order to contribute to various areas, unlike the formalist ideal that ends up making mathematical objects end in mathematics itself, which can be called "mathematics for mathematics' sake".

Currently, the greatest advocate of the philosophy of humanistic mathematics in Brazil is Professor Carlos Eduardo Mathias Motta, an associate professor in the Department of Applied Mathematics (GMA) at the Federal Fluminense University (UFF) who has a YouTube channel called Humanist Mathematics, in which he dedicates his videos to discussing aspects of the philosophy of humanistic mathematics and promoting reflections on mathematics education. On this channel, the professor also proposes principles for humanistic practices in the classroom by mathematics teachers.

According to Carlos Mathias, a mathematics teacher who follows a humanistic perspective in their teaching methodologies understands that the purpose of studying mathematics is not to teach the content itself, but rather to support student learning. The focus of the class should be on students' construction of knowledge. A humanistic mathematics teacher knows how to decentralize the teaching process from themselves, promoting active student interaction so that exchanges and the construction of meaningful knowledge are possible (Mathias, 2019).

A humanist mathematics teacher understands the need to show students the meaning of those objects of study (Mathias, 2019). A common mistake made by those who do not practice mathematics is to view it as a set of answers without questions. Often, mathematicians themselves publish their discoveries without referencing the questions that motivated their investigation, yet they are aware of their existence. After all, mathematical discoveries are rarely made by chance but are motivated by human and social curiosity or need.

In his book *Fazeres Matemáticos Humanistas* [Humanistic Mathematical Practices], published in 2025, Carlos Mathias offers reflections on mathematical practices, using resources such as allegories, metaphors, and aphorisms. Throughout the text, the author introduces a discussion of the curriculum, school colonization, and the depersonalization of mathematics education, as he constructs the conception of the philosophy of humanistic mathematics.

According to Mathias (2025), there is a perception of democracy embodied in the expression "school for all." However, he considers it necessary to achieve a "school for each individual," which constitutes one of the greatest challenges in education today. He argues that current education plans and offers curricula for *everyone* at the cost of discarding their uniqueness, in what he calls the depersonalization of teaching.

Regarding teaching in mathematics teacher training courses, Mathias (2013, n.p.) reinforces that "specific and pedagogical knowledge is fundamental to the mathematics teacher; however, such knowledge should be accompanied by reflection on the nature of mathematics and the role of the mathematician: philosophical knowledge" (Mathias, 2013, n.p.).

At this point, it is important to define what we understand as the *nature of mathematics*, based on the philosophy of humanistic mathematics. Each philosophical current presents aspects and assumptions that delimit the understanding of this nature, so that the nature of mathematics defended by Platonism is distinct from that defined by Formalism, which, in turn, differs from humanist conceptions, for example.

From a humanistic perspective, drawing on the work of Hersh (1997), Ernest (1998), and Mathias (2025), we understand the nature of mathematics as a set of social, historical, and cultural aspects. Mathematics, in this perspective, is a human construct in which human groups discover and create their objects and concepts. It is important to emphasize that the acts of creating and discovering do not cancel each other out; on the contrary, they occur concomitantly and are inherent to mathematics and to mathematical practice (Mathias, 2025). According to Mathias (2025, p. 115), "creations arise from the interaction between individual actions and the world, as well as from the intersubjective movements that make them public, while discoveries occur amidst normative references that reflect what is socially accepted." Hersh (1997) exemplifies that integers constitute discoveries of humanity, while other numbers are human constructs, thus distinguishing between "countable numbers — adjectives applied to collections of physical objects — and pure numbers — objects, ideas in the shared consciousness of a portion of humanity" (Hersh, 1997, p. 75). Furthermore, Hersh (1997) defines the acts of creating and discovering as two types of mathematical advancement and exemplifies the case in which a created theory demands the discovery of properties through different instruments and practices, thereby concluding that creation leads to discovery.

Thus, mathematical truths exist and have validity externally to the human subject, but they do not have validity externally to the human species (Mathias, 2025). This statement is corroborated by Hersh's (1997) view that mathematical objects, once created, belong to human culture, no longer to their creator. Therefore, mathematics is "internal to society as a whole and external to the individual, like you and me" (Hersh, 1997 apud Mathias, 2013, n.p.). These are constructions that often stem from the needs of cultural groups and return to them, therefore contributing socially to their results.

From a humanist perspective, mathematics is fallible and subject to revision and correction, with proof serving to explain and/or convince — especially the mathematical community — but not to determine *absolute* truth (Ernest, 1998). For Mathias (2025, p. 115), "the accuracy attributed to *mathematics* is not a divine or extra-human characteristic, but a historically constructed, cultural and variable attribute, adhering to the rules that we weave, revisit and modify in different circumstances."

In short, "knowledge of the nature of mathematics lies in an ability to do it" (Ernest, 1998, p. 50). Mathematics is constituted by the capacity to be taught and, therefore, learned. To learn mathematics, in this sense, the student needs to engage actively and autonomously, so as to learn by doing, understanding this practice, not just assimilating truths understood as absolute and reproducing patterns.

According to Mathias (2025), the philosophy of humanistic mathematics understands mathematical practices as normative postures adopted in humanity's search for social materiality, with mathematics itself serving as an example. In this sense, mathematical practices are not limited to the manipulation of mathematical objects per se, or to practices such as counting and measuring. Mathematical symbols, functions, and geometric forms, for example, considered mathematical objects, should not be reified, but rather interpreted as mathematical practices constituted from the search for social materiality. Mathematical practices, from a humanistic perspective, form a subset of human practices.

It is also worth noting that when we present this conception of mathematics and its nature, we do not aim to reify these terms, making them static. Mathias (2025, p. 77) understands mathematical knowledge as "a social materiality, essentially variable and, therefore, incapable of accommodating the level of permanence of a thing, be it ideal, abstract, social, or cultural". Similarly, we understand that mathematics and its nature are not concepts that can be wholly and precisely defined in a few words, nor can they be encapsulated. It is necessary to understand that the nature of mathematics as understood here consists of both objective and subjective aspects.

3. Methodology

The work was constructed from a qualitative perspective, using bibliographic, videographic, and documentary research, with data analysis performed according to the criteria of discursive textual analysis (DTA), as described by Moraes and Galiazzi (2016).

Regarding the bibliographic research, we adopted the perspectives of Reuben Hersh (1997) and Mathias (2025), focusing on the philosophy of humanistic mathematics. Both works reflect on the breadth of mathematics, its applications, and how this concept has been constructed over time, while reconstructing the conception of the philosophy of mathematics with a human character, a product of sociocultural actions, which enriches and is enriched by human action. The former was the first work to mention the expression *philosophy of humanistic mathematics* (Mathias, 2025), serving as its most prominent reference. The second is an important addition to the understanding of this philosophy, especially for describing it in terms of the tangible world, offering contemporary, extremely relevant reflections. These understandings together constitute our conception of the philosophy of humanistic mathematics. It is worth noting that Ernest's (1998) socioconstructivist vision also contributes to this understanding. In this regard, related books and articles were revisited, as well as videos from the *Matemática Humanista* [Humanist Mathematics] YouTube channel.

Regarding the documentary research, the aim was to analyze the pedagogical project (PPC) of the teaching degree course in mathematics at the Federal Institute of Education, Science and Technology of Minas Gerais — São João Evangelista campus (IFMG-SJE), which came into effect in 2023. This choice is justified because:

> Documentary research offers several advantages. Firstly, we must consider that documents constitute a rich and stable data source. As documents persist over time, they become the most important data source in any historical research (Gil, 2002, p. 46).

In this sense, it is important to define our understanding of what these documents mean, based on what Macdonald and Tipton (1993) state:

> Documents are texts we can read and relate to aspects of the social world. Clearly, this includes things made with the intention of recording the social world — official reports, for example — but also private and personal records, such as letters, diaries, and photographs, which may not have been made for publication. However, beyond the intended record, there may be things that openly seek to provoke amusement, admiration, pride, or aesthetic enjoyment — songs, buildings, statues, novels — and which undoubtedly tell us something about the values, interests, and purposes of those responsible for producing them (Macdonald; Tipton, 1993, p. 188 apud Silva, 2017, p. 39).

This justifies the choice of the PPC as an analytical document, as it is an institutional regulation imbued with social, political, cultural, and economic nuances. It is one of the most important documents for the constitution of the mathematics teaching degree course at IFMG-SJE and the actions that stem from it.

For the document analysis, two steps were taken, namely: i) the process of reading and understanding the PPC, taking into account aspects such as curriculum organization, curriculum matrix and syllabus, understanding its guiding principles and guidelines for the initial training of mathematics teachers; ii) the discursive textual analysis (DTA) of the PPC syllabus, from the perspective of Moraes and Galiazzi (2016), with inspiration from the works by Bicalho, Allevato and Silva (2020), and Carreta and Allevato (2023).

4. Textual Discourse Analysis (TDA)

According to Moraes and Galiazzi (2016), TDA is a qualitative data analysis methodology that, starting from a corpus, allows for the understanding and reinterpretation of the texts under analysis within a theoretical framework. Corpus is the set of texts (or signifiers) that will be analyzed through TDA. For TDA, text, beyond being a set of organized sentences, is a linguistic manifestation, which can be in written form, transcribed oral form, images, among others (Moraes; Galiazzi, 2016).

TDA can be understood as a cycle encompassing three processes: unitarization, categorization, and the capture of the new and emergent. Unitarization corresponds to the deconstruction of the corpus, yielding units of analysis, also called units of meaning or sense. Categorization, in turn, is the act of grouping units of analysis that are related to each other into categories. The capture of emerging information occurs when a new vision of the corpus is constructed, made possible by the processes of unitarization and categorization within the selected theoretical framework. Within this focus on the cycle, the production of metatexts takes place. A metatext can be defined as a text constructed from another text and can be created by the author who elaborated the original text, as in the case of revisions, or elaborated by other authors, in critiques and reviews, for example (Moraes; Galiazzi, 2016).

It is important to emphasize that, according to Moraes and Galiazzi (2016):

> The cycle of discursive textual analysis focused here is an exercise in producing and expressing meanings. Texts are assumed to be signifiers in relation to which it is possible to express symbolic meanings. The aim is, therefore, to construct understandings from a set of texts, analyzing them and expressing, based on the analysis, the possible senses and meanings. The results obtained depend on both the authors of the texts and the researcher (Moraes; Galiazzi, 2016, p. 36).

In this sense, TDA does not have the ambition to achieve the complete idea that the author wanted to express in more depth in his text, a practically impossible task, since each individual makes their own interpretations, which may vary according to each person's life experiences and, in the case of TDA, according to the theoretical frameworks determined or not — every analysis has a theoretical basis, whether consciously selected or already rooted in the worldview of the person doing the analysis (Moraes; Galiazzi, 2016).

In the following subsections, we outline steps taken for TDA in the analysis of the PPC.

4.1. Unitarization

According to Moraes and Galiazzi (2016), unitarization corresponds to the process of deconstructing the texts that make up the corpus and defining the units of meaning, also called units of analysis or sense. Thus, during the decomposition of the texts, the researcher highlights the important elements that emerge from the analysis, constituting the units of meaning that must be named and coded for the identification of their origin in the texts. In this sense, when analyzing the fields of objectives, syllabi, and bibliographic references of the subjects in the PCC syllabus, the passages that revealed relationships with principles of the philosophy of humanistic mathematics became the units of meaning (UM). Each UM received an alphanumeric code for its identification.

In this analysis, the unit codes were defined based on the subject codes in the PPC syllabus. These codes correspond, in short, to the initials of the subject names. Thus, we have the following codes and their respective subjects: AEBI for Algebra in Basic Education I; CALI for Calculus I; CAL II for Calculus II; DG for Geometric Drawing; ESB for Basic Statistics; FISI for Physics I; FISII for Physics II; GEBI for Geometry in Basic Education I; HM for History of Mathematics; MF for Financial Mathematics; RP for Problem Solving; TEM for Trends in Mathematics Education; and TN for Number Theory. A number representing the unit order is added to each of these codes. The combination of the subject codes with the numbering forms the unit codes described in Chart 1.

The aforementioned subjects were selected because they focus on teaching mathematical concepts, some of which will constitute teachers' teaching practice in basic education. Thus, the aim was to identify the approaches that these subjects bring to mathematics teaching in the teaching degree.

Chart 1: Units of meaning of the PPC of the mathematics teaching degree

UM Code	Page	Unit of Meaning	Noticed Aspects
AEBI.1	43	The subject aims to discuss aspects of the teaching of Algebra in Basic Education, such as sets, relationships, and functions, and **to enable students to apply these concepts in everyday situations**.	The mathematics of/in everyday life; Contribution of mathematics to everyday and professional life; Mathematics for social emancipation.
GEBI.1	44	Present to the student an overview of geometry and **its historical evolution**.	Historical evolution of mathematics; The construction of mathematics.
CALI.1	54	The subject aims **to instill in the student an investigative and deductive spirit in** the study and demonstration of the limit.	Active learning; Student autonomy.
CALI.2	54	**Instigate in the student the development and resolution of problems** that involve derivatives.	Active learning; Student autonomy.
DG.1	54	The subject aims to **instill in the student an investigative and deductive spirit regarding** possible geometric constructions using the ruler and compass.	Active learning; Student autonomy.
DG.2	55	Present to the student an overview of geometry and its **historical evolution**.	Historical evolution of mathematics; The construction of mathematics.
CALII.1	59	**Awaken in the student an interest** in solving problems through integrals.	Active learning.
CALII.2	59	**Inspire the student to develop and solve problems** that use integrals.	Student autonomy; Active learning.

MF.1	61	The component aims to develop an understanding of financial mathematics as a fundamental element for **acquiring knowledge and for decision-making in the consumer society**.	Mathematics for social emancipation; Contribution of mathematics to everyday and professional life.
MF.2	61	Explain **the importance of financial mathematics in the context of the consumer society**.	Mathematics, culture, and society; Mathematics for social emancipation.
MF.3	61	Discuss **financial education in the context of the consumer society**.	Mathematics, culture, and society; Mathematics for social emancipation.
MF.4	61	**Use the concepts of financial mathematics** in different socio-political and cultural contexts.	Mathematics, culture, and society; The mathematics of/in everyday life; Contribution of mathematics to everyday and professional life.
MF.5	61	Identify and calculate financial operations, **relating them to the daily situations of companies and their own lives**, using different technological resources.	The mathematics of/in everyday life; Contribution of mathematics to everyday and professional life.
MF.6	61	Understand financial information **to support control and decision-making processes**.	Mathematics for social emancipation; Contribution of mathematics to everyday and professional life.
ESB.1	62	Provide a **critical reflection on the use of statistics in everyday life**.	The mathematics of/in everyday life; Contribution of mathematics to everyday and professional life.
ESB.2	62	Assisting in **decision-making based on the analysis of statistical data**.	Mathematics for social emancipation; Contribution of mathematics to everyday and professional life.
FISI.1	65	The basic objective of the course is to introduce students to the fundamental principles of mechanics, thermodynamics, hydrostatics, and hydrodynamics, providing an understanding of **the various physical phenomena they will encounter in their professional life**, enabling them to identify and analyze, qualitatively and quantitatively, the relevant properties present in the various systems, articulate their knowledge with that **of other areas in order to develop appropriate solutions for everyday situations,** connecting theory and practice.	The mathematics of/in everyday life; Contribution of mathematics to everyday and professional life; Mathematics for social emancipation.
FISI.2	66	TIPLER, Paul Allen; MOSCA, Gene. **Física para cientistas e engenheiros**: volume 1: mecânica, oscilações e ondas, termodinâmica. [Physics for scientists and engineers: volume 1: mechanics, oscillations, and waves, thermodynamics]. 6. ed. Rio de Janeiro: LTC, c2009 v. 1.	Contribution of mathematics to everyday and professional life.
FISI.3	66	SANTOS, Luciane Mulazani dos; MACEDO, Luiz Roberto Dias de. Tópicos de **história da física e da matemática** [Topics in the history of physics and mathematics]. Curitiba: Intersaberes, 2014.	Historical evolution of mathematics; The construction of mathematics.
TN.1	69	The subject aims **to instill in students an investigative and deductive spirit in the study and demonstration of the properties of** integers.	Student autonomy; Active learning.

TN.2	69	Present **the history of numbers** and numbering systems.	Historical evolution of mathematics; The construction of mathematics.
FISII.1	69	The basic objective of the course is to introduce students to the fundamental principles of mechanics, thermodynamics, hydrostatics, and hydrodynamics, providing an understanding of **the various physical phenomena they will encounter in their professional lives**, enabling them to identify and analyze, qualitatively and quantitatively, the relevant properties present in the various systems, articulate their knowledge with that of other areas in order to **develop appropriate solutions for everyday situations**, connecting theory and practice.	The mathematics of/in everyday life; Contribution of mathematics to everyday and professional life; Mathematics for social emancipation.
FISII.2	70	TIPLER, Paul Allen; MOSCA, Gene. Física para cientistas e engenheiros: volume 2: eletricidade e magnetismo, óptica [Physics for scientists and engineers: volume 2: electricity and magnetism, optics]. 6. ed. Rio de Janeiro: LTC, 2009.	Contribution of mathematics to everyday and professional life.
RP.1	75	Understand the **historical path** of problem solving.	The construction of mathematics.
RP.2	75	**Stimulate and promote research and project attitudes** across different mathematical content areas through problem-solving.	Student autonomy; Active learning.
HM.1	76	The course presents **mathematical achievements across the main civilizations and historical periods**: Egyptian and Babylonian; Ancient Greece; Arabic, Hindu, and Chinese; Medieval Europe; and the Dawn of Modern Mathematics.	The development of mathematics in different cultures; The construction of mathematics; Historical evolution of mathematics.
HM.2	76	Present an overview of the **history of the development of the main mathematical concepts**, as well as the **mathematicians responsible for this development**.	The construction of mathematics. Historical evolution of mathematics;
HM.3	76	Explain how the **problems that generated the development of the main mathematical concepts** arose.	The mathematical construction by human needs; The construction of mathematics.
HM.4	76	**Correlate the historical moment with the development of mathematics** as a science.	Sociocultural contributions to the development of mathematical science; The construction of mathematics.
TEM.1	80	The component aims to address mathematics education as a field of studies and research, **its historical trajectory, interfaces, and interlocutions with social, cultural, economic, and environmental factors, as well as its trends.**	The social and historical nature of mathematics education; Historical evolution of mathematics;
TEM.2	80	[...] different themes will be discussed, including: **History of Mathematics Education**; Curriculum; Assessment; Didactics of Mathematics; **Ethnomathematics**; **Philosophy of Mathematics**; Teacher Education; **History of Mathematics**; Mathematical Modeling; Research in Mathematics Education; **Problem solving**; Technologies Spplied to the Teaching and Learning of Mathematics; **Mathematics Education in Youth and Adult Education and Critical Mathematics Education**.	The historical construction of mathematics education; The development of mathematics in different cultures; The nature of mathematics; The construction of mathematics; Active learning; Mathematics for social emancipation; Mathematics, culture, and society.

Source: Prepared by the authors (2024)

The philosophy of humanistic mathematics is implicitly present in the PPC syllabus. Although there is no direct mention of this philosophy, humanistic principles are perceived in the description and objectives of a considerable portion of the listed disciplines. These principles relate to the aspects listed in Table 1, which shows that a large part of the defined UMs presents more than one aspect related to the philosophy of humanistic mathematics.

Continuing with TDA, we dedicated ourselves to building categories based on the defined UMs.

4.2. Categorization

Categorization, according to Moraes and Galiazzi (2016), is the process of selecting units of meaning and grouping them according to the common aspects they share. The groups constitute the analysis categories, which are precisely constructed and named within the theoretical framework. It is the foundations of the theoretical framework — explicit or not — that enable the researcher to define the categories.

In this sense, the categories described in Chart 2 were developed.

Chart 2: Categories os analysis of the PPC of the mathematics teaching degree

Units of Meaning	Aspects in Common	Analytical Categories
HM.3	The construction of mathematics due to human needs	Mathematics as a human construct
DG.2; FISI.3; GEBI.1; HM.1; HM.2; HM.3; HM.4; RP.1; TEM.2; TN.2	The construction of mathematics	
TEM.2	The nature of mathematics	
HM.4	Sociocultural contributions to the development of the mathematical science	
DG.2; FISI.3; GEBI.1; HM.1; HM.2; TEM.1; TN.2	Historical evolution of mathematics	
HM.1; TEM.2	The development of mathematics in various cultures	
AEBI.1; ESB.1; FISI.1; FISII.1; MF.4; MF.5	The mathematics of/in everyday life	Mathematics with a social purpose
ESB.2; FISI.1; FISII.1; MF.1; MF.2; MF.3; MF.6; TEM.2	Mathematics for the social emancipation	
AEBI.1; ESB.1; ESB.2; FISI.1; FISI.2; FISII.1; FISII.2; MF.1; MF.4; MF.5; MF.6	Contribution of mathematics to everyday and professional life	
MF.2; MF.3; MF.4; TEM.2	Mathematics, culture and society	
TEM.1	The social and historical character of the mathematics education	
CALI.1; CALI.3; CALII.1; CALII.2; DG.1; RP.2; TEM.2; TN.1	Active learning	Student-centered teaching
CALI.1; CALI.3; CALII.2; DG.1; RP.2; TN.1	Teacher's autonomy	

Source: Prepared by the authors (2024)

Aspects perceived in the Ums were grouped into three categories, presented in Chart 2: 1) Mathematics as a human construct; 2) Mathematics with a social purpose; and 3) Student-centered teaching. These categories are directly related to the philosophy of humanistic mathematics, both in terms of the conception of the nature of mathematics (categories 1 and 2) and the vision of the intended teaching-learning process (category 3). Based on the defined categories, we produced the metatext described in the following subsection.

4.3. The new emerging in metatext form

Category 1, *Mathematics as a human construct*, encompasses aspects of the history of mathematics and its evolution across cultures throughout human history. When studying the history of mathematics, it is natural to think of great mathematicians from ancient and modern times, their exceptional achievements, and the importance of their creations for humanity. In this sense, the contribution of human actions and feedback to the development of mathematics is emphasized.

HM.3 unit stands out, "explaining how the problems that gave rise to the development of the main mathematical concepts arose" (IFMG, 2022, p. 76), which highlights the constitution of mathematical objects by human need, contributing to the advancement of human societies. Mathias (2023) states that there are mathematical objects created from more tangible human and social needs, such as the creation of natural numbers, fundamental elements for counting in individual, social, and professional daily life, while others are created for purposes further removed from everyday reality, based on already constructed and formalized mathematics, as is the case with imaginary numbers, for example (Mathias, 2023). In any case, such objects translate into cultural constructions that impact people's lives at different levels.

In this sense, the initial training of mathematics teachers should enable prospective teachers to understand that the mathematics in the curriculum has been prioritized at the expense of other subjects. It is necessary to understand that the mathematical practices favored in textbooks and curricula have reached this privileged position for various reasons and contexts, as Mathias (2025, p. 118) calls it, "a robust conquering, religious and commercial undertaking" that built the hegemony of mathematical knowledge. Thus, it can be inferred from unit TEM.1 that, by discussing mathematics education taking into account "its historical trajectory, interfaces and interrelations with social, cultural, economic and environmental factors, as well as its trends" (IFMG, 2022, p. 80), the IFMG-SJE mathematics education program contributes to the development of a critical understanding of mathematics teaching, colonized by a hegemony that is — essentially — eurocentric.

Without this understanding, one might think that ethno-cultural groups, such as Indigenous communities, have not developed mathematical practices — or that these practices are not relevant — because they are not widely disseminated or studied academically (Mathias, 2025). By proposing the study of D'Ambrosio's ethnomathematics (TEM.2), the mathematics teaching degree of IFMG-SJE legitimizes the mathematical practices of different peoples and cultures, and provides pre-service teachers with the opportunity to learn about these mathematical practices and objects, possibly never before understood as such by many, due to a lack of experiential opportunities, considering an already-colonized basic education.

Category 2, *Mathematics with a social purpose*, in turn, relates to Category 1 regarding the contribution of mathematics to society, since if knowledge originates from human need, its purpose is to contribute socially to one or more cultural groups. In line with the nature of mathematics, this category also focuses on the contribution of studying mathematics to the lives of individuals involved, especially students.

Some of the analyzed subjects presented principles that seek the social emancipation of the students involved in the study, promoting activities and discussions that foster in students the critical capacity to analyze, reflect, and make decisions. Notable units include MF.1, "The subject aims to develop an understanding of financial mathematics as a fundamental element for acquiring knowledge and concepts essential for decision-making in a consumer society" (IFMG, 2022, p. 61), MF.6, "Understanding financial information that assists in the process of control and decision--making" (IFMG, 2022, p. 61), and ESB.2, "Assisting in decision-making based on the analysis of statistical data" (IFMG, 2022, p. 62). These units are based on the need to foster in students the mastery of mathematical concepts and their use in everyday life situations (AEBI.1; ESB.1; FISI.1; FISII.1; MF.4; MF.5) to promote their personal and professional success (AEBI.1; ESB.1; FISI.1; FISI.2; FISII.1; FISII.2; MF.4; MF.5).

Thus, in addition to "pulls mathematics out of the sky and sets it on earth" (Hersh, 1997, p. 246), presenting its tangible nature, the units above aim for the constructed knowledge to be applied in the extracurricular lives of the undergraduates, both in terms of professional and technical preparation, and in the development of skills that allow them to live in society with autonomy and critical awareness, thus enabling them to have greater success in building these potentialities with their students. This does not develop merely through the assimilation of algorithms but depends on the development of a social awareness of oneself, others, all of us, and each individual. The current school, to fully promote the comprehensive education it proposes, will need to address a major challenge that emerges "in the difficulty they encounter in proposing curricular experiences sensitive to the social fabric and structure of human life" (Mathias, 2025, p. 126).

Finally, Category 3, *Student-centered teaching*, highlights aspects related to active learning and student autonomy in this process. The subjects related to this category aim to encourage students to learn through investigation, problem-solving, and project development.

The ability to teach is one of the driving forces of the philosophy of humanistic mathematics. To teach mathematical content from a humanistic perspective, it is necessary to encourage students to practice mathematics through activities that promote an active stance (CALI.1; CALI.3; CALII.1; CALII.2; DG.1; RP.2; TEM.2; TN.1) and develop their autonomy (CALI.1; CALI.3; CALII.2; DG.1; RP.2; TN.1). After all, mathematics "is not done by memorizing the times table or Peano's axioms. Mathematics is learned by computing, solving problems, and conversing, more than by reading and listening" (Hersh, 1997, p. 27).

The humanistic principles described in the three categories of analysis aim to build in mathematics teaching degree students an understanding of the nature of mathematics as human, social, and cultural, so that this conception is also reflected in the discussions of pre-service teachers with their students when they are teaching. Furthermore, the subjects analyzed seek to train teachers who are critical and active citizens, who use the mathematics they learn for their own self-realization and provide their students with this opportunity.

5. Final Considerations

This paper presents an overview of the approaches to the philosophy of humanistic mathematics within the pedagogical project of the mathematics teaching degree course (PPC) at IFMG-SJE. We consider that the philosophical principles adopted by — or ingrained in — teachers directly influence their teaching and, consequently, students' learning and development. Therefore, it becomes extremely necessary to promote discussions and reflections on the philosophies of mathematics and its teaching in initial teacher training courses in mathematics.

The analysis of the PPC revealed that, although the philosophy of humanistic mathematics is not directly mentioned in the document, its syllabus includes humanistic principles in the subjects focused on teaching mathematical content. Therefore, the philosophy of humanistic mathematics is implicit in the course offered by IFMG-SJE, especially regarding the conception of mathematics as a human construct — developed from the needs of human groups and returning to humanity, as it has a social purpose — as well as the understanding that meaningful teaching occurs in light of the centrality of its process in the student. In this sense, we envision that the next PPCs for the course should emphasize humanistic principles more directly promote discussions of the philosophy of mathematics and the nature of mathematics, and establish its sociocultural characteristics. Furthermore, we hope that the teaching-learning process will be increasingly student-centered in the new documents, thereby training teachers with a more evident humanistic vein.

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Appendix – Editorial Details

Editorial History
Received: 14/03/2025.
Accepted: 08/08/2025.
Published: 12/11/2025.

How to cite – ABNT
REIS, Gedeilson Santos; LOPES, Leidiane Nunes; BICALHO, Jossara Bazílio de Souza. Beyond the undoubted and the algorithms: the philosophy of humanistic mathematics in initial teacher training. **REVEMOP**, Ouro Preto/MG, Brazil, v. 7, e2025014, 2025. https://doi.org/10.33532/revemop.e2025014

How to cite – APA
Reis, G. S., Lopes, L. N., & Bicalho, J. B. de S. (2025). Beyond the undoubted and the algorithms: the philosophy of humanistic mathematics in initial teacher training. *REVEMOP, 7*, e2025014. https://doi.org/10.33532/revemop.e2025014

Funding
Not applicable

Conflicts of Interest
The authors declare that there is no conflict of interest of a personal, commercial, academic, political, or financial nature regarding this article.

Contribuição dos Autores
Resumo/Abstract/Resumen: Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **Introduction or First considerations:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **Theoretical framework:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **Methodology:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **Data analysis:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **Discussion of results:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **Conclusion or Final considerations:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **References:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **Manuscript review:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho; **Approval of the final published version:** Gedeilson Santos Reis, Leidiane Nunes Lopes, Jossara Bazílio de Souza Bicalho.
CRediT – Contributor Role Taxonomy – https://credit.niso.org/.

Data Availability
Not applicable / These research data have not been published in the data repository; however, the authors are committed to sharing them if the reader is interested.

Similarity Check
This article has been subjected to a similarity check using text detection software **iThenticate** from Turnitin, through the service **Similarity Check** from Crossref.

Review Process
Double-blind peer review

Reviewers
Two *ad hoc* reviewers evaluated this article and did not authorize the disclosure of their names.

Translation / Proofreading
This article was funded by the Minas Gerais State Research Support Foundation (Fundação de Amparo à Pesquisa do Estado de Minas Gerais–FAPEMIG), Project APQ-04960-23, Notice N. 008/2023–Support program for scientific and technological publications.