Diversitas Journal
ISSN 2525-5215
Volume 11, Number 2 (Abr../Jun. 2026) p. 0237 – 0254
https://diversitasjournal.com.br/diversitas_journal

Pedagogical projects in initial Mathematics education in the Northeast: Implications with digital technologies

Projetos pedagógicos na formação inicial em Matemática do Nordeste: implicações com as tecnologias digitais

SANTOS, José Elyton Batista dos[1]; RODRIGUES, Bruno Meneses[2]; SANTOS, Iris Grasielle Xavier dos[3]

[1] 0000-0003-1763-8134; SEMED of Rio Largo, teacher and researcher, Brazil, Email: elyton_batista@hotmail.com.
[2] 0000-0002-6228-7233; SEMED of Cristinápolis, teacher and researcher, Brazil, Email: drbrunomr@hotmail.com.
[3] 0000-0003-0869-3035; SEMED of Maceió, teacher and researcher, Brazil, Email: igx29.psicoped@hotmail.com.

A B S T R A C T

The present research aimed, in general, to analyze the Pedagogical Projects of the Courses (PPC) of undergraduate Mathematics programs at federal universities in the Northeast, with emphasis on the Federal University of Sergipe (*Universidade Federal de Sergipe* - UFS), seeking to understand how Digital Technologies (DT) are being addressed in initial teacher education. The investigation used a qualitative, exploratory, and descriptive approach, based on the documentary analysis of 36 PPCs from 15 federal institutions. The results show that, although there are courses with instrumental and pedagogical approaches, these are still limited and, in many cases, outdated. The absence of effective pedagogical practices with DT was observed, which compromises the preparation of undergraduates for the contemporary challenges of mathematics education.

R E S U M O

A presente pesquisa teve como objetivo geral analisar os Projetos Pedagógicos dos Cursos (PPC) de licenciatura em Matemática das universidades federais do Nordeste, com ênfase na Universidade Federal de Sergipe (UFS), visando compreender como as Tecnologias Digitais (TD) estão sendo tratadas na formação inicial docente. A investigação utilizou uma abordagem qualitativa, exploratória e descritiva, com base na análise documental de 36 PPCs pertencentes a 15 instituições federais. Os resultados evidenciam que, embora existam disciplinas com abordagem instrumental e pedagógica, essas ainda são limitadas e, em muitos casos, desatualizadas. Observou-se a ausência de práticas pedagógicas efetivas com TD, o que compromete a preparação dos licenciandos para os desafios contemporâneos da educação matemática.

INFORMAÇÕES DO ARTIGO

Histórico do Artigo:
Submetido: 11/11/2025
Aprovado: 26/02/2026
Publicação: 12/04/2026

Keywords:
Teacher training, digital technologies, mathematics education, pedagogical projects, curriculum

Palavras-Chave:
Formação de professores, tecnologias digitais, educação matemática, projetos pedagógicos, currículo

DOI: 10.48017/dj.v11iEspecial_2.3701

Introduction

The Pedagogical Course Projects (PPC) of Mathematics are fundamental in teacher training, as they bring in their texts theoretical-conceptual, epistemological, political conceptions, as well as local, regional, and national dimensions. They are responsible for guiding the curriculum and teaching practices of the course, aiming to ensure teacher training with skills and competencies to work in basic education that meet the needs of the historical and situational context in which Brazilian society is found. One of the main relevances of these documents lies in the fact that PPC serve as instruments that assist undergraduate students with their theoretical foundation.

This foundation allows them to understand the theoretical and practical fundamentals of Mathematics, as well as its applications. Regarding theoretical training, it refers to axioms, definitions, properties, principles, and mathematical structures in different fields, such as algebra, geometry, numbers, statistics, and education. Concerning practice, it refers to the ability of future teachers to relate the content to situations connected to students' daily lives. The unity of theoretical and practical knowledge is essential and, at the same time, significant for the understanding of concepts in the daily lives of undergraduates and, consequently, in the teaching of Mathematics in formal and non-formal settings. This inseparability allows identifying, selecting, or creating contextualized problems, highlighting their importance for students' lives and for future teaching careers. The development of critical, logical, deductive, and inductive thinking skills, in addition to decision-making and strategy formulation, contributes to problem-solving.

The PPCs go beyond the curricular structure and encompass the formation of citizens aware of their social role. In the context of future teachers, it is important that they understand the value of society, being able to establish connections between the subject and other areas of knowledge, thus contributing to the comprehensive education of students. They are also understood as constructs that define the formative process to be offered, considering the professional profile reflected in technical, methodological, evaluative, social, economic, educational, political, and cultural issues. This implies understanding that education is not limited to the teaching of specific Mathematics content, but aims at the formation of citizens capable of facing the challenges imposed by the transformations of the contemporary world and its historical phases.

The PPCs are developed in accordance with the Institutional Pedagogical Project (*Projeto Pedagógico Institucional* - PPI) and the Institutional Development Plan (*Plano de Desenvolvimento Institucional* - PDI). As highlighted by Brasil (2006), the development of each course aligns with the institutional academic policies present in these documents, which are realized in the PPCs as guiding instruments for actions. They define the formative identity in human, scientific, professional, and methodological aspects for teaching, learning, and evaluation, in addition to the curriculum and academic structure. According to Favaro (2019),

their elaboration involves three dimensions: Contextual, theoretical-explanatory, and operational.

The contextual dimension defines the particularities of the environment in which the course is inserted, taking into account socioeconomic, cultural, and educational aspects, with the goal of aligning the training with local and regional demands. According to Favaro (2019), the articulation between the university and society takes into consideration the social aspect, the characteristics of the institution, and its physical and logistical infrastructure. Thus, the explicit statement of assumptions supports the relationship between teaching and the environment, highlighting commitment and responsibility.

The theoretical-explanatory dimension comprises the conceptual and epistemological basis of the course, including the theoretical foundations, pedagogical approaches, and methodological strategies that support training with a focus on sociopolitical, psychological, anthropological principles, and concepts of the field of knowledge. It promotes the articulation between research, extension, and teaching in the learning process. Thus, it encompasses the foundations of the PPC, the philosophical stance, the epistemological and educational principles that are inherent to it and that are in accordance with the PDI and the PPI (Favaro, 2019).

In the elaboration of the PPC, the operational dimension is also considered, which addresses the conceptions, principles, planned actions, and organizational guidelines that guide initial teacher education. These factors are related to the foundations established for the course, considering that theory and practice are inseparable (Zainko, 2014). From this perspective, curricular structuring occurs: The organization of subjects, the workload, evaluation strategies, among other aspects that ensure the implementation of theoretical proposals and the achievement of the educational objectives foreseen in the PPC.

With so many changes underway in the educational field, especially in the face of the rapid advancement of Digital Technologies (DT), it becomes increasingly necessary to reflect on the role that the PPCs of undergraduate Mathematics teaching courses have played in this scenario. Although many of these documents present well-constructed theoretical and epistemological foundations, it is observed, in practice, that the integration of DT in teacher education does not always occur effectively. In many cases, there is a noticeable disconnect between what is stipulated in the documents and what is actually experienced in pedagogical practices, particularly regarding critical, creative, and technology-contextualized teaching in the school environment.

Starting from this concern, the present article aims to analyze the PPCs of undergraduate Mathematics teaching courses at federal universities in the Northeast, with special focus on the Federal University of Sergipe (*Universidade Federal de Sergipe*). The objective is to understand how DT are being addressed in these guiding documents for initial teacher education. More than noting the presence or absence of these technologies, it seeks to

understand the way they are treated, their pedagogical and epistemological foundations, and how they relate to the reality of schools.

Methodological paths

The study is classified as a qualitative research, of the exploratory and descriptive type, with a technical basis in documentary research. Research can be characterized as exploratory when it seeks to provide an initial and comprehensive view of a given phenomenon, especially in situations where the subject has not yet been sufficiently studied, making it difficult to formulate well-defined and operationalizable hypotheses. The descriptive aspect refers to the effort to present the characteristics of a population or phenomenon, or even to establish relationships between variables, usually supported by standardized data collection techniques, which are quite common in this type of study (Gil, 2008). Given this investigative direction, it is worth mentioning that, despite being a qualitative research, the present study also makes use of the description of some quantitative data.

The documents analyzed were the PPCs of the undergraduate Mathematics teaching courses of the federal universities in the Northeast. In the Northeast, there are 20 federal universities that offer undergraduate courses in various areas, specializations, postgraduate programs at the master's and doctoral levels, in addition to research, teaching, and extension activities. Regarding the undergraduate Mathematics teaching course, in the face-to-face modality, not all HEIs offer it, with 15 federal institutions being delineated in this analysis, totaling 36 courses.

Throughout this review, they observed the general and specific objectives and the analysis criteria established by each author to support the choice of parameters used in the analysis of the PPCs of undergraduate Mathematics courses at federal universities in the Northeast. They analyzed the legal basis of the PPCs, resolutions, guidelines, and regulations that guide the structuring of the documents. Then, they examined the objectives (general and specific), the profile of graduates, the theoretical-conceptual conceptions, and the courses, considering aspects such as workload, nature, and syllabus. Finally, research projects, extension activities, and specific programs of UFS, São Cristóvão Campus, were considered, enriching the study of the institutional and situational context regarding DT in the initial teacher training of this institution.

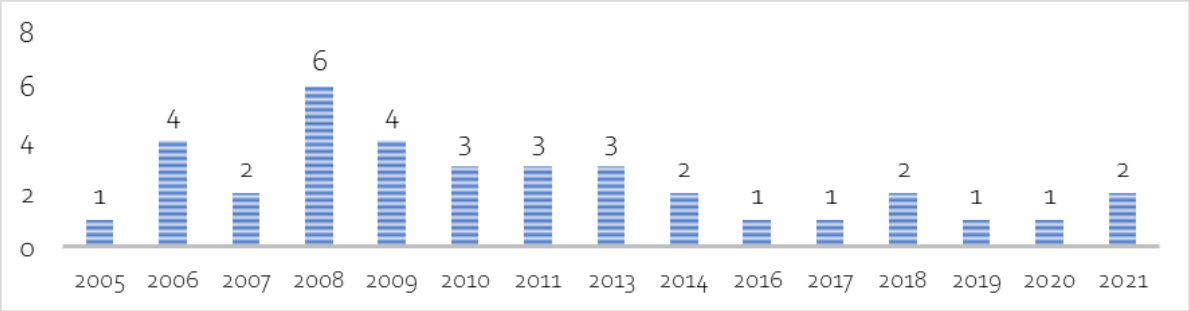
The pedagogical projects of Mathematics courses in the Northeast

In the Northeast region, there are universities that still have curriculum based on guidelines, opinions, or resolutions from 1997, 2001, 2002; that is, out of the 36 courses analyzed, 25 are more than two decades old, as shown in the following chart 1. According to some scholars, such as Santos (2018) and Cunha (2018), this situation occurs because initiating processes of change within educational institutions is not a simple challenge to face.

This fact highlights an inherent difficulty in these tasks, revealing complexity and setbacks in the implementation of curriculum changes, which are reflected in teacher training.

Chart 1.

Year of reformulation of the Mathematics PPC in the Northeast.



Source: Prepared by the author (2023), according to the PPCs of the Northeast federal universities.

These data highlight a problem regarding the capacity of institutions to adapt to social developments and the complexity of contemporary and technological knowledge. There is a need for an interdisciplinary approach in education. The fixation on outdated guidelines can limit the educational perspective, preventing updated viewpoints. It is important to emphasize that six courses located in the states of Alagoas (3)[1], Bahia (2)[2] and Ceará (1)[3] are aligned with the national curricular guidelines for initial higher education training, as well as with continuing education, as established by CNE/CP Resolution No. 2, of July 1st, 2015.

With regard to CNE/CP Resolution No. 2, of December 20th, 2019 (revoked), which defined the curricular guidelines for initial teacher education, only one institution, UNILAB, located in the state of Ceará, uses this resolution as a basis for the construction of its curriculum. It is notable that the formulation without the participation of higher education institutions generally resulted in a lack of adherence to the aforementioned resolution. This fact highlights not only the update of the guidelines themselves but also the democratic and participatory process needed to ensure representativeness in the Brazilian educational scenario. According to Cunha (2018) and Gonçalves and Malacarne (2021), the 21st century teacher faces several challenges, especially regarding curriculum reform, public policies for teacher education, teacher appreciation, and technologies in the educational environment.

In a context permeated by incessant transformations, characterized by the constant emergence and improvement of DT, a resonant echo is observed in the field of Mathematics. In this dynamic scenario, teachers in this area find themselves confronted with the pressing need to reformulate not only the methods of teaching the subject but also to reconfigure their conceptions and perspectives regarding society. This adaptation is not limited to mere

[1]Federal University of Alagoas (*Universidade Federal de Alagoas*), Maceió and Arapiraca Campus.
[2]Federal University of Recôncavo da Bahia and Federal University of Western Bahia (*Universidade Federal do Recôncavo da Bahia; Universidade Federal do Oeste da Bahia*).
[3]Federal University of Cariri (*Universidade Federal do Cariri*).

technical updating, but requires them to articulate technological advances, social dynamics, and the very nature of Mathematics, thus promoting a pedagogical approach that goes beyond traditional boundaries and aligns with the complexity inherent in contemporary times.

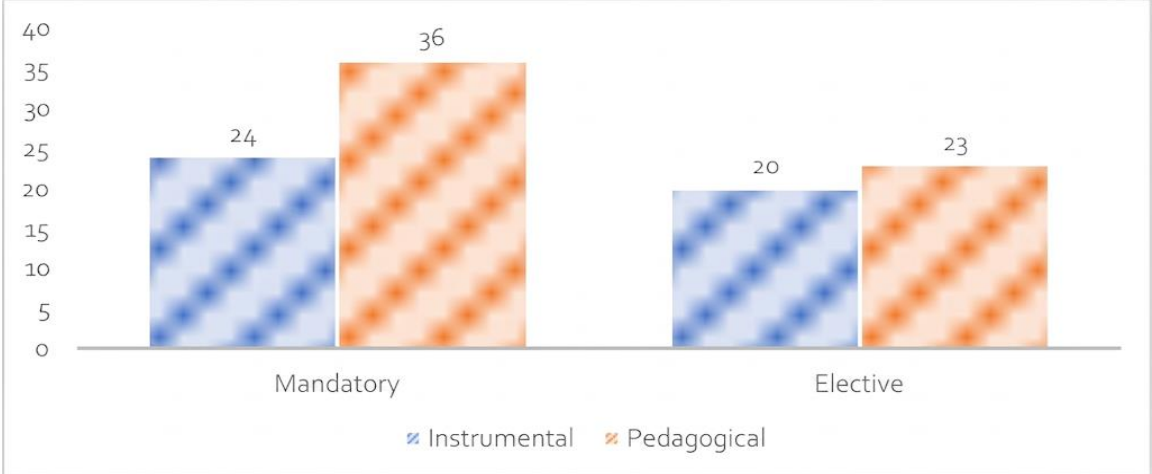
In view of this scenario, it becomes essential to ensure adequate training for undergraduate students in teaching, which includes proposals for experiences with technologies aimed at promoting teaching and learning in the classroom. It is in this training process that future teachers should experience the use of technologies with the purpose of producing scientific knowledge in the field of Mathematics, linked to the pedagogical act and the school environment as a whole.

However, from a technological perspective, when analyzing the Course Pedagogical Projects (PPC) of the mathematics teaching degrees at universities in the Northeast, a small difference is observed between the number of mandatory and elective courses present in the curriculum, with the latter predominantly focused on instrumental knowledge and theoretical discussions about technologies. The absence of practical experiences and the scarcity of diverse situations aimed at teaching and learning mathematics directly impact future teaching practice, being aggravated by the reduced number of elective courses intended for such purposes.

The curriculum structure of these courses reveals that 43% of the disciplines with a technological component are offered as electives, which does not guarantee their availability every semester, while 58% are classified as mandatory (see chart 2). This division reflects the importance attributed to technological competencies in the training of future Mathematics teachers; however, the percentage of mandatory courses with this focus, compared to the total analyzed, is still considered insignificant when compared to the number of elective components. This finding is reaffirmed when considering the pedagogical and instrumental aspects present in the curriculum.

Chart 2.

Configuration of subjects (instrumental and pedagogical).



Source: prepared by the author (2023) according to the PPCs of the Northeast federal universities.

It is observed that 23% of the analyzed courses are mandatory and of an instrumental nature, while 20% are elective. Regarding courses with a pedagogical character, it is identified that 35% are mandatory and 22% elective. These data highlight a significant difference between the proportions of courses with instrumental and pedagogical focuses, which directly influences the development of specific competencies in Mathematics, related areas, and the pedagogical skills necessary for a comprehensive and consistent education. Among the mandatory and elective subjects present in undergraduate Mathematics courses, it is common to find curricular components that address, from an instrumental perspective, content such as the study of hardware and operating systems, discussions about computer networks, software licensing, elementary algorithms, programming techniques, in addition to familiarity with the physical components of computers, such as processors, memory, and storage devices.

Similar nomenclatures are observed among these disciplines, as illustrated in Table 1, although their syllabi may present variations, including or omitting certain content. However, the limitation observed in these disciplines lies in the approach focused exclusively on "concepts," without considering a critical perspective that enhances technical proficiency combined with the didactic-pedagogical dimension (Silva; Andrade, 2021).

Table 1.

Instrumental subjects.

Discipline	Nature	Workload
Algorithms and Programming Language	Mandatory	60 hours
Algorithms and Programming Logic		90 hours
Algorithms and Programming		54 and 64 hours
L and L2 Computing		60 hours
Introduction to Computing		60 hours
Introduction to Computing		30 hours
Introduction to Computer Science		54 hours
Introduction to Programming Logic		68 hours
Theory of Computation		68 hours
Elements of Computational Epidemiology	Elective	60 hours
Programming Fundamentals		80 hours
Introduction to Computer Science		96 and 60 hours
Introduction to Quantum Computing		60 hours
Introduction to Computer Science		60 hours
Introduction to Microcomputing		60 hours
Programming Language		60 hours
Computer Programming I and II		60 hours
Theory of Computation		60 hours

Source: Prepared by the author (2023), according to the PPCs of the Northeast federal universities.

These disciplines of an instrumental nature, although relevant for understanding the technological machine, also contribute to the management of "[...] teaching activities, for example, in preparing lessons, developing activities, tests, and grades" (Silva; Andrade, 2021, p. 4). However, this contribution proves to be limited when related to the future pedagogical

practice of Mathematics teachers, since it does not favor the exploration of DT as a didactic resource for the teaching and learning of mathematical concepts (see Table 2).

Table 2.

Subjects of a pedagogical nature.

Discipline	Nature	Workload
Computer in Mathematics Education	Mandatory	60 hours
Didactics		60 hours
Supervised Internship I		75 hours
Computational Tools for Teaching Mathematics		60 hours
Computer Science Applied to Mathematics		60 hours
Applied Informatics in Education		60 hours
Computer Science in Mathematics Education		60 hours
Instrumentation for the Teaching of Mathematics I and II		60 hours
Mathematics Education Laboratory I and II		64 and 45 hours
Mathematics Teaching Laboratory II and III		60 and 68 hours
Laboratory of Pedagogical Practices I		96 hours
Mathematics Teaching Methodology		90 hours
New Technologies and Mathematics Education		60 hours
New Technologies and the Teaching of Mathematics		60 hours
The Computer as a Teaching Tool		60 hours
Pedagogical Practice II		90 hours
Educational Practices III		45 hours
Digital Technologies and Mathematics Teaching		68 and 64 hours
Technologies in Mathematics Education		90 hours
Distance Education	Elective	60 hours
Educational Informatics		64 and 32 hours
Informatics in Education		64 hours
Introduction to Informatics in Education		68 and 102 hours
Introduction to Audio-Visual Resources in Education		45 hours
Introduction to Education I		60 hours
Introduction to New Technologies Laboratory		60 hours
Mathematics Applied to Education		64 hours
Multimedia in Education		60 hours
Mathematical Software		60 hours
Technoteaching		64 hours
Tech Teaching EAD		64 hours
Trends in Mathematics Education		60 hours

Source: Prepared by the author (2023), according to the PPCs of the Northeast federal universities.

The courses that include subjects with these perspectives in their curriculum demonstrate an acknowledgment of the need to train future teachers to incorporate them into their pedagogical practices. In this way, students have the opportunity to (re)construct knowledge and skills to promote mathematics education in the digital world. According to Morin (2018, p. 5), knowledge employs abstraction, however, it is essential that this is contextualized in order to understand that it is necessary to activate general intelligence and mobilize comprehensive knowledge, because "[...] we produce the society that produces us. At the same time, we must not forget that we are not only a small part of a whole, the social whole, but that this whole is within ourselves." Such understanding refers to the overview presented

in this section. Knowledge-producing institutions are sometimes rooted in obsolete curriculum, but at the same time, they value technological innovation and changes in basic education teaching. This expected result is the product of an unknown that reveals the existence of a contradiction between reality based on the PPC and the syllabi of the subjects.

When analyzing the Mathematics undergraduate courses at UFAL, A. C. Simões Campus, it is observed that their PPC was updated in 2021; however, there is no mandatory or elective course with a technological approach in the curriculum, even though this document mentions the need to use DT as a resource and acknowledges contemporary society's immersion in digital culture. This situation reveals that curriculum reform is necessary; however, it does not guarantee changes in the proposal for training with DT.

The lack of appreciation for an education aligned with the reality of students demonstrates a recursive cycle in future pedagogical practice. Morin (2015, p. 74) states that "[...] products and effects are at the same time causes and producers of a process of reproduction that is prior to us. But once we are products, we become the producers of the process that will continue." By not adapting teaching to the needs and contexts of students, they perpetuate an outdated and inadequate educational model that does not properly prepare future teachers to innovate and respond to contemporary challenges. This continuity results in an education that does not develop and, instead of forming agents of transformation, reproduces entrenched obsolete practices and disseminates methods that do not meet the emerging demands of society.

The syllabi of the courses in Table 2 cover topics on education with DT in the teaching and learning process, as well as the potential and challenges of including these technologies in the teaching of Mathematics. They also involve the study and analysis of mathematical software and applications, exploring their functionalities and educational possibilities. In addition, holding debates on specific resources, spreadsheets, digital games, calculators, and virtual learning environments, among others, enhances meaningful mathematics teaching. These technological interfaces help future Mathematics teachers explore content in a dynamic and interactive way, boosting student engagement.

The situation of the curricular matrices of some mathematics teacher education courses in specific institutions was observed. At UFBA, for example, in the evening course, there is a mandatory subject, but without a pedagogical focus, while the others are elective; in the daytime course, on the other hand, there is an elective subject. At UFOB, UNILAB, and UFCA, there is a mandatory pedagogical subject, followed by elective subjects. At the Federal University of Ceará (*Universidade Federal do Ceará* - UFC), Fortaleza Campus, no mandatory subjects are offered, only electives. Regarding this last situation, studies such as those by Souza and Schneider (2016) reveal the circumstances in which the analyzed universities include subjects related to DT become evident. These subjects are offered as electives, which places them among various other options in the curricular matrices. Furthermore, the absence of

teachers from the beginning of the period results in an accelerated pace and ineffective practices. Other research, such as that of Silva and Andrade (2021), reveals the lack of understanding of the basic education situation by the trainers, which hinders the contextualized proposal of the technological approach in initial teacher training, resulting in academic ignorance and blindness.

The argument referred to as “ignorance and blindness” refers to the mistake of limiting oneself, having a unilateral and reductionist view, seeing one element and one aspect of a reality that, in its essence, is simultaneously one and multiple, that is, complex (Morin, 2017). And this is what the PPC reveal - the invisibility of elements essential to teachers' pedagogical practice. This situation can occur when relationships between possible teaching strategies are not established, considering the various approaches, such as manipulable materials, TD, and other trends related to the social context in which they are involved.

It is observed that at UFMA and at UFPE, Agreste Campus, there is a predominance of pedagogical and mandatory subjects. At UFCG, in the campuses of Cajazeiras and Cuité; at UFPB, on Campus I in João Pessoa; at UFPE, on the Recife Campus; and at UFPI, on the Senador Helvídio Campus, there are mandatory subjects with an instrumental approach. Although DT are present in people's lives, a limited trend in educational use was identified, being restricted to the sharing of audios, messages, and videos, without exploring the formative potential of these technologies. Resistances to breaking this simultaneous single and double paradigm persist. In the educational sphere, closed, bureaucratized spaces ingrained in customs are observed, for which challenges and uncertainties are invisible (Morin, 2018).

On the other hand, some institutions show concern with the offering of mandatory courses that cover both the instrumental and the pedagogical dimensions, contributing to the necessary breakthrough for an education with technologies. This is the case of UFPI, at the Teresina Campus; UFRB; UFCG, at the Campina Grande Campus; UFAL, at the Arapiraca Campus; and UFS, at the São Cristóvão and Itabaiana Campuses. In these institutions, discussions are proposed on basic concepts of operating systems and computer networks, types of commands, basic programming techniques, studies of algorithmic language and programming, in the instrumental context.

Silva and Andrade (2021) warn that technical mastery is not sufficient for an undergraduate teaching course. Such a finding contradicts the educational proposal. Teacher trainers need to understand both the machine and the mathematical concepts; however, this does not necessarily make them good teachers. There is a need to go beyond this context - it is necessary to understand the organizational elements of the class, the socialization processes, and the construction of knowledge. According to Morin (2018), a mindset focused on isolation and separation should be replaced by one that emphasizes distinction and unity. It is essential to replace fragmented and reductionist thinking with a complex approach, in the authentic sense of complexus, that which is interwoven.

In the pedagogical field, the analyzed disciplines discuss media in education and in the teaching of Mathematics, educational programs, computers, the internet, TV Escola, platforms and virtual environments, GeoGebra, Maple, Winplot, Cabri-Geometry, mathematics with videos, mobile applications, computer science as practice, computer architecture and operation, teaching machines, technological resources, and others. Based on the nomenclatures and content present in some syllabuses, it is possible to recognize the need to update the PPC disciplines or, in some cases, the entire document itself, as required by competent bodies. The DT have not remained static over time: They have modernized, and others have emerged, becoming realities in various social contexts, also impacting the teacher training process.

Schlemmer, Felice, and Serra (2020) state that, in most cases, technologies are being used instrumentally, as "informatics," "architecture," "machines," "tools," "resources," or "supports," resulting in instructional practices that do not meet the purposes of a teacher training course. Calling these practices pedagogical, or even online or distance education, is a mistake arising from a lack of information. The simple transfer of a face-to-face class to digital platforms does not constitute a change in modality nor represent innovation.

In the face of the mutation of spaces and means, it is necessary to understand the potentialities and limits of DT to reconfigure activities, methodologies, curriculum, and courses. This need becomes evident due to the lack of experimentation and theoretical discussions about technologies in the teaching and learning of Mathematics, a situation observed in the analysis of the PPCs of federal universities in the Northeast. The antagonistic stance of some teachers regarding technologies in the classroom reflects a training that does not prepare them to explore and provide meaningful experiences with DT for students. Although they are immersed in digital dynamics outside the school environment, initial training still neglects the development of pedagogical skills aimed at critical, creative, logical, and problem-solving thinking.

According to Morin (2018), thought should not be restricted to a location nor tied to a specific time or space. It must be capable of encompassing totalities and transformations, promoting the development of a sense of responsibility and citizenship. The change of this thought significantly impacts formative processes, challenging fragmented and one-dimensional views. By considering totalities and understanding global and local problems, individuals become capable of facing challenges and proposing solutions. The paradigm shift required is, therefore, simultaneously theoretical and practical, involving educational dynamics and social phenomena experienced by the communities in which the courses are embedded.

This gap in training is reflected in the profile of Mathematics undergraduates at the analyzed universities when it comes to technology. UFAL, at the Maceió and Arapiraca Campuses, based on CNE/CP Opinion 009/2001 and CNE/CP Resolutions 1/2002 and

2/2002, seeks to train graduates who meet the curriculum guidelines, with a critical and social view of their teaching role, adaptability, sensitivity to students' actions, understanding of Mathematics as a tool for civic education, mastery of diverse methodologies, collaborative work, overcoming prejudices, preparation and analysis of teaching materials, creativity and autonomy, as well as participation in school projects and continuing education (UFAL, 2018, 2021).

Other institutions, such as UFMA, UFPB (Rio Tinto and João Pessoa Campuses), UFPE (Agreste and Recife Campuses), UFC, the Federal University of Delta do Parnaíba (Ministro Reis Velloso Campus), the Federal Rural University of Pernambuco, and again UFPB (Campus I), also present graduate profiles aligned with the aforementioned principles. At UFBA, the course aims to train teachers with solid, up-to-date knowledge and a critical view of Mathematics and its teaching. At UFRB, graduates must be aware of their teaching role, adapt to different realities, promote the teaching of Mathematics, and work as teachers, managers, and advisors. UFCA aims to train professionals for Elementary and High School with critical reflection and constant pursuit of training. UNILAB emphasizes the accessibility of mathematical knowledge and the promotion of citizen education.

At UFCG (Campuses of Campina Grande, Cuité, and Cajazeiras), the goal is to train teachers with a solid mathematical and pedagogical background, a critical view of teaching, and innovative methodologies, with the use of technologies and the promotion of active student participation. At UFPI, in the Campuses of Picos and Teresina, the emphasis is on mastery of mathematical content, understanding the history of Mathematics, teaching methods, and integration with related areas. At UFRN, in the Natal Campus, the aim is to train teachers for Basic Education with an emphasis on Basic Education content, logical abstraction, problem-solving, communication, and DT, with possibilities of working in multiple contexts and continuing in postgraduate studies. At the Caicó Campus, the objective is to train professionals with a solid teaching identity, grounded in mathematical knowledge and interdisciplinary relationships, reflective and engaged.

At UFS, on the São Cristóvão and Itabaiana Campuses, the graduate profile includes teaching skills, organization of educational projects, dissemination of knowledge, mastery of logical reasoning, familiarity with various methodologies and materials, individualized attention to students, commitment to professional development, and ethical and humanistic practice. Just like other federal universities in the Northeast, the Mathematics teacher education courses at UFS include in their curriculum subjects (see Table 3) with theoretical (conceptual discussions), pedagogical and technological (practices with DT), and instrumental (theory and practice unrelated to pedagogical objectives) configurations. These different approaches allow future teachers to become familiar with DT, understanding its application in the teaching and learning process, developing digital skills for pedagogical purposes, and also creating or functionally mastering educational software.

Table 3.

Courses offered in the daytime and evening Mathematics degree programs at the São Cristóvão Campus with discussions and technological practices.

Discipline	Workload	Offer		Menu
		Diurnal	Nighttime	
Mathematics Teaching Methodology	90 hours	3rd period	5th period	Mathematics Education. Research lines in Mathematics Education. Methodological trends for teaching Mathematics. PCN of Elementary and High School. Textbooks and Complementary Books for elementary and high school education. Assessment of teaching and learning Mathematics: processes, instruments.
New Technologies and the Teaching of Mathematics	60 hours	4th period	6th period	The importance of media in Education. Use of Media in teaching Mathematics. Introduction to computer science. Internet and teaching mathematics. LaTeX text editor. Mathematical software. Educational programs.
Mathematics Teaching Laboratory	90 hours	4th period	6th period	Teaching laboratory. Methodological proposals for elementary and high school education. Teaching resources: construction and application for teaching Mathematics in elementary and high school. Project methodology.
Introduction to Computer Science	60 hours	6th period	6th period	General concepts. Algorithms and flowcharts. Scientific programming. Functions and procedures.

Source: Prepared by the author (2023), based on UFS data (2009).

When discussing the knowledge required to train Mathematics teachers, both mathematicians and Mathematics Education teachers agree on the importance of solid and deep specific knowledge of the subject. However, few dare to question, reflect, and investigate what it truly means to possess deep knowledge of Mathematics, especially considering the challenge of teaching it to children and young people in primary and secondary education (Moreira; David, 2018). This issue is still little reflected upon in the academic community for training Mathematics teachers. However, in the last decade, this scenario has been changing, as can be seen by the increase in research, the creation of products, workshops, extension courses, and other activities that contribute to reflection and know-how in future teaching practice.

In the case of UFS, São Cristóvão Campus, it is noted that, of the 35 courses offered throughout the initial training of Mathematics teachers, only two - one of a pedagogical nature and another instrumental, both with a technological dimension - are offered specifically to undergraduate students in teaching. Among the other courses, two are identified that involve discussions and practices with technologies. There is a variety of technologies available for teaching and learning Mathematics; however, even in courses such as New Technologies and Mathematics Teaching, which have a pedagogical purpose, it is observed that the syllabi

prioritize instrumental content to the detriment of proposals that connect experiences between the university and basic education. According to Souza and Schneider (2016), taking students to computer labs or proposing isolated activities is not sufficient, since such actions do not promote interaction among students and with the world of cyberculture.

Discussing the importance or explaining the operation of the LaTeX text editor, for example, does not meet the contemporary demands of training critical and creative individuals. Although the concepts and experimentation with programming are highlighted, primary and secondary education teachers report that such knowledge, for the most part, has contributed little to their teaching practices. In certain situations, they were able to show students the relevance of Mathematics by highlighting its presence in software and platforms integrated into smartphones, but such approaches proved to be occasional.

In Nora's (2020) research, it was observed that institutions that train Mathematics teachers develop few activities with DT, and when they do, the results are limited regarding the effective appropriation of these technologies. This gap reveals an inadequacy in relation to the reality experienced by student teachers since basic education, in their various living contexts. Regarding UFS, it is noted that this scenario does not differ substantially. Among the 227 projects analyzed, only 30 involved DT, being proposed by nine of the 50 faculty members of the department. Of these, ten projects (see Table 4) were specifically aimed at Mathematics teaching and learning, which led them to observe the training of the responsible teachers: three of them had a master's and doctoral degree in Education.

The information presented in Table 4 reveals the need for greater emphasis on the inclusion of DT in research projects aimed at Mathematics teaching, with the goal of strengthening the educational practices of future teachers, contributing to the development of didactic products and, consequently, enhancing mathematical learning considering the diversity present in Brazilian basic education classrooms. When analyzing the curriculum of the teacher trainers responsible for the subjects with a technological dimension, they did not identify any project specifically aimed at teaching or learning with DT directed at future practices in basic education.

Table 4.

Research projects developed by the teachers of DMA/UFS.

Project	Knowledge area	Year
An investigation into the use of technologies for solving mathematical problems by 6th-grade elementary school students.	Teaching methods and techniques	2012
An investigation into the strategies adopted by 9th grade elementary school students to solve mathematical problems with and without the use of manipulable or technological resources.	Teaching methods and techniques	2013-2016
Multimedia game library for teaching Mathematics.	Information systems	2016
Development of activities for teaching Mathematics in the Scratch environment.	Mathematics, teaching methods and techniques	2016-2017
Development of inclusive activities for teaching Mathematics in the Scratch environment.	Teaching methods and techniques	2017
Development of games and websites focused on accessibility.	Teleinformatics	2017
Adaptation of inclusive activities for teaching Mathematics in the Scratch environment.	Teaching methods and techniques	2018
Use of touchscreen in the tactile representation of inclusive educational objects.	Teleinformatics	2019
Support software for curation in Education.	Teleinformatics	2019
The Mathematics curriculum in the post-pandemic context: high school, textbooks, and digital technologies.	Specific curriculum for levels and types of education	2023

Source: Prepared by the author (2023), according to UFS data (04/2023).

According to Morin (2018), the absence of research projects with this approach highlights significant resistance to educational reform. The educational structure is described as a colossal machine, characterized by rigidity, inflexibility, closure, and bureaucracy. Many teachers remain rooted in their routines and in a disciplinary autonomy that, according to the author, leads them to act like "wolves marking their territory and reacting aggressively to any intrusion." Although they are part of a department focused on teacher training, they treat higher education and basic education as isolated and disconnected spheres in the formative process. Furthermore, the frequency of activities with DT in initial training, as in the case of UFAL, is quite low.

Regarding extension activities, the data collected revealed a similar scenario at UFS, with only seven out of 139 activities registered in SIGAA related to the use of DT. However, the information in Table 5 shows that these extension activities include a variety of approaches aimed at training Mathematics teachers with technology, including the use of games and software in dynamic geometry, teaching with technology, and theoretical discussions on the topic.

Table 5.

Extension activities developed by the DMA teachers.

Título	Evento/Modalidade	Ano
Teaching Mathematics with digital technologies in the post-pandemic period: Moving backward or advancing to the next stage?	14th Mathematics Week/Lecture	2022
Introduction to the text editor LaTEX	14th Mathematics Week/Mini-Course	2022
Sequence of remote activities: Building concepts of Spatial Geometry through games and dynamic geometry software.	Workshop	2021
Application of the derivative: Construction and interpretation of function graphs using GeoGebra software.	10th Mathematics Week/Mini-course	2017
Introduction to Python for Mathematicians.	Course	2016
Itinerant Laboratory for Mathematics Teaching.	Exhibitions of didactic activities that involve mathematical content through the use of manipulable and technological resources.	2014
Itinerant Laboratory for Mathematics Teaching.	Exhibitions of educational activities that employ manipulable and technological resources.	2013

Source: Prepared by the author (2023), according to UFS data (04/2023).

The extension activities analyzed include events and projects in which teachers acted as speakers, coordinators, and collaborators. Of the actions presented in Table 5, three were identified as impactful on the practice of the Mathematics teacher. As pointed out by Santos (2018) and Lima and Araújo (2021), when DT are incorporated into teacher education, they promote significant transformations both in the pedagogical practice of the trainer and in the educational process as a whole. Such changes affect teaching and learning, in both face-to-face and virtual environments, besides influencing the organization of time and space dedicated to the act of teaching and learning. When observing the panorama of extension activities, without disregarding research projects in the Mathematics undergraduate program at UFS, they found that this reality is still incipient.

It identifies a latent difficulty in the initial training of Mathematics teachers, which highlights the challenge of ongoing reform projects when dealing with an invisible space: that of technologies. This gap, according to Morin (2018), would only become visible if there had been a prior reform of mentalities. However, this creates a deadlock, as it is not possible to reform the institution without first changing ways of thinking, just as it is not feasible to transform thoughts without reforming institutions. Such a deadlock constitutes a double blockage, resulting in a logical impossibility.

The situation analyzed reveals an obstacle both in teacher education programs and in basic education. They found that there is a significant number of teachers who do not develop pedagogical practices using DT, limiting themselves to basic resources such as the electronic

gradebook, PowerPoint slide presentations, and text editing environments. In view of this, they understand that teacher education programs should be conceived as a continuous process of professional development, which not only accompanies but also influences and shapes contemporary educational practices. Technological adaptability is not a simple task: it requires research, willingness, continuous training, and planning. The mere transition from one communication format to another does not constitute innovation, but rather the conscious application of pedagogical, didactic, and technological knowledge that allows for problematizing and expressing, in an understandable and meaningful way, the concepts and knowledge at play. Being in constant training and understanding the human condition are essential aspects of the process of transformation and adaptation in the face of unexpected situations (Santos; Rosa; Souza, 2021).

Thus, they understand that initial training does not represent an end, but the beginning of a continuous journey of learning and knowledge building in the face of the uncertainties and transformations that mark contemporary society.

Final considerations

The configurations of the pedagogical projects of Mathematics courses at the federal universities of the Northeast revealed a scenario of challenges, requiring a reassessment of the curricular components that do not address the different social, cultural, economic, and academic contexts, unfortunately treating technologies as tools to support teaching. The advances and transformations in society have still not been sufficient to overcome the reductionist view of DT, maintaining pedagogical practices based on content and the instrumentalization of teaching practice. The predominance of a technicist approach after decades reflects resistance in the appropriation of technologies in schools and universities, which contrasts with the commitment and dedication of higher education institutions to invest in research, science, and innovation for social development. This implication with technologies limits the action of change and the re-signification in the field of education, highlighting the relevance of pedagogical practices with technologies in the digital era.

The pedagogical projects of initial training courses in Mathematics depend on knowledge and practice that go beyond the inclusion of subjects with technological skills and teaching with mathematical software. Recognizing technology in the educational process is essential. This involves rethinking not only the content but also the epistemology of practices and learning methodologies. The Mathematics PPC (Pedagogical Course Project) at the Cidade Universitária Prof. José Aloísio de Campos campus of the Federal University of Sergipe (*Universidade Federal de Sergipe*), São Cristóvão, is outdated and does not meet the initial teacher training guidelines, whether Resolution No. 2/2015, No. 1/2019 (both revoked), or No. 1/2024 (current). The restructuring of this project by the Structural Teaching Nucleus and the Course Collegiate becomes urgent, aiming for processing among the competent bodies at the Federal University of Sergipe (*Universidade Federal de Sergipe*).

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