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Educação Matemática Debate

# Technological resources and their (possible) use in the initial education of Mathematics teachers

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**ARTICLE**

***Abstract:*** We analyzed excerpts from interviews with graduates of the Mathematics Degree Course at Unimontes, who graduated between 2020 and 2023, regarding their perceptions of the technological resources available on the course, and whether or not they were used by teachers and the reasons for this. Methodologically based on Oral History, we conducted interviews with 17 graduates of this program. We concluded that there are technological resources available, but not all teachers use them, even in subjects where technology could be an ally, such as Differential and Integral Calculus. Thus, it can be inferred that the challenge of integrating digital technologies into initial teacher education goes beyond the mere provision of physical infrastructure.

***Keywords:*** Bachelor's Degree in Mathematics. Oral History. Graduates' Perceptions. Technological Resources. Digital Technologies.

## Recursos tecnológicos y su (posible) utilización en la formación inicial del profesor de Matemáticas

***Resumen:*** Analizamos extractos de entrevistas a graduados del Grado en Matemáticas de la Unimontes, formados entre 2020 y 2023, en relación con sus percepciones sobre los recursos tecnológicos disponibles en el curso, y el uso o no por parte de los profesores y los motivos para ello. Basándonos metodológicamente en la Historia Oral, realizamos entrevistas a 17 graduados de este curso. Llegamos a la conclusión de que existen recursos tecnológicos en él, pero no todos los profesores los utilizan, incluso en disciplinas en las que la tecnología podría ser una aliada, como Cálculo Diferencial e Integral. Por lo tanto, se deduce que el reto de integrar las tecnologías digitales en la formación inicial de los profesores va más allá de la mera disponibilidad de infraestructura física.

***Palabras clave:*** Licenciatura en Matemáticas. Historia Oral. Percepciones de los Graduados. Recursos Tecnológicos. Tecnologías Digitales.

## Recursos tecnológicos e sua (possível) utilização na formação inicial do professor de Matemática

***Resumo:*** Analisamos excertos de entrevistas de egressos do curso de Licenciatura em Matemática da Unimontes, formados entre 2020 e 2023, no tocante às suas percepções a respeito dos recursos tecnológicos disponíveis no curso, e da utilização ou não por parte dos professores e os motivos para isso. Fundamentados metodologicamente na História Oral, realizamos entrevistas com 17 egressos desse curso. Concluímos que há recursos tecnológicos nele, mas nem todos os professores os utilizam, mesmo em disciplinas que poderiam ter a tecnologia como aliada, como Cálculo Diferencial e Integral. Assim, infere-se que o desafio de integrar as tecnologias digitais à formação inicial de professores ultrapassa a mera disponibilização de infraestrutura física.

***Palavras-chave:*** Licenciatura em Matemática. História Oral. Percepções de Egressos. Recursos Tecnológicos. Tecnologias Digitais.

## 1 The horizon we look to...

The incorporation of Digital Information and Communication Technologies (DICT) has opened up horizons for the development of new pedagogical practices, making it a relevant topic in research in the field of education today. Among the various aspects highlighted in the literature, the limited initial education of teachers in the pedagogical use of digital technologies stands out.

From this perspective, different studies have fostered discussions related to the integration of digital technologies in the educational sphere. Cursino (2017), for example, highlights the importance of incorporating these technologies into teaching practice, enabling the promotion of more contextualized learning. Silva (2015), in turn, studies the relationship between technology and education from the perspective of students enrolled in the Pedagogy Course, highlighting perceptions, challenges, and potentialities of the use of these resources in the education process.

Specifically in Mathematics, in Aguiar *et al*. (2025) and in Oliveira and Pacheco (2025) defend the need to integrate technologies into Mathematics teaching, primarily in Basic Education, in order to assist in the learning process of students, in addition to stimulating their logical reasoning through technological resources.

Gravina and Santarosa (1998) emphasize the relevance of using educational *software* as pedagogical proposals that can provide opportunities for conceptual understanding and the development of students' logical reasoning. Moran (2000) encourages discussions about the transformations in teaching and learning methods mediated by technologies, highlighting the need to (re)think pedagogical methodologies and practices in light of the possibilities promoted by TDIC. This gap is pointed out as one of the main reasons for the limited presence of technologies in teaching, learning, and assessment processes, especially in Basic Education (Marin and Penteado, 2011).

The presence of TDIC has promoted a reinterpretation of pedagogical practices, *de-emphasizing* traditional models based on memorization and knowledge transmission, and proposing new ways of constructing knowledge. This transformation is not restricted to basic education, but also extends to higher education, where the use of technological resources by teachers is becoming increasingly inseparable from their practice.

In this scenario, constant challenges emerge that require teachers to adopt a critical, reflective, open attitude that is favorable to the synergy between technology and the teaching and learning processes. To this end, this convergence requires not only infrastructure and access, but above all, initial and continuing education that promotes the development of digital skills aligned with the demands of an ever-changing educational scenario.

As Marin and Penteado (2011) point out, the situation is even more fragile in undergraduate courses, especially with regard to the use of digital technologies in initial teacher education courses. This context is further aggravated by the resistance to using technologies that persists among teachers. According to Sancho (2006), the lack of motivation for professional qualification and the reluctance to break with traditional practices are obstacles that permeate the work of these professionals.

In this vein, Moran (2013) emphasizes that, although teachers may show a certain willingness to use TDIC and try to keep up with the rapid changes that make up the education process, they often face structural and education limitations, such as lack of infrastructure, lack of specific education, and work overload, which hinders the planning of technology-mediated practices. These professionals are hostage to methodologies centered on memorization and repetition, which creates uncertainty about how to transform their practices and introduce new

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pedagogical possibilities.

On the other hand, according to Siqueira, Molon, and Franco (2021), there is a progressive movement, mainly in initial teacher education courses, to promote the inclusion of TDIC at different moments and in different education activities. For the authors, educational institutions, in the search for a more consistent education of their graduates, have begun to incorporate competencies and skills related to technological integration into the Pedagogical Course Project, treating this theme as a cross-cutting axis linked to curricular activities.

This is, therefore, an institutional effort towards teacher education that is more consistent with the demands of contemporary education, in which technology plays a central role in mediating teaching and learning processes. In this sense, in this study, we aim to analyze excerpts from interviews with graduates of the Mathematics Degree course at Montes Claros State University (Unimontes), who graduated between 2020 and 2023[1], regarding their perceptions of the technological resources available in the course, and whether or not they were used by teachers and the reasons for this.

To this end, the paper is organized as follows: in addition to these initial discussions and final conclusions, there are three more sections. In the first, based on researchers who address the subject, we discuss the theme of technological resources in initial teacher education; subsequently, we present our methodological choice, namely Oral History and the voices of this study; finally, we analyze excerpts from the interviews with our respondents[2].

## 2 Technological resources in initial teacher education

According to Siqueira, Molon, and Franco (2021), the advancement of TDIC has impacted the processes of teaching, learning, and evaluating. In the specific context of initial teacher education, the integration of these technologies emerges as a contemporary requirement, while simultaneously presenting itself as a challenge to be faced by institutions and educators (Kenski, 2013).

According to Prensky (2001), 21st-century teacher trainees have been exposed to the digital universe from an early age, providing them with different tools and resources. Growing up in an environment permeated by these technologies, future teachers intuitively develop skills and familiarity with digital devices and platforms.

This technological immersion, which permeates their biological, social, and cultural experiences, can provide advantages in the processes of learning, interaction, and social integration, especially when there is critical awareness of the positive and negative effects of this incessant contact with the digital world.

However, higher education teachers, identified as *digital immigrants* (Prensky, 2001), were trained in contexts where access to digital technologies was limited or even non-existent, thus causing a divergence and maintaining the cycle of non-technological education of future teachers.

Because they may not have considered discussions about the pedagogical use of TDIC in their education, the influence of teachers' lack of understanding, use, and integration of these

[1] We justify the time frame (2020-2023) because 2020 was the beginning of the Covid-19 pandemic. Even though it is not an integral part of the analyses in this study, we use it as the initial historical milestone of the study. The year 2023 is the final milestone because graduates licensed in that year, hypothetically, chose to teach in 2024, the year the data was produced.

[2] In this paper, "we adopt the term *deponent* because we understand that it recognizes its active role in sharing memories, experiences, and perceptions, contributing directly to the construction of history. By focusing on the indicial paradigm, Italian historian Carlo Ginzburg shows us that testimony is a way of making and reconstructing stories, based on talking about and pointing out events that were part of the life of the person giving testimony, establishing and presenting evidence of the events of their life (or part of it), with the researcher listening to learn about them. In other words, the witness is the living witness who tells the story from their point of view" (Oliveira and Almeida, 2025, p. 3).

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technologies in their practices is a recurring issue. This generational and experiential difference highlights the need to (re)think education processes and teaching models, seeking a more effective approximation between the digital universe of teacher trainees and the pedagogical mediation of teacher trainers.

It is up to the teacher, as a subject in constant education, to critically evaluate and incorporate, whenever possible, different TDIC into their pedagogical practices. This incorporation must consider the multiple sociocultural and educational contexts in which it is inserted. In this process, it is necessary for teachers to develop or expand their digital competence focused on teaching.

More than technical mastery, it is about knowing how to use these technologies with discernment and pedagogical intent. In view of the educational changes driven by the arrival and use of digital technologies, it is imperative to recognize that teacher trainees also need to be prepared to act with digital competence in their teaching practice.

In this sense, education should encourage critical thinking about how different technological tools can mediate pedagogical practice. These discussions are central to the construction of a praxis more aligned with the current demands of society.

According to Siqueira, Molon, and Franco (2021, p. 46), "different terms and nomenclatures have been used in the literature to address the didactic-pedagogical capacities, abilities, and skills necessary for teachers to integrate TDIC into their classes". Terms such as *digital competence* and *digital fluency* have become commonplace in an attempt to measure the degree of engagement and technological appropriation by educators. These concepts have underpinned models that seek to understand the adoption of technologies in the educational context.

In this field, there has been an expansion of the model developed by Shulman (1986), which presented the articulation between pedagogical knowledge and mastery of specific content — entitled *Pedagogical Content Knowledge* (PCK). Technological dimensions were incorporated into this model, giving rise to *Technological Pedagogical Content Knowledge* (TPACK), developed by Mishra and Koehler (2006). This new model aims at an integrated understanding of teaching knowledge, including not only content and its pedagogical aspects, but also critical mastery of technology as a mediator of teaching and learning processes.

Still within this approach, Schneider (2012) proposes the concept of *technological-pedagogical fluency*, structured on three levels: technical, practical, and emancipatory. Technical fluency refers to basic instrumental mastery, such as handling equipment, using computers, and navigating Virtual Learning Environments (VLE). Practical fluency involves the ability to mediate pedagogy through technology, including the ability to use media resources strategically. The combination of these two levels gives rise to emancipatory fluency, which represents a more critical, creative, and transformative use of technologies in the educational process.

From this perspective, digital fluency is not limited to proficiency in the use of technological tools, but also encompasses cognitive skills focused on critical thinking in their use. Thus, integrating TDICs into teachers' work requires more than technical skills: it calls for a necessary constant (re)vision of pedagogical practice, in dialogue with the challenges and possibilities of today's digital culture.

## 3 Oral History and the *voices* of the study

The study is characterized as qualitative, of the case study type. Therefore, this section details the methodological procedures adopted, based on Oral History and focused on recognizing and valuing the *voices* of the interviewees. The excerpts from the narratives[3] analyzed refer to graduates of the Mathematics Degree course at Unimontes, who completed their education between 2020 and 2023. Attentive listening to these subjects allowed for the construction of a *corpus* of experiences, whose reports serve as a basis for understanding perceptions about the technological resources available in the course and their possible use in the context of the degree program.

According to Meihy (2005), Oral History is a methodological practice aimed at constructing narratives through the use of electronic devices, especially those related to the recording of testimonials. It is a structured set of procedures that begins with the formulation of a project, followed by the careful selection of the group of interviewees, and ends with the collection and transcription of the accounts.

This methodology represents a relevant alternative for social research, as it provides access to individual (or collective) experiences and memories, transformed into written documentation from oral records. Thus, Oral History is consolidated as a systematic process of knowledge production, anchored in listening to and valuing voices that often remain on the margins of historiography.

Thompson (1998) and Meihy (2005) consider Oral History to be a valid and consistent scientific method. Both authors argue that the accounts constructed through interviews — later transcribed[4] , textualized[5], and analyzed — offer unique interpretations of experienced events, allowing access to social reality from the perspective of the research participants. Thus, the testimonies not only complement other historical sources, but also enable the appreciation of individual and collective memory, revealing subjective and contextual dimensions that are often invisible in official data.

Oliveira and Almeida (2025, p. 6) discuss that Oral History is “a methodology employed in studies with testimonies from people, constructed through interviews planned and conducted in advance, with the aim of preserving and analyzing their past experiences and memories.” In this process, “there is a valorization of voices that were not previously included in official data, allowing for an understanding of the past from both a subjective and collective perspective of a given social group (Oliveira and Almeida, 2005, p. 6).

Thus, in this study, we worked with excerpts from narratives constructed from interviews, which were later transcribed and textualized. We then returned the writings to the interviewees so that the document could be validated by them and its use authorized through letters of assignment of rights.

The interviewees were selected based on our prior contact with each graduate[6] who completed the Mathematics Degree course at Unimontes between 2020 and 2023. The 17 graduates who agreed to participate in this study are presented in Table 1 below, which includes their names, the date, location, and duration of each interview.

Regarding the use of proper names, Rolkouski (2008, p. 66) asserts that “the preservation of the names of interviewees [is] a requirement of [Oral History], given its intention to constitute historical sources to be made available to other researchers”. At the time

[3] The narratives comprise “a homily in which voices come together in a foundation that sustains them, being the inevitable fruit of a loud, identity-affirming voice that seeks to say who is saying what and what they are doing” (Fernandes, 2014, p. 16).
[4] The transcription is “the raw and most reliable possible record of the statements of the witnesses, preserving the language vices and linguistic elements present in the narratives and dialogue” (Almeida, 2015, p. 57).
[5] Textualization “consists of organizing ideas in a logical sequence, omitting language vices and repeated statements, thereby promoting the organization of a coherent text articulated to the research questions” (Almeida, 2015, p. 57).
[6] We submitted a request to the General Secretariat of Unimontes, requesting information on these graduates, after the research was approved by the Ethics Committee for Research Involving Human Subjects. This research was approved by Opinion No. 6,832,524, dated May 17, 2024.

of the interview, participants were informed about the possibility of having their names included in the research. For those who did not allow their names to be published, we honored important figures in the field of Mathematics.

Table 1: Interview data

| Graduate's name | Date | Location | Duration |
|---|---|---|---|
| Igor Soares Santos | September 28, 2024 | Google Meet[7] | 1h 18min 55s |
| Luiz Fernando Saldanha Vieira | 09/29/2024 | Google Meet | 1h 27min 46s |
| Ada Lovelace[8] | September 30, 2024 | Google Meet | 59 min 27 s |
| Saulo Henrique Furtado Leite | October 2, 2024 | Google Meet | 1h 23min 13s |
| Welber Paraizo Ferreira | 10/02/2024 | Google Meet | 1h 10min 46s |
| Giovanna Souza Rodrigues | 10/04/2024 | CCET[9] | 1h 51min 05s |
| Samuel Scarcela e Souza | 10/04/2024 | CCET | 1h 02min 26s |
| Pedro Quintino da Silva Neto | 10/04/2024 | Google Meet | 43 min 19 s |
| Jadde Thaine dos Santos Oliveira | 10/05/2024 | Google Meet | 1h 13min 55s |
| Maria Luiza Gomes | 10/05/2024 | Google Meet | 57 min 08 s |
| Dyanna Ramos Fiel | 10/07/2024 | Google Meet | 1h 09min 04s |
| Tiago Henrique Dias | October 8, 2024 | Google Meet | 1h 14min 38s |
| Marcio Henrique Ferreira de Oliveira | 10/16/2024 | Google Meet | 2h 27min 36s |
| Sophie Germain[10] | 10/19/2024 | Google Meet | 51 min 12 s |
| Alysson Patrick Vieira Santos | 10/23/2024 | Google Meet | 1h 18min 23s |
| Isaac Newton[11] | 10/26/2024 | Google Meet | 2h 53min 05s |
| Emmy Noether[12] | November 3, 2024 | Google Meet | 2h 05min 24s |

Source: Own elaboration

## 4 Technological resources and their (possible) use

In this section, excerpts from the interviews are presented, selected in accordance with the objective of this study. Based on a careful reading of the 17 texts produced, it was possible to identify the analytical category *Technological resources and their (possible) use*, which will

[7] We emphasize that the interviews conducted through the Google Meet application took place at the request of the interviewees.
[8] The participant did not authorize her name to be published in the research. Therefore, her code name will be Ada Lovelace. According to Morais (2024, p. 6), “Ada Lovelace is recognized as a crucial figure in the history of Mathematics, especially in the context of computing. She is known for her significant contributions to the understanding and development of Charles Babbage’s analytical engine, a machine designed in the 19th century that is considered a precursor to modern computers.”
[9] Center for Exact and Technological Sciences, located in Building 3 on *the* Darcy Ribeiro *campus* of Unimontes.
[10] The participant did not authorize her name to be published in the research. Her code name will be: Sophie Germain. According to Hall, Jones, and Jones (2004), Sophie Germain was a French mathematician who, due to the restrictions imposed on women in her time, adopted a male name to pursue her studies in Mathematics. She devoted herself to the field of Number Theory, her most notable contribution being the formulation of the numbers called *Germain primes*, in which she demonstrated the validity of Fermat's Last Theorem for prime numbers.
[11] The participant did not authorize the publication of their name in the research. Therefore, their code name will be: Isaac Newton. According to Moraes, Barroso, and Rosa (2020, p. 3, emphasis added) Newton is considered one of the greatest mathematicians and the most influential scientist in the history of science. He “formulated the theorem known as Newton's Binomial Theorem, wrote about infinite series (the embryo of differential and integral calculus), built the first reflecting telescope, among other achievements. His main work was *Mathematical Principles of Natural Philosophy* (*Principia*), considered one of the most influential in the history of science”.
[12] The participant did not authorize her name to be published in the research. Therefore, her code name will be Emmy Noether. According to Patrão (2016, p. 1), “Emmy Noether was considered the most important woman in the history of Mathematics by, among others, Pavel Alexandrov, Herman Weyl, Norbert Wiener, and Albert Einstein himself. She simply changed the face of modern algebra, having revolutionized the theories of rings, fields, and algebras”.

be discussed based on the methodological proposal of the analysis of convergences and divergences.

This approach requires the researcher to carefully observe the data, identifying both recurring elements and those that differ from each other, that is, seeking convergences and divergences in the statements. In this context, the narratives of the interviewees will be examined in light of the similarities and contradictions that emerge from their statements, allowing for a broader and deeper understanding of the meanings attributed by the participants to the theme under investigation.

According to Lacerda (2017, p. 19), "technology has always been present in human development, from the origin of the species to the present day", and each period of civilization carries technological milestones that defined it. Education is no different; technological resources are increasingly used in classrooms because their use promotes "new forms of interaction, communication, and representation of knowledge, opening new perspectives for teaching and learning processes and defining new roles for educators" (Spagnolo and Mantovani, 2013, p. 3).

For Bonilla (2011), the initial teacher education process should involve, in an articulated manner, technological content, digital education for teachers, and the production of knowledge through technology. For this, there must be technological resources in the course, such as computers, digital whiteboards, internet access, educational *software*, and AVA, as well as a curriculum that includes them, in addition to instructions for using technological tools.

Given this, in this category, we analyzed excerpts from the interviewees who reported their perceptions and experiences regarding the technological resources available to them in the Mathematics Degree Course at Unimontes, and their possible use during classes by teacher trainers.

> [13]*For me, the technological resources that the teachers used and that were available were sufficient. The classrooms were equipped with projectors, there were laboratories with computers, and there was also a Mathematics Education room* (Excerpt from the testimony of Igor Soares Santos).
>
> *For me, the technological resources were sufficient, as the teacher education course does not require many technological resources. Although I like a lab that has working computers, with internet access and GeoGebra, LaTeX, and some programming software, I think it's okay* (Excerpt from the testimony of Saulo Henrique Furtado Leite).
>
> *I would say that the technological resources we used during the course were sufficient. It just depended, because we shared the computer labs with three or four other courses, so they weren't always available* (Excerpt from Samuel Scarcela e Souza's statement).
>
> *Regarding the technological resources used and available in the course, in my view, for the practical classes we have in our course, the computer labs are sufficient. When we needed to see something practical in the Physics subjects, we went to the lab in building 2* (Excerpt from the testimony of Maria Luiza Gomes).
>
> *I believe that the technological resources, in my opinion, were sufficient to train a teacher. We basically used GeoGebra, LaTeX, and the computer. And I think they are sufficient. For me, there was no need for any other fancy resources, but if there were, it would be cool* (Excerpt from the testimony of Marcio Henrique Ferreira de Oliveira).

Converging with each other, the five statements above highlight that the technological

[13] We clarify that, from now on, all excerpts from our collaborators' testimonials will be written in italics to emphasize their narratives.

resources available in the course were sufficient for the teacher education process and for the demands of the course. However, it is possible to infer that, although the existing resources met the needs of the course and the subjects, in the graduates' view, they affirm that the provision of other technological tools could contribute to the teaching and learning processes.

Specifically for Igor, the fact that the classrooms were equipped with projectors and the laboratories had computers would already guarantee the technological education of teachers. Saulo, on the other hand, presents a pragmatic view that teacher education courses do not need many technological resources. Samuel highlights the high demand for computer labs, which may be a factor that limits their use by teacher trainers. Similar to Saulo's view, Marcio reaffirms the use of *software* such as GeoGebra and LaTeX in his education, stating that there was no need for a *"fanciful resource"*.

However, simply using technology does not significantly alter the physical spaces of classrooms or the dynamics used to teach and learn (Kenski, 2012, p. 87). In this sense, it is not enough to simply have adequate infrastructure in institutions and for teachers and academics to know how to use it, even if only superficially. It is necessary to discuss how and for what purposes digital technologies should be integrated into classes, as Cervera, Martínez, and Mon (2016) also point out. Regarding the non-use of technological resources, Luiz, Ada, Sophie, and Emmy add the following:

> *I believe that in terms of technological resources, the course has the necessary equipment. All classrooms have televisions, there are computer labs with working computers, there is a physics lab, where I have already had practical classes. So, in terms of resources, I think it is well equipped, and teachers should use them more often* (Excerpt from the statement by Luiz Fernando Saldanha Vieira).
>
> *I think the technological resources available were sufficient. The classrooms had projectors, then televisions were added, we had computer labs with computers, and sometimes the internet, which wasn't very good, but it was there. Generally, the teachers didn't use these resources very much* (Excerpt from Ada Lovelace's statement).
>
> *The undergraduate program has good resources, which are sufficient for classes. The problem is that they are not always used. At least in Mathematics Education classes they were used, but in Pure Mathematics classes, not so much. It is very difficult to find, for example, a Calculus teacher who will teach limits in practice using a technological resource. Generally, academics do not find this. For the teacher, teaching this subject is only done using a blackboard and chalk* (Excerpt from Sophie Germain's statement).
>
> *[...] the question of technological resources, whether they are sufficient or not, I think that initially we have to consider that some of the teachers on the course are from the mid-2000s, they have been there for a while, and at that time technological resources were not so present in their lives. So, we can see that there are teachers who are somewhat afraid to use technological resources. And we can observe that, for example, in Calculus, which is visual, technology could help with visualization, but teachers do not use it. And it is not because there is no computer lab, because there is, but many of them do not want to use it* (Excerpt from Emmy Noether's statement).

In the testimonials presented by the four graduates, it is possible to identify three convergences, namely: the availability of technological resources, the lack of use, and the teachers' fear of using them in class. Although the interviewees acknowledge that the course has adequate infrastructure in terms of equipment, such as televisions, computer labs with working machines, and a physics lab, there is also criticism of the fact that these technological resources are not widely used, especially in Calculus classes[14], as Sophie and Emmy point out. For these graduates, having technology combined with the subject would help in learning concepts such as limits, for example.

The subject of Calculus, mentioned by the interviewees, is traditionally based on “presentations and solving exercises. However, research in Mathematics Education has shown that more interactive and engaging approaches tend to promote understanding of the content” (Oliveira and Lopes, 2024, p. 12). Teaching practices that use, for example, GeoGebra[15] can aid in student learning, as this *software* helps “make abstract concepts more concrete, allowing students to visually experience mathematical principles interactively” (Oliveira and Lopes, 2024, p. 13).

The four testimonials analyzed above shed light on a question: Did teacher trainers receive technological education to use such resources in their classes? — since, according to Santos (2021, p. 113), “you only teach what you know”. In view of this, Kenski (2012, p. 57) points out that one of the challenges teachers face in using technological resources is due to a lack of knowledge about them, since teachers “are not trained in the pedagogical use of technologies”.

In this vein, Fonseca and Santos (2022, p. 83) reveal that “sometimes, discussions about digital technologies are not part of initial teacher education courses, which in itself interferes with the way teachers relate to these resources”. Regarding the lack of infrastructure, Giovanna, Tiago, Jadde, and Alysson assert:

> *Basically, the technological resource available to the course is the laboratory. In my opinion, I don't think it was sufficient, but in some of the subjects I took, for example, Applied Computer Science in Mathematics, even though the institution's resources were insufficient, I saw that the teacher tried to bring in several other examples of technological resources for us to use in the classroom. Therefore, even though it was not sufficient, some teachers managed to broaden our horizons for the use of these resources* (Excerpt from the testimony of Giovanna Souza Rodrigues).
>
> *In my day, the technological resources available in the course were not sufficient. But I think it has improved today. In my day, it was much less. For example, not all computers worked, and the projector failed a lot. Today, it seems to me that there is a television in the classroom, which is very good. The internet was not good for doing research in some subjects that required it* (Excerpt from Tiago Henrique Dias' statement).
>
> *As for technological resources, in math classes, it was practically only GeoGebra that some teachers used, but it was a bit rare. In more practical subjects, we used the labs* (Excerpt from the testimony of Jadde Thaine dos Santos Oliveira).
>
> *In my day, technological resources were not good or sufficient, but I know that things are changing now. When I was there, we basically only used GeoGebra and had some contact with Mathlab, but it was very superficial, without any depth. Some teachers tried to bring in this technology, for example, Professor Hypatia of Alexandria*[16] *, who once gave a trigonometric*

[14] The graduates who mention Calculus refer to Differential and Integral Calculus, studied in three subjects: Differential and Integral Calculus I, II, and III, as presented in the Pedagogical Project of the Mathematics Degree Course at Unimontes.

[15] GeoGebra “is a tool that integrates Geometry, Algebra, Calculus, and other areas of Mathematics in a dynamic and interactive environment. It allows students to explore mathematical concepts in a visual and manipulative way, which can make the abstract topics of Calculus more tangible, visual, and accessible. In addition, GeoGebra offers the opportunity to investigate and visualize relationships between different mathematical concepts, promoting a deeper understanding of the content" (Oliveira and Lopes, 2024, p. 13).

[16] We emphasize that the names mentioned by the interviewees during the interviews were identified with code names of important figures in Mathematics in order to protect their identity. According to Morais (2024, p. 3), “considered the first known female mathematician, Hypatia contributed to geometry, algebra, and astronomy. Her work and teachings were fundamental to the development of Mathematics in antiquity.”

> *cycle class to my class using GeoGebra, which I still remember today. So, I believe that more classes involving technology are needed, as it helps a lot* (Excerpt from the testimony of Alysson Patrick Vieira Santos).

The testimonials of the four graduates, diverging from the others, reveal their experiences with the technological resources available in the course, expressing the lack of infrastructure, but also revealing the individual efforts of teachers who, even with the limitations imposed, valued the expansion of the use of technologies in the teaching and learning processes, as pointed out by Giovanna and Alysson.

Alysson's account allows us to converge with the testimonies of Luiz Fernando, Ada, Sophie, and Emmy, concluding that teachers made little use of technological resources in class. Alysson's testimony also expresses his perception that technology combined with the teaching of mathematical concepts aids student learning.

The statements analyzed in this category present the perceptions of graduates of the Mathematics Teaching Degree Course regarding the use of technological resources available in the course. The narratives show both convergences and divergences: while five graduates stated that the available resources were sufficient for classes, eight revealed the poor technological structure of the course and even the limited use by teachers, despite evidence that using technology could help, for example, in the learning process in subjects such as Differential and Integral Calculus, studied during the course.

## 5 In conclusion

Based on the analyses carried out and discussed in the previous section, we summarize our final considerations, successfully achieving our objective, which was to analyze excerpts from interviews with graduates of the Mathematics Degree course at Unimontes, who graduated between 2020 and 2023, regarding their perceptions of the technological resources available in the course, and whether or not they were used by teachers and the reasons for this.

The analysis of the narratives revealed contrasting perceptions regarding the availability and, above all, the use of technological resources by teacher trainers throughout the initial education of graduates. Although some of the respondents, five, considered the infrastructure offered to be satisfactory, highlighting the use of projectors, televisions, and laboratories equipped with *software* such as GeoGebra and LaTeX, others, eight, emphasized the underuse of these resources by the teaching staff, especially in pure Mathematics subjects, such as differential and integral calculus, which could have technology as an ally and mediator in the teaching and learning processes.

Therefore, we can infer that the presence of technological resources alone does not ensure education that is consistent and aligned with the challenges of contemporary education. The use of TDIC must be linked to intentional pedagogical practices capable of transforming traditional methodologies int[17], and promoting more interactive learning.

To this end, there is an urgent need to invest in the technological and pedagogical education of teachers who work in undergraduate programs, education teachers so that they can use the available resources in a critical and contextualized manner, assisting in the teaching and learning processes.

Thus, we conclude that the challenge of integrating digital technologies into initial teacher education goes beyond infrastructure: it is a process that requires public education

[17] We understand, as already pointed out, that traditional methodologies, based on memorization, are those in which the student assumes a passive role as a receiver of information, while the teacher acts as a mere transmitter of knowledge.

policies, curriculum restructuring, and the development of digital skills by teacher trainers. We hope that with this set of actions, it will be possible to train teachers capable of acting critically and autonomously in the face of 21st-century demands, promoting a Mathematics Education that is more connected to technological reality.

This study contributes to the understanding of the possible use of technological resources in initial teacher education, based on the perceptions of graduates of the Mathematics Degree course at Unimontes. However, like any study, this one also has limitations that need to be considered.

One of the limitations concerns the sample used in the production of data: the number of participants may restrict the scope of the conclusions, making them specific to the reality investigated. In addition, the focus on a single institution, Unimontes, limits the possibility of generalizing the findings to other Mathematics Degree courses, whose curricular structures and institutional conditions may be different.

Another aspect to be considered is the subjective nature of the information collected. Thus, even though the analyses achieved the proposed objective, the results reflect a focused and subjective perspective, which may not represent the totality of the experiences lived in the course.

Given these limitations, proposals for future research in the field of Mathematics Education can be indicated. First, we suggest expanding the sample to include a larger number of participants, preferably graduates from different higher education institutions, to allow for a comparative and representative analysis of the national reality.

Furthermore, it would be interesting to investigate the technological education of teacher educators, seeking to understand how their conceptions, beliefs, knowledge, and pedagogical practices influence the integration of digital technologies into Mathematics teaching. Studies that explore new curriculum proposals, the impact of public policies on teacher education, and the development of specific digital skills for Mathematics teaching are also promising horizons.

## Conflicts of Interest

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

## Data Availability Statement

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

## Note

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