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The use of GeoGebra software in the initial training process of mathematics teachers: a case study with undergraduate students of the mathematics teacher education program at IFCE[1]

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ABSTRACT

This study aims to reflect on the use of GeoGebra software as a methodological possibility and its contribution to teaching practices in the initial training of Mathematics teachers. The work was developed based on qualitative research principles, employing the case study method and using a questionnaire as a tool for data collection. The research results highlight the importance of using technological tools in the training process and how they can assist in improving aspects related to teacher identity and professional development. These tools influence the process of rethinking practices, fostering critical thinking, and allowing reflections on issues surrounding the process of discovery.

KEYWORDS: GeoGebra; Initial Training; Mathematics Teacher.

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O uso do software GeoGebra no processo de formação inicial de professores de Matemática: um estudo de caso com discentes de Curso de Licenciatura em Matemática do IFCE

RESUMO

O presente trabalho tem por objetivo refletir sobre a utilização do software GeoGebra como possibilidade metodológica e sua contribuição em práticas de ensino na formação inicial de professores de Matemática. O escrito foi desenvolvido a partir de pressupostos da abordagem qualitativa, utilizando como método de pesquisa, o estudo de caso e como instrumento para a construção de dados, recorreu-se a utilização de questionário. Os resultados da pesquisa, apontam para a importância do uso de ferramentas tecnológicas no processo formativo e o quanto podem auxiliar na melhoria de aspectos inerentes a identidade docente e ao desenvolvimento profissional, na medida que, implicam no processo de reelaboração de práticas, possibilitando criticidade e permitindo reflexões sobre questões que permeiam o processo de descoberta.

PALAVRAS-CHAVE: GeoGebra; Formação inicial; Professor de Matemática.

El uso del software GeoGebra en el proceso de formación inicial de profesores de matemáticas: un estudio de caso con estudiantes de la curso de matemáticas del IFCE

RESUMEN

El presente trabajo tiene como objetivo reflexionar sobre el uso del software GeoGebra como una posibilidad metodológica y su contribución a las prácticas docentes en la formación inicial de profesores de Matemáticas. El estudio se desarrolló a partir de los supuestos del enfoque cualitativo, utilizando el estudio de caso como método de investigación y empleando un cuestionario como instrumento para la recopilación de datos. Los resultados de la investigación destacan la importancia del uso de herramientas tecnológicas en el proceso formativo y cómo estas pueden contribuir a la mejora de aspectos relacionados con la identidad docente y el desarrollo profesional, ya que influyen en el proceso de reelaboración de prácticas, fomentan la criticidad y permiten reflexiones sobre cuestiones que atraviesan el proceso de descubrimiento.

PALABRAS CLAVE: GeoGebra; Formación Inicial; Profesor de Matemáticas.

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Introduction

With the advancement of technologies in the global context, education has undergone a series of changes and redefinitions of educational practices, thus developing new approaches to propose the construction of knowledge for students. In this context, educational software emerged as a means of enhancing teaching and learning processes.

According to Silva, Pitangui, and Oliveira (2020), software can be defined as computer resources used in the learning context, enabling, to some extent, innovative, engaging, and even challenging teaching practices. Thus, it becomes possible to explore the world, fostering creativity and assisting in the initial training process.

In this sense, different methodological possibilities tied to teaching practices, as evidence suggests, are of paramount importance in all educational domains, as they enable the provision of more dynamic teaching.

With regard to Mathematics education, there is an urgent need to seek educational tools that can assist in the construction of knowledge, demystifying the notion that this subject is inherently difficult or a "black hole" that distances students from the object of study. Mathematics is often considered difficult by students due to teaching and learning approaches centered on formulas without real meaning (Franzin *et al.*, 2021).

In the field of Mathematics Education, it is observed that teaching this subject becomes more dynamic when applied to students' daily lives. This enables a broader view of the entire educational context, as it immerses students in various possibilities for learning to take place. According to Ponte, Brocardo, and Oliveira (2016), the active involvement of students is a substantial condition for the learning process, allowing the promotion of mathematical development at different levels of association.

Regarding Geometry, one of the greatest challenges for teachers and students concerns teaching and, consequently, learning approaches—how

these contents should be taught. As pointed out by Santos, Alves, and Lima (2023), these difficulties are centered on methodological strategies and the need to provide opportunities for geometric visualization from the perspective of knowledge construction by students.

From a didactic perspective, GeoGebra was created in 2001 as part of Markus Hohenwarter's thesis at the University of Salzburg. The software presents itself as a methodological proposal that can assist in the development of geometric constructions, which, to some extent, facilitates the understanding of topics that, theoretically, are often insufficient for developing geometric knowledge.

With the aid of GeoGebra, students, among other aspects, can dynamically visualize "[...] demonstrations and examples of mathematical content, enabling conceptual understanding and stimulating students' interest and curiosity" (Lima; Tomaz, 2022, p. 64), which are key elements for acquiring geometric knowledge.

Abar and Almeida (2017) emphasize that the use of the software should not be considered merely a technological resource but rather a tool that contributes to the teaching and study of mathematical concepts. However, they caution that GeoGebra, by itself, does not create Mathematics. It is understood that the resource serves as an important support for learning, aiming to address mathematical content with greater detail and allowing students to better visualize graphic and algebraic elements.

With these prerogatives, the research was guided by the following central question: What is the importance of the GeoGebra software in the initial training process of Mathematics teacher education students?

The study proves relevant due to the opportunity to address discussions on the use of GeoGebra as a methodological possibility for students in a Mathematics teacher education program, particularly in Geometry content. It considers processes that can assist in the construction of geometric knowledge, such as the use of educational software and engaging lessons that allow students to relate the content to real-life situations.

Reinforcing this perspective, Pacheco (2019) mentions that a learning environment can be created through the use of diverse tools, offering students a more dynamic teaching/learning experience as well as fostering autonomy and creativity.

Thus, the study aims to reflect on the use of GeoGebra software as a methodological possibility for teaching and learning mathematics and its contribution to the development of pedagogical practices in the initial training of Mathematics teachers.

The use of GeoGebra software in mathematics teaching

Although the technological development process has a historical milestone spanning years, this topic has recently gained prominence in the educational context. This is because technologies have "[...] had a significant impact on practically all segments of our society, our lives, and, above all, on the development of scientific knowledge and advances in science" (Almeida; Valente, 2012, p. 58).

In this sense, debates about the use of technologies aimed at education have become recurrent, especially regarding the urgency of changes in teaching perspectives to address classroom dynamics. The view is that mechanized, repetitive processes and endless lists of exercises seem insufficient for acquiring knowledge.

While this wave of technology enters educational environments, attention is needed regarding how this integration occurs. However, it is essential to remember that schools and teachers must prepare for this advancement. This scenario has impacted the educational configuration, which now demands more agility from professionals and institutions concerning teaching and learning processes, without compromising the desired quality in these processes.

The use of these technologies requires continuous teacher training to acquire knowledge that will assist them in their professional journey.

Therefore, discussions on this topic within the contours of the educational field are necessary, as the teacher's role will be to mediate knowledge in the classroom, fostering learning moments with a focus on the use of these tools.

When looking at mathematics, it becomes evident that this technological revolution greatly contributes to the development of teaching, as it brings the discipline closer to the current context. According to Sá and Machado (2017):

> The use of technologies in the classroom has become a tool of great importance, as it assists both teachers and students in explaining and understanding the content. With technology in the classroom, students feel more motivated to learn, and as a result, teachers can teach in a more dynamic and creative way (Sá; Machado, 2017, p. 1).

With the aim of enhancing mathematics education and moving away from a mechanized and abstract teaching approach to a more accessible language, technological resources tend to make students protagonists of their own knowledge, fostering greater autonomy.

In this context, the use of educational software as a methodological tool to support teaching has become indispensable in promoting greater interactivity and participation in the learning process, offering numerous advantages for both students and educators.

In light of this, it is understood that the emergence of educational software aimed at teaching is of utmost importance for the development of student learning. However, "[...] software alone does not promote learning; it connects thoughts, but the teacher's pedagogical role becomes fundamental and is redefined in this new social context permeated by new technologies and information" (Silva; Pitangui; Oliveira, 2020, p. 4).

In this context, GeoGebra emerged in 2001 as a free mathematical software for all levels of education, encompassing Geometry, Algebra, Calculus, and Statistics content. It proposes new teaching and learning

strategies, enabling the exploration, conjecture, and investigation of these topics in the construction of mathematical knowledge.

It is inevitable to discuss teacher training without mentioning teaching methodologies for constructing mathematical knowledge. In this context, in recent years, GeoGebra has become an essential software "[...] for Mathematics teachers and students; however, like digital technologies in general, it is still underutilized as a pedagogical resource in teacher training courses" (Silva; Zamperetti, 2021, p. 3).

It is also believed that there is a deficit in the integration of technological resources in Mathematics teacher education programs. Silva and Zamperetti (2021), when analyzing these spaces for the training of Mathematics teachers, assert that "[...] specific content in the field occupies just over 30% of the total course workload, on average. Included in this is 1.7% of the workload allocated to knowledge related to technologies" (Silva; Zamperetti, 2021, p. 4). Additionally, there is an almost complete absence of the use and training of future teachers grounded in technologies and the curricula that make up formative subjects (Silva; Zamperetti, 2021).

However, the importance of incorporating educational software to support the teaching of mathematics is evident. As such, "[...] it is necessary to create spaces where teachers can learn to work with such resources, feel comfortable, and have the 'confidence' to reflect and discuss their use" (Cyrino; Baldin, 2012, p. 44). These technological resources are important for the training process of future mathematics teachers, envisioning more dynamic lessons aimed at improving students' learning.

Thus, preparing lessons, seeking innovation, and improving teaching practices are essential aspects of the teaching profession. From this perspective, Freitas *et al.* (2014, p. 130) highlight that planning and selecting "[...] activities is significantly important for teacher training programs to achieve certain objectives, such as rethinking their own classroom methodologies, integrating technology into lessons, and enriching the teaching of mathematics".

In this regard, GeoGebra emerges as a tool that can facilitate and contribute to the development of teaching practices with greater meaning for students. This is because the use of "[...] GeoGebra as a pedagogical resource, used collaboratively by students, complements traditional lessons" (Silva; Zamperetti, 2021, p. 10).

Therefore, GeoGebra is an important resource for teachers and should be integrated into the classroom context, as it can contribute to the learning of mathematical content. It is necessary to raise teachers' awareness "[...] regarding its use and in planning that establishes objectives and directs the actions to be developed in the classroom". Moreover, "[...] understanding the resource should be a fundamental premise for its use in a classroom context" (Gonçalves; Lima, 2020, p. 1069).

Methodological procedures

This study was developed based on the perspectives of a qualitative approach, as "[...] as a research exercise, it is not presented as a rigidly structured proposal; it allows imagination and creativity to lead researchers to propose works that explore new possibilities" (Godoy, 1995, p. 23).

The research method used is a qualitative case study, which, according to Yin (2005, p. 32), "[...] is an empirical investigation that examines a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and the context are not clearly defined". Corroborating this, Gil (1999) mentions that this method consists of an in-depth study that allows for extensive detailing of knowledge. Yin (2005) highlights that a case study can be single or multiple, emphasizing that the researcher can investigate a single factor (unit) or analyze multiple units.

As for data collection, the questionnaire was used as an instrument, "composed of an ordered series of questions that must be answered in writing and without the presence of the interviewer" (Marconi; Lakatos, 2003, p. 201).

It is believed that this approach provides the research participants with more autonomy and freedom to express their opinions on the subject.

It is worth noting that the questionnaire consisted of four open-ended questions, allowing for the collection of more precise data focused on the research proposal. The logic outlined by Gil (1999) was applied, emphasizing the importance of using the "funnel technique", starting with general questions and then progressing to more specific ones, thereby avoiding any discomfort for the participants. It is also important to highlight that, for this research to take place, the participants signed an informed consent form (ICF) to ensure complete clarity regarding any risks or discomforts that might arise from the research questions and to address ethical considerations.

TABLE 1: Questions used in the questionnaire instrument.

QUESTIONNAIRE
1. Describe your academic journey, highlighting aspects of your education, exploring your entry into the teacher education program, and your perceptions of educational software in mathematics teaching.
2. In your experience as a basic education student, what are your perceptions, as a future teacher, about the practices involving the use of educational software in basic education and its contribution to the initial training process of mathematics teachers?
3. GeoGebra software was created to introduce new teaching and learning strategies for mathematical content. In this sense, have you had contact with this software? What is your perception of using this methodological tool in mathematics classes?
4. What is the importance of GeoGebra software as a methodological possibility and its contribution to the initial practices of mathematics teachers?

Source: Prepared by the authors (2024).

The research participants were second-semester undergraduate students enrolled in the Mathematics Teacher Education program, specifically in the Mathematics Laboratory course, at a campus of the Federal Institute of Education, Science, and Technology of Ceará (IFCE, acronym in Portuguese). The choice of this group was based on the need to understand how students at the beginning of their teacher training program perceive the importance of methodological possibilities to support their teaching practice, focusing on the use of GeoGebra in Geometry teaching.

In this study, to ensure ethical compliance and maintain confidentiality in the handling and analysis of the data, the participants were identified as Student 1, Student 2, Student 3... Student 10. This approach was adopted to protect the identities of the students involved in the research.

The data collected throughout the methodological proposal were tabulated using Bardin's (2016) content analysis, which consists of three phases: Pre-analysis; Material exploration, categorization or coding; and Treatment of results, inferences, and interpretation.

Through data tabulation, analysis axes were identified based on recurring ideas presented, generating a central discussion axis titled "Considerations on GeoGebra software and its importance in teaching practice". From this formulation, we will discuss formative aspects inherent to GeoGebra from the perspective of its methodological potential.

Considerations on GeoGebra software and its importance in teaching practice

Freitas *et al.* (2014) emphasize the significance of new technologies, highlighting the evident technological advancements and the necessity for future teachers to be qualified to work with these new technological tools. In this regard, technological advancement has made discussions about teaching methods increasingly relevant, being considered a fundamental aspect of the formative process for future educators.

In mathematics teaching, this context can become an essential bridge between knowledge and students, as “we must learn to teach our students” (Student 1). Similarly, Student 2 mentions that “as a student in the Mathematics Teacher Education program, future teachers need to stay updated on advancements in mathematics teaching technologies so that they can facilitate students' understanding”.

In agreement, Freitas *et al.* (2014) add that for new generations and future teachers, technology will require the inclusion of computational tools “[...] and the understanding of the meanings, capabilities, and limitations of technologies” (Freitas *et al.*, 2014, p. 128). Along these lines, Student 7 mentions that the lack of engaging lessons often alienates students from the subject of study.

> When you are a child, the lack of software and the lack of "options" to stimulate Basic Education leads many students to not want to engage with or study the subject. Many say they hate it. Perhaps with such resources, more people would feel motivated to study and become Mathematics teachers. (Student 7)

Broadly speaking, another relevant aspect mentioned is the low number of professionals opting for a teaching degree, often based on the idea that it is a challenging and unattractive profession. The lack of appreciation for educators is also a concern, and the perception that teacher education is merely the “last resort” in a university journey further exacerbates the issue. Santos, Loreto, and Gonçalves (2010) contribute by suggesting that the use of educational software can effectively aid in knowledge acquisition, benefiting both students and teachers.

The authors affirm that such software “[...] helps increase organization, concentration, and attention in the classroom, thus leading to more meaningful learning” (Santos; Loreto; Gonçalves, 2010, p. 62). Student 7 believes that technologies “should not only facilitate but also bring a new way

of enabling knowledge acquisition without being a 'monologue', where only the teacher speaks and the students merely take notes" (Student 7).

In this context, a key consideration arises: mechanized processes that do little to assist in the construction of mathematical knowledge. It is important to emphasize that this work does not aim to legitimize only new teaching methods but also considers preexisting approaches as highly relevant, alongside the adoption of new frameworks to complement the teaching process. Thus, "[...] it will be essential for such educational software to promote not only exploration and observation but also experimentation, creation, and the acquisition of new knowledge" (Santos; Loreto; Gonçalves, 2010, p. 63). In this sense, educational software can make it easier to understand "difficult" topics.

From this perspective, Student 3 mentioned something extremely relevant: "there is no point in using something without a previously established plan". Planning becomes an essential step for the effective use of technologies in the classroom. First, the content must be presented in its essence, and then these resources can be used to facilitate understanding.

According to Silva, Pitangui, and Oliveira (2020), "[...] educational software needs to be investigated and applied as a resource to enhance learning, giving students a voice and allowing them to take the lead in the learning process" (2020, p. 2). Regarding the use of educational software in the teaching process, students provide important perspectives on its application.

> I believe that the use of software in teaching, both in basic education and in teacher training, is beneficial for students, as it provides more practical and easier learning. For teachers, I believe that any playful way of teaching mathematics is valuable. (Student 1)

> Educational software in mathematics teaching, in my opinion, is an excellent option and a tool that assists us in education. Besides bringing a different dynamic to the classroom, it also leverages technology in our favor. (Student 4)

> There is a dichotomy regarding the use of technologies at home and in school, considering that teachers could use the same technologies in the school context for educational purposes. This might be unfamiliar to students, who use cell phones, computers, or the internet at home mainly for entertainment—casual and unstructured use with no commitment to knowledge construction. However, these uses are recognized as learning opportunities. (Gonçalves; Lima, 2020, p. 1064).

Demystifying the perception that technology is a barrier in teaching, or that students become disconnected from the main subject due to excessive use, is key. The term "addiction" will not be the focus of this study. It is understood that when technology is used consciously under teacher mediation, it can contribute positively to the topic. It allows for teaching that is more aligned with students' realities and, in a way, supports the development of their identity construction and professional growth, particularly considering the teacher education students involved in the process.

In this sense, it is understood that educational tools, as a possibility for teaching, provide dynamism "[...] that can be used for students to work as researchers, investigating the mathematical problems proposed by the teacher and constructing solutions instead of waiting for a model to follow" (Lima, 2009, p. 36).

Student 5 makes an important remark, pointing out the need for institutions to be structurally prepared for the integration of these technologies. They note that "the only concern would be regarding its implementation in schools because not all institutions have good infrastructure".

From this perspective, the future teacher observes that the use of technologies in their field of work – schools – seems to be subject to various challenges, primarily due to a lack of infrastructure and educational investment. It is worth noting that some schools lack

computer labs, and even when they do exist, many computers are often defective. This is concerning, as it greatly limits teachers' actions instead of integrating technologies into teaching.

Corroborating this perspective, Oliveira and Cunha (2021) affirm that:

> There are many obstacles that prevent teachers from using technological resources, among them the lack of specific training and the fact that schools do not provide computer labs. Worse still, public schools often have poor basic infrastructure, sometimes even lacking electricity, which makes it truly unfeasible to conduct lessons with technological resources. (Oliveira; Cunha, 2021, p. 1).

The experience of Student 5 seems to have been shaped by these adverse situations, but they still highlight the importance of using such software in the teaching process, stating that "the software only adds value to teaching".

In this regard, Franzin *et al.* (2021) argue that the wide variety of available software allows for diverse approaches in mathematics teaching. Beyond serving as a mediator and facilitator of learning, it also becomes a significant promoter of interdisciplinarity. Supporting this same perspective, Student 6 emphasizes the importance of incorporating these tools into mathematics teaching, stating that using software "facilitates the application of subjects, increasing the possibilities for creating and solving mathematical problems".

Thus, the potential use of tools can add value to the training process, as Monteiro and Silva (2023) mention. Software can act as a facilitating resource, and beyond that, it can positively impact student motivation and simplify the problem-solving process. It is evident how the use of these tools can become invaluable aids in the teaching and learning process.

That said, it is relevant to consider how the subject of mathematics is being approached. Moreira (2014) points out that in practice, multiple methods and problems are used, often met with significant disinterest when students:

> […] show disdain for the subject, based on frequent complaints from teachers. For students, mathematics classes consist of mere definitions, concepts, demonstrations of formulas, and results that, for them, hold no meaning. (Moreira, 2014, p. 10).

In this regard, Student 8 agrees with this perspective, stating that the integration of such software can make a difference in classes, given that students often consider mathematics a subject difficult to understand. These tools "[...] help learning by sparking students' interest in mathematics classes, as students often find the subject challenging" (Student 8).

Thus, it is understood that educational tools, when used in the school setting, can promote more dynamic, participatory lessons with better learning outcomes. They enable students to think critically about how to approach the subject, demystifying the notion of something predetermined and unchangeable (Oliveira; Cunha, 2021).

Focusing on the software used in the research, GeoGebra, it is evident that, as an educational tool, it can contribute to more practical teaching, moving beyond the traditional blackboard to a universe of new discoveries. In Geometry, it is frequently used, allowing students to visualize different aspects of the content. Pacheco (2019, p. 199) notes that GeoGebra can enhance teaching, as "[...] it is possible to make teaching and learning activities in mathematics more dynamic and enriching, as it is a Dynamic Geometry software".

From these situations, the research participants highlight several contributions that GeoGebra software can offer for their teacher training and as a methodological possibility when working in schools. They note that "the use of this tool allows for easier and more dynamic learning" (Student 8).

Thus, the application is widely recognized by mathematics teachers for enabling students to be active participants in the construction of their own learning. Additionally, it fosters a closer relationship between students and

teachers in the pursuit of knowledge necessary for consolidating teaching and learning (Oliveira; Cunha, 2021).

This perspective reaffirms that conscious use, supported by proper planning, can indeed significantly contribute to improving teaching, particularly in terms of the skills and competencies needed for content selection. In other words, proper grounding is essential to meet the objectives proposed for the study. If the reverse occurs, the educational goals will not be achieved, which could hinder the association of topics (Lima; Tomaz, 2022).

One of the most striking features of GeoGebra is its ability to provide 2D and 3D visualizations, offering a wide range of possibilities to enhance the knowledge being constructed. It is important to highlight that in teacher education programs, GeoGebra can serve as a vital tool for students, especially when dealing with extremely complex content that traditional expository methods may not fully clarify. At this point, the use of resources such as GeoGebra becomes essential.

In general terms, GeoGebra can contribute to the construction and understanding of mathematical concepts and skills, fostering an investigative spirit and autonomy (Pacheco, 2019). It allows students to assimilate content through an active structure, connecting it to real-life situations.

Student 8 highlights this perspective in their statement, mentioning that "GeoGebra software is important to facilitate teaching and to allow better visualization in Mathematics, as well as to contribute to teacher training through technology". Similarly, Student 3 adds, "figures and graphs can be manipulated with theoretical rigor and ease, which manual construction may lack".

It becomes recurrent in the statements the need to understand mathematical content; however, it is common:

> [...] among students, the tendency to avoid, at all costs, the abstraction and generalization of mathematical content, which are essential characteristics for understanding the subject, in

> favor of simplifications that hinder visualization and assimilation. Students need to understand that they must know and know how to do (Lima; Tomaz, 2022, p. 62).

Some teacher education students did not have access to the software during their basic education, nor in the early stages of their teacher training program. It is worth noting that the research participants are still in the second semester of their program, with the possibility of learning a bit about GeoGebra later this semester. It is necessary to create a more conducive environment for quality teaching, where "environments favorable to dialogue, discovery, trial and error, and reflection on what each of these complementary stages represents in the construction of knowledge" can be established (Freitas *et al.*, 2014, p. 127).

In this context, the educational software mentioned repeatedly in this study creates the possibility for more interactive classes. It appears to be a dynamic application designed to facilitate learning. From conversations with peers who have already had access to it, students recognized the potential to study with it and highlighted positive aspects of its use. As Student 9 noted, "I realize that GeoGebra must be very useful for studying and for better conveying content to students in a practical way".

Abar and Almeida contribute by stating that "[...] the use of GeoGebra software is not just another technological resource but also a tool that aids in the development of mathematical concepts" (2017, p. 139). Student 1 mentions that they have not had contact with it but affirms that "it is beneficial in all aspects, both for students and teachers." In line with this, Students 4 and 7 assert that:

> I believe that software tools are great resources. During my basic education, I did not have much contact with them, I admit, but as a future teacher, I think that software would help me in my explanations, and I will try to use them in the classroom (Student 4).

> Unfortunately, I did not have the opportunity to interact with the software, but based on what I know about it, I believe it would help and encourage students' interest in Mathematics, generating more professionals in this field, as well as in several other areas strongly influenced by Mathematics (Student 7).

In this context, future teachers express concerns about teaching methods and the breadth of knowledge they hope to carry with them after completing the program. As Student 9 states, "In Basic Education, I still didn't have a clear perspective. And so far, in the process of training in the mathematics teacher education program, I have the desire to learn and know as much as possible to teach as best as I can".

Gonçalves and Lima (2020, p. 1) highlight that the practice of teaching mathematics deserves attention regarding the ways these topics are addressed, "[...] as mathematics, which is everywhere, seems invisible to the vast majority of students who try to decipher it, and, without much success, move further away from the subject".

Innovation was also brought up in the responses. Even though the software was created in 2001, it is often seen as something new and innovative due to its ability to combine theoretical and practical teaching. As Student 10 mentions, "I believe it will be very valuable because it will be something innovative that will increasingly spark students' curiosity, allowing them to learn in a fun way". Pacheco (2019, p. 200) states that the search for "[...] new educational tools for teaching mathematics, such as software, allows educators to enhance and innovate teaching and learning within classrooms", encouraging students to enjoy learning mathematics.

In this way, it is evident that the research participants, in general, recognize that educational software, particularly GeoGebra, can significantly contribute to the initial training context of teacher education students. Additionally, it facilitates active and engaging teaching, envisioning changes in classroom practices.

Conclusion

The use of educational software, in general, has become something innovative, particularly in supporting mathematics teaching. Throughout the presentation of the results, it is evident that the research participants highlight the importance of using these tools in their training process and how this can improve aspects related to teacher identity and professional development.

The participants also bring up discussions about structural, methodological, and pedagogical difficulties in using these software tools. It is necessary to rethink these issues, as significant progress has been made, but there is still a long way to go. Addressing these aspects can bring greater opportunities for students. Despite these challenges, the research participants emphasize that the proper use of these tools still stands out due to the differentiated teaching methods they can provide.

Introducing these discussions within the teaching profession and the teacher training process can be extremely relevant to the development of these professionals, encouraging them to constantly seek innovation to provide students with all the advantages that these software tools can offer.

As seen, many research participants had little to no contact with such software during their basic education. Based on their statements, they believe that educational software can improve performance in mathematics and increase the relevance of discussions in teacher training programs, ensuring that this scenario does not persist in basic education.

It is clear how software like GeoGebra can contribute to the training process of teachers as well as to mathematics teaching. Indeed, the creation of GeoGebra has supported mathematics education, standing out as an educational tool that aids these future professionals in their practice.

In summary, research focused on teacher training, particularly in its initial stages, offers a range of approaches and discussions aimed at

contributing to the teacher training process, specifically for mathematics teachers. Regarding the use of software, it is well known that these tools, when combined with proper planning and teaching strategies, significantly enhance the teaching and learning process.

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