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Overview of publication on blended teaching in mathematics teacher training

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Abstract: This State of Knowledge study investigated Blended Teaching in mathematics teacher training. The analysis revealed weaknesses in the articulation between theory and practice, as well as limited use of digital technologies, teacher overload and low student participation. In this regard, the need for curricular restructuring and institutional support was highlighted. It was concluded that effective implementation of Blended Teaching requires public policies, continuing education and investment.

Keywords: Blended Teaching; Teacher Training; Digital Technologies.

Panorama das Publicações sobre Ensino Híbrido na Formação de Professores de Matemática

Resumo: Este Estado do Conhecimento teve como objetivo investigar o Ensino Híbrido na formação de professores de Matemática. A análise revelou não só fragilidades na articulação entre teoria e prática, mas o uso limitado de tecnologias digitais, sobrecarga docente e baixa participação discente. Destaca-se, nesse sentido, a necessidade de reestruturação curricular e suporte institucional. Conclui-se que políticas públicas, formação continuada e investimentos são essenciais para uma implementação eficaz do Ensino Híbrido.

Palavras-chave: Ensino Híbrido; Formação de Professores; Tecnologias Digitais.

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Panorama de las Publicaciones sobre Enseñanza Híbrida en la Formación de Profesores de Matemáticas

Resumen: El objetivo de este estado del conocimiento fue investigar la enseñanza híbrida en la formación de profesores de matemáticas. El análisis reveló debilidades no solo en la articulación entre la teoría y la práctica, sino también en el limitado uso de las tecnologías digitales, la sobrecarga docente y la baja participación del alumnado. En este sentido, se destaca la necesidad de reestructurar el plan de estudios y de mejorar el apoyo institucional. En conclusión, se destaca la necesidad de políticas públicas, formación continua e inversiones para una implementación eficaz de la enseñanza híbrida.

Palabras clave: Enseñanza Híbrida; Formación de Profesores; Tecnologías Digitales.

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1 INTRODUCTION

In recent decades, education has undergone profound transformations driven by the rapid advancement of Digital Technologies (DT) and increased access to information. These changes have demanded new approaches to teaching and learning that are more connected, personalized, and student-centered. Even before the novel coronavirus (Covid-19) pandemic, Blended Teaching had emerged as a promising pedagogical approach.

Blended Teaching goes beyond simply combining different learning environments. It intentionally articulates in-person and online activities to expand educational possibilities. This approach considers the diversity of subjects, different learning rhythms, and the use of DT as instruments of mediation and personalization.

The isolation period of the pandemic and remote education practices highlighted challenges in the educational system and the need for flexible, inclusive methodologies. In this context, Blended Teaching and Distance Education (EaD, as it is called in Brazil and hereafter) gained ground and notoriety. Blended Teaching, regulated by Opinion 34 of 2023 of the National Council of Education (CNE/CP), is characterized as a flexible, technology-mediated approach. Distance Education, on the other hand, is defined as "a synchronous or asynchronous teaching and learning process carried out through the use of information and communication technologies, in which the student and the teacher or other person responsible for the educational activity are in different places or at different times" (Brasil, 2025, p. 2, translated by us).

In the field of Mathematics Education, the challenges posed by remote education have become more apparent, given the inherent complexity of teaching this subject and the specific demands it places on knowledge. In the post-pandemic context, initial and continuing education for mathematics teachers plays a crucial role in critically and creatively integrating DT, fostering the connection between theory and practice, and developing pedagogical skills that meet the demands of contemporary society.

Considering the educational challenges presented, as well as the changes in the current educational paradigm and the evolving profile of students in schools, this study aimed to answer the following question based on a review of the literature: How is blended teaching incorporated into the initial training of mathematics teachers?

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2 STATE OF KNOWLEDGE

Systematizing and analyzing academic productions in one's disciplinary field, especially in one's own country, is essential to laying the conceptual foundations for a qualified study (Morosini; Kohls-Santos; Bittencourt, 2021). To this end, a literature review is conducted. This study adopted the State of Knowledge (SOK) methodology, which is defined as "the identification, registration, and categorization that lead to reflection and synthesis on the scientific production of a given area in a given period, bringing together journals, theses, dissertations, and books on a specific theme" (Morosini; Kohls-Santos; Bittencourt, 2021, p. 2, translated by us).

According to Morosini, Kohls-Santos and Bittencourt (2021), the first step in constructing a State of Knowledge is to delimit the corpus of analysis. This is characterized by searching for academic productions related to the researched topic. This search can be conducted in university thesis and dissertation repositories, the Brazilian Digital Library of Theses and Dissertations (BDTD), the CAPES thesis database, education journals, or other databases.

To systematize the search for works addressing blended teaching in the initial training of mathematics teachers, two databases were chosen: the Digital Library of Theses and Dissertations (BDTD) and the institutional repository of São Paulo State University (UNESP) — due to its significant contributions to mathematics education produced by the graduate program in mathematics education[1]. Subsequently, the descriptors were defined. Morosini, Nascimento and Nez (2021, p. 8, translated by us) defined them as "expressions chosen to standardize synonyms in order to facilitate the location of data in specific databases.".

In September 2024, a search was conducted for papers using the following descriptors: "blended teaching," "initial teacher training," "degree in mathematics," "mathematics," "degree," and "teacher training," according to the combinations described in Table 1. Four different searches were carried out in the Digital Library of Theses and Dissertations and the Institutional Repository of São Paulo State University (UNESP), using a time frame from 2019 to 2024. This generated a total of 44 papers.

Table 1 – Summary of database search.

[1] The Graduate Program in Mathematics Education at UNESP has a concept 7 according to the latest quadrennial evaluation (2017-2020) by CAPES.

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SEARCHED TERM	TITLES FOUND
"blended teaching" AND "initial teacher training" AND "mathematics"	14
"blended teaching" AND "degree in mathematics"	7
"blended teaching" AND "degree" AND "mathematics"	20
"blended teaching" AND "mathematics teacher training"	3
Total	**45**

Source: Prepared by the authors (2024).

Once the corpus was complete, the pre-selected texts were skimmed. This reading aimed to establish initial contact with the data collected by the researcher and generate a general understanding of the texts. This enabled the texts to be organized into three stages: an annotated bibliography, a systematized bibliography, and a categorized bibliography (Morosini; Kohls-Santos; Bittencourt, 2021).

2.1 Annotated Bibliography

After approaching the analysis corpus, the annotated bibliography was created. It is defined as the "organization of complete bibliographic references of abstracts of publications found" (Morosini; Kohls-Santos; Bittencourt, 2021, p. 64, translated by us). At this stage, the works were categorized by year, author, title, keywords, and abstract, as shown in Chart 1.

Chart 1 – Example of systematization of the Annotated Bibliography

No.	YEAR	AUTHOR	TITLE	KEYWORDS
1	2020	TREML, Henrique	Experience with Khan Academy in the initial training of mathematics teachers	Teacher Training; Mathematics; Khan Academy; Learning Platform
ABSTRACT: Nowadays the use of digital resources is present for the most different purposes in different sectors of society, despite the profusion in terms of technological advances, changes in education are slow but inevitable. In this sense, it is urgent that the teacher, to update/help their practice, have knowledge and make use of available digital resources, many of which are free and easily accessible, as in this case, educational platforms. Therefore, this work aims to investigate the contributions that the use of the Khan Academy platform can provide for the initial training of mathematics teachers*.				

Source: Prepared by the authors and extracted from the work in question in chart 1 (2024). *Abstract and Keywords extracted from the original text.

After completing the annotated bibliography, a brief reading of the works was conducted to identify those consistent with the research. The exclusion criteria were themes unrelated to the State of Knowledge, pedagogical practices of curricular components other than mathematics, and works that did not present blended teaching. After excluding works that fell outside the scope of the

investigation, the systematized bibliography was created.

2.2 Systematized Bibliography

After creating the annotated bibliography, it is necessary to further organize the works. At this stage, the systematized bibliography is created. It is defined as a "more targeted and specific selection for the research objective" (Morosini; Kohls-Santos; Bittencourt, 2021, p. 67, translated by us). The works are then categorized by year, author, title, level, objectives, methodology, and results, as shown in Chart 2.

Table 2 – Example of structuring the Systematized Bibliography

No.	YEAR	AUTHOR	TITLE	LEVEL	OBJECTIVES	METHODOLOGY
1	2020	TREML, Henrique	Experience with Khan Academy in the initial training of mathematics teachers	Dissertation	To investigate the contributions that the use of the Khan Academy platform can provide to the initial training of mathematics teachers while they perform their teaching role.	Quantitative-qualitative research of an exploratory nature
RESULTS: As for the contributions of the insertion of Khan Academy in the teaching practice, the fact that it promotes a creative and stimulating environment stands out; enables the monitoring of individual learning, as the teacher observes the student's mistakes, through activity performance reports, can recommend auxiliary content and platform activities to overcome the difficulties; provides greater interaction between teacher and student; makes the class productive and the student more independent in the construction of knowledge. Although the use of digital technologies is common in the daily lives of undergraduates, the insecurity in using them in the classroom persists, and the need for more approaches such as those in this research, using digital resources such as applications and educational platforms in initial training courses, is pointed out**.						

Source: Prepared by the authors and extracted from the work in question in Chart 2 (2024). **Results extracted from the original text.

Thus, the delimitation of the systematized bibliography concluded with the organization and presentation of the list of works that comprise this state of knowledge in Chart 3.

Chart 3 – Works that make up the *corpus* of analysis

Title	Author	Year	Level
Cultural practices (re)constituted when math classes are mediated by the internet in a hybrid environment	Barros, Ana Paula Rodrigues Magalhães de	2019	Thesis
Experience with Khan Academy in the initial training of mathematics teachers	Treml, Henrique	2020	Dissertation
Online continuing teacher training and mobile devices	Gontijo, Elda Jane de	2021	Dissertatio

	Almeida		n
Pedagogical practices adopted by math teachers in the state schools of Assis and Presidente Prudente	Mendonça, Valdirene Gross	2022	Dissertation
Teachers' challenges when teaching math through remote classes at a technology college	Santos, Claudia Pereira dos	2023	Thesis
Aspects between the concepts of Function and Differential and Integral Calculus I in the teaching practice of Mathematics teachers	Barthmann, Jessica Algarve Lopes	2023	Dissertation
Professional development of math teachers in a context of collaborative partnership for the practice of blended teaching in elementary school	Perez, Leonardo Anselmo	2023	Thesis

Source: Prepared by the authors (2024).

After delimiting the analysis *corpus*, the keywords of the works were cataloged and, subsequently, a word cloud was constructed, which helped to delimit the emerging categories.

Figure 1 – Keywords of the works that make up the analysis *corpus*

Source: Prepared by the authors (2024).

Among the works that constitute the *corpus* of analysis of this State of Knowledge on Blended Teaching in the initial training of Mathematics teachers, five are dissertations and three are theses, published between 2019 and 2023. In this sense, graph 1 presents the distribution of works by year and by level.

Graph 1 – Distribution of publications by year and level

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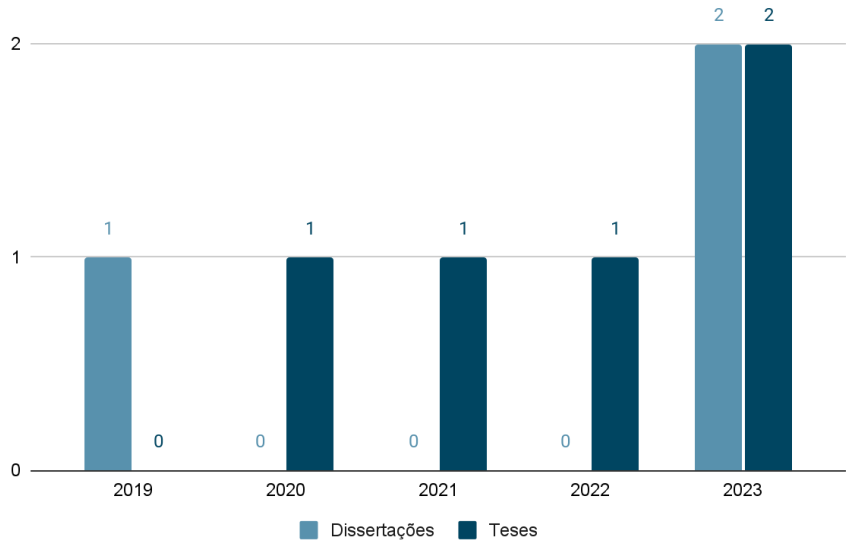

Source: Prepared by the authors (2024).

Regarding the works analyzed, it can be seen that, until 2022, there was a certain consistency in the publication of theses and dissertations. In 2023, however, there was an increase in the number of publications.

2.2 Categorized Bibliography

The analysis of the works was based on Discursive Textual Analysis (Moraes; Galiazzi, 2016). Emerging categories were formed, which the authors defined as those that emerge from data analysis without being previously established by the researcher. The initial categories were defined as follows: Teaching Practices, Initial Training, and Continuing Education. However, as expected, the categories were refined with an in-depth reading of the works and writing of this SOK. The final categories of analysis are as follows: BlendedTeaching, Initial and Continuing Education, and Practices and Reflections on the Pandemic.

3 BLENDED TEACHING

According to Moran (2015), we live in a plural and unequal society. In this society, each student is shaped by a complex web of experiences, exchanges, reflections, histories, and relationships that are interconnected in a vast network of knowledge. In this light, it is clear that each student is

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unique. Thus, standardizing learning makes schools imperfect. According to Moran (2015, p. 28, translated by us), "in a changing, developing, contradictory society with professionals at different stages of cognitive, emotional, and moral development, everything is more complex and difficult. An imperfect school is the expression of an equally imperfect, hybrid, and contradictory society."

Although a decade has passed, the relationship between schools and society remains extremely relevant, especially in the post-pandemic context. In other words, the pandemic has exposed and accentuated existing imperfections and inequalities in educational institutions, revealing the urgent need for a metamorphosis of schools (Nóvoa, 2022). In a constantly changing world where technologies and social dynamics evolve rapidly, schools must evolve to provide critical and reflective education that meets contemporary societal demands.

According to Pérez (2023, p. 21, translated by us), "instead of waiting for information from one source, we now seek information from multiple sources, share stories, and follow what interests us." From this perspective, Moran (2015) pointed out that teaching is hybrid because we are always both teachers and students, building and disseminating knowledge through different media on various platforms in different formats.

According to Moran (2015), education is inherently hybrid because it blends knowledge, values, areas of expertise, and methodologies through activities, games, challenges, and problems, whether collaborative or not, with or without technology, and whether face-to-face or not. Therefore, blended teaching cannot be reduced to merely a blend of face-to-face and online learning. Rather, it should be understood as the articulation of teaching and learning processes in these formats.

Bacich (2020) notes that the term "blended teaching" was adopted during the pandemic to describe the combination of in-person and remote learning activities. Notably, in some of the analyzed studies, the term "hybrid or blended" referred to in-person classes delivered to students at home.

This is evident in the works of Bartmann (2023), Brandão (2023), Santos (2023), Mendonça (2022), and Barros (2019), who presented teacher reports on their practices and activities developed during Remote Teaching. These works point to teachers' lack of preparation for developing activities with digital technologies and their lack of digital fluency, which ultimately leads to the domestication of digital technologies. According to Clesar (2022, p. 175, translated by us):

> Teachers who lack digital fluency cannot create innovative teaching strategies that incorporate digital technologies. They may use digital technologies in their classes, but only through domestication — using the technologies in the same way they use other resources

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> without changing their practice. The expectation is not simply replacing an analog resource with a digital one, such as moving an exercise list from a folder of photocopies to a Moodle environment. Rather, it is the full exploitation of digital technologies' potential to create learning situations that would not be possible without them.

Contrasting these experiences, Perez (2023, p. 22, translated by us) points out the differences between the concept of Blended Teaching and the practices adopted during Remote Teaching.

> What differentiates the capitalized term "Blended Teaching" (BT) from what was discussed during Emergency Remote Education is the role of technology. In the BT advocated in this research, technology is not just a way to deliver content or deliver a lesson to students who are not in school. Digital technologies must support personalization, considering different languages and the plurality of teaching and learning methods, as well as data collection and identification to improve student learning.

The author points out that the main distinction between blended teaching and remote teaching lies in the role of digital technologies in teaching and learning processes and how they are used. Generally, remote teaching was an improvised adaptation in an emergency, while blended teaching proposes a more strategic use of digital tools. In blended teaching, digital technologies facilitate personalized learning, allowing each student to progress at their own pace and explore different resources. This contributes to a more flexible education that meets the needs of individual students.

According to Horn and Staker (2015, p. 34, translated by us), Blended Teaching has three components. The first part refers to online learning and states that "Blended Teaching is any formal educational program in which a student learns, at least in part, through online learning, with some element of student control over time, place, path, and/or pace."

Horn and Staker (2015) also emphasize that blended teaching is not characterized by the casual use of digital technologies to deliver lessons and activities. To be considered blended, a learning environment must offer digital activities integrated into a structured school curriculum. Furthermore, the definition emphasizes the importance of online learning, which goes beyond the use of basic tools. Students' ability to control the pace, content, and location of their studies is a fundamental element of blended teaching that differentiates it from live-broadcast classes.

The second part of the Blended Teaching definition states that "students learn, at least in part, in a supervised physical location away from home" (Horn; Staker, 2015, p. 35, translated by us). According to this definition, students must attend a school with teachers or supervisors who can guide them through the learning process. Otherwise, the approach would not be characterized as blended

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teaching.

The final part of the definition states that "the modalities along each student's learning path in a course or subject are connected to provide an integrated learning experience" (Horn; Staker, 2015, p. 35, translated by us). Therefore, the online and in-person components must work together to provide integrated teaching and avoid overlapping concepts and activities.

Furthermore, it's important to emphasize that students of the same age have different needs and predispositions due to the diversity present in each classroom. In other words, students do not all learn or interact with each other, their teachers, or technology in the same way. Therefore, teaching must allow for "personalization," enabling each student to create their learning path. According to Bacich, Tanzi Neto and Trevisani (2015, p. 51, translated by us),

> A personalized learning project that truly serves students requires them to collaborate with their teacher to outline their learning process and select resources that best align with their learning style. When reflecting on personalized teaching, aspects such as pace, time, place, and learning style are relevant.

Furthermore, the authors argue that digital technologies and online teaching are essential for personalized learning. This new educational reality requires new methodologies and reconfigured roles for teachers, students, and educational institutions. Therefore, it is crucial for teachers to adapt their pedagogical practices and explore alternative learning methods. Additionally, educational institutions must develop resources to support this approach.

Hybrid Teaching is currently characterized by a more sophisticated and dynamic approach that integrates multiple methodologies, environments, and educational contexts. This enables the development of flexible, personalized learning spaces that respond to individual student needs and foster meaningful interactions between teachers and students (Santos, 2024).

In short, blended teaching emerges as a response to the demands of a constantly changing society characterized by the hybridization of knowledge, technologies, and forms of interaction. As Moran (2015) advocates, the blended teaching proposal transcends the mere combination of in-person and online learning. It encompasses a pedagogy that integrates different resources, models, methodologies, and learning environments to meet the diversity of students' needs and learning styles.

4 INITIAL AND CONTINUING TRAINING

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Education is an interactive process involving people with different levels of knowledge, with the purpose of sharing and constructing knowledge. In a school setting, this dynamic presupposes the participation of individuals with varying educational experiences. Those with more knowledge and experience work alongside those in the early stages of learning or with less mastery of knowledge and practices. The goal is to promote social, moral, cognitive, and affective development within a specific historical context. Whether face-to-face or remotely, people give meaning to this process.

In school settings, teachers are responsible for facilitating learning processes. Thus, training educators plays a central role in formal educational processes, contributing to the construction of a civilization that promotes better living conditions and more inclusive participation for all (Gatti, 2014).

Therefore, initial training must promote the ability to investigate and master different ways of accessing information and develop the critical capacity to evaluate, gather, and organize relevant information. (Albuquerque; Gonçalves; Bandeira, 2020).

Furthermore, integrating emerging technologies into pedagogical practices is essential to improving the current educational system. This fosters the development of competencies and skills that promote student autonomy in the digital age and enable them to thrive in a more connected society. Clesar and Giraffa (2022) emphasize the importance of offering students diverse learning experiences through various digital technologies and teaching methodologies. This allows students to develop teaching strategies based on these technologies during their initial training and teaching practice.

From this perspective, Treml (2020) highlights the importance of implementing practices that utilize digital technologies, as students have grown up in a daily life immersed in these technologies, making learning more natural and meaningful. We can highlight the concern for basic education here:

> To efficiently integrate digital tools into teaching practices, ongoing training is essential, especially for initial teacher training. Teacher training should incorporate diverse perspectives and learning theories to provide teachers with a solid foundation and help them determine which approach best fits their teaching style. This allows teachers to be open to incorporating different approaches to continually improve and expand their teaching (Treml, 2020, p. 17, translated by us).

Concerning the above, Gatti (2014) points out that traditional initial training has proven ineffective in preparing new teachers because it is theoretical and disconnected from current school realities. For the author, it is necessary that initial training has a "[...] permanent mobilization of

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knowledge acquired in work situations, which will constitute subsidies for training situations and, from these, for new work situations" (Gatti, 2014, p. 39, translated by us).

However, Figueira and Fontoura (2024) reveal a professional identity crisis in which teaching is heavily based on technicalities, and education merely serves as a manual for presenting formulas and concepts. The authors argue that the "conception-programs-training" triad is partly responsible for this identity crisis and requires structural changes to develop quality initial training.

Imbernón (2011) asserts that during initial training, it is crucial to develop the knowledge necessary for classroom practice through various teaching sessions. Furthermore, De Paula and Fiorentini (2023) argue that teachers must be able to transcend mathematical concepts. In other words, teachers must connect mathematics with students' realities and its social uses to make their practice useful and indispensable to students.

In this sense, Treml (2022) emphasizes the importance of incorporating digital technologies into mathematics education, as these technologies are becoming increasingly prevalent in students' daily lives.

According to the author, it is essential to incorporate digital technologies into initial training so that undergraduates can use these resources in their future pedagogical practices.

Gontijo (2021) indicates that to appropriately implement DT in the classroom, it is necessary to not only rethink initial training and take a critical and reflective look at it, but also adapt the profile of teacher trainers and the initial training curriculum.

> This possibility of professional innovation requires a reflective analysis of the role of digital technologies in teacher training. We understand that training programs require transformations in their curricula and in educators' conceptions of professionals in training for teachers to be able to use digital technologies in their teaching practices (Gontijo, 2021, p. 82, translated by us).

To this end, it is crucial that, in addition to rethinking initial teacher training, attention is also focused on continuing education. In this regard, Gontijo (2021) emphasizes the importance of professional contexts for the continuing education of mathematics teachers.

> We understand that preparation is an ongoing process of teacher education. These ongoing efforts allow teachers to learn about new resources and create communities of dialogue, reflection, and experience-sharing that motivate them to implement practices that facilitate knowledge construction (Gontijo, 2021, p. 80, translated by us).

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It is also essential that continuing education meet the needs of its intended audience. Continuing education "is not a proposal that seeks to standardize teaching; on the contrary, we seek to highlight the relevance of in-service training that takes into account the context of teachers and their possibilities for continuing education" (Gontijo, 2021, p. 82, translated by us). In this case, the conceptual gaps in continuing education courses are highlighted. Teacher reports point to continuing education courses that present tools but lack conceptual depth and how they can be used more critically and in-depth, since "professional training emphasizes the use of communication technologies but does not mention or demonstrate the use of applications for understanding and using mathematical calculations" (Santos, 2023, p. 21, translated by us).

According to Modelski and Giraffa (2022, p. 84, translated by us), "it is necessary to promote moments of interaction and integration among teachers to facilitate the sharing of experiences that encourage reflection on didactic possibilities." Likewise, Imbernón (2024) argues that continuing education cannot happen in isolation and that integration among teachers is necessary, given that continuing education is linked to a socio-historical moment.

Despite social transformations driven by technological advancement and the presence of these technologies in daily life, schools still operate within traditional structures. As Imbernón (2024) discusses, changes in schools and universities have been limited, reflecting a resistance to innovation. Therefore, educational transformation must extend to both initial and continuing teacher training. In this context, Nóvoa and Alvim (2021) emphasize the need to reevaluate the role of teachers in contemporary society. They highlight that the urgency of teacher training, which integrates new technologies and promotes critical and reflective pedagogical practice, was brought to light by the pandemic. Thus, teacher training must be restructured to meet the demands of a constantly evolving society and ensure that education becomes a dynamic, adaptable process.

5 PRACTICES AND REFLECTIONS DURING THE PANDEMIC

While reading the works that comprise this State of Knowledge, a common thread emerges. Most of the works reflect on the pandemic context that has been experienced since late 2019. One factor that significantly impacted teachers' performance during this period was their lack of preparation for the new paradigm that emerged.

Since the pandemic occurred unexpectedly, the vast majority of teachers were unprepared to

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work remotely. As the pandemic unfolded, no prior training was available, leaving teachers unsure of how to adapt.

According to Barthmann (2023), in this context, schools and universities moved their classes to remote teaching as soon as they realized the virus would not be temporary, seeking to maintain continuity in teaching activities. Teachers had to adapt their practices to this new teaching format and develop strategies with the help of technology.

However, this adaptation required greater commitment from teachers because they had to balance work, family, chores, classes, and personal demands, often in the same environment. Furthermore, remote teaching presented several challenges, including an increase in activities, an excessive workload, and everyday problems within each person's home.

> With several courses and meetings taking place virtually, something we hadn't anticipated happened: the pressure was intense, causing mental fatigue for me and several of my colleagues. Teachers also complained about being overworked; it was a very stressful period. Because we were socially isolated, not only did we have to study a lot, but we also faced challenges such as internet difficulties, power outages during orientation meetings or during classes, having family at home, and, sometimes, external noises, such as crying children and pets, among other factors, hindered the teaching and learning process (Barthmann, 2023, p. 24, translated by us).

Thus, the main difficulties highlighted by the teachers interviewed in Barthmann's (2023) research include excess work, inappropriate environments, difficulties using the internet, an inadequate electrical system, and a lack of psychological support.

Furthermore, teachers did not naturally adapt their practices. According to Barthmann (2023), teachers' unfamiliarity with DT led to difficulties adapting classes and assessments. Not only were DTs rarely used, but when they were, their use was limited to presentations, which only changed the lecture technique (Silva, 2023).

Modelski, Giraffa and Casartelli (2019) define digital fluency as the ability to perform in-person and virtual tasks with digital technologies and their impact on teaching. Thus, as Clesar (2022) highlights, digital fluency influenced, but did not determine, pedagogical practices during remote teaching. Teachers with greater digital fluency demonstrated greater fluidity in working in the digital environment.

Another notable point is the low level of student participation. Júnior and Monteiro (2020) point out that students were shy during remote classes. This occurs because teacher mediation is

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essential for the effective use of DTs, since the mere use of these resources does not guarantee achievement of pedagogical objectives.

> [...] it's been difficult for everyone, but there are a lot of people just waiting for things, so, for example, I had 50 or more students who entered the Classroom, [...] I can count on one hand which students or how many students participated, who asked a question or brought an exercise to clarify doubts, [...] in the end, you don't know who is participating and who isn't, those who are there asking questions you still know are participating, the rest you don't know if they are sleeping, if they left or not, because you see that they stay logged in there, and there are students sometimes that even you leave the Meet and then they are still there (Barthmann, 2023. p. 148, translated by us).

As such, it is evident that students rarely participated in synchronous moments during remote teaching, resulting in low attendance and engagement. This was characterized by closed cameras and microphones, which made teachers feel isolated (Clesar, 2022).

Several studies, including those by Barthmann (2023), Brandão (2023), Santos (2023), Treml (2022), and Perez (2023), highlight the importance of face-to-face interaction for teachers. In Brandão's (2023) study, teachers interviewed identified face-to-face interaction as the primary difference in remote teaching. Students' body language is crucial in teaching and learning processes, but it cannot be considered in an online context with closed cameras. This has made remote teaching more challenging.

Another significant factor is the lack of definition regarding the teaching modality developed during the pandemic. "[...] what we did is not Distance Education, what we did is a remote activity that we adapted; no one prepared the course to be distance learning, the course is in-person, and we did our best" (Barthmann, 2023, p. 160, translated by us).

Similarly, Bacich (2020) notes that the term Blended Teaching was adopted to describe the pedagogical practices developed during the pandemic because it was difficult to define these practices.

The pandemic certainly revealed several weaknesses in mathematics teacher training and practice, such as a lack of familiarity with DT, which hindered everything from planning to evaluation and permeated the entire teaching practice. Other weaknesses include a lack of ongoing DT training, work overload, and limited student access to technology and the internet.

6 FINAL CONSIDERATIONS

The objective of this State of Knowledge was to deepen the understanding of how Blended

Teaching manifests itself in the initial training of mathematics teachers and to investigate its relevance in developing teaching practices. However, the corpus analysis revealed an incipient incorporation of personalized educational proposals in mathematics teacher training and significant reflections on remote learning experiences. This demonstrates that although blended teaching has gained relevance in education in recent years, its presence in initial training is still incipient compared to basic education. This fact underscores the importance of blended teaching in training new mathematics teachers.

Throughout the development of this study, contradictions within an educational system that still operates with outdated structures were uncovered. These contradictions are evident throughout the works that comprise this SOK. The pandemic undoubtedly revealed vulnerabilities in the educational system but also opened space for reflection and innovation, placing teachers at the center of tensions ranging from the need to master digital technologies to the urgency of rethinking teaching methods to accommodate an increasingly diverse student population.

On the other hand, traditional initial teacher training models are inadequate. They fail to provide future teachers with the didactic, pedagogical, and technological framework necessary to address the complexities of the current educational context. In other words, teachers are being trained using a model that no longer meets contemporary societal demands.

The challenges teachers face in remote teaching have revealed significant weaknesses and opportunities for transforming education. One of the main challenges teachers face in remote teaching is excessive workload. In other words, planning and implementing classes that integrate in-person and online activities requires considerable effort, often without sufficient support from educational institutions. Furthermore, a lack of technological infrastructure, such as quality internet access and adequate devices, poses a significant barrier for many teachers, particularly those in less developed regions. The pandemic has certainly exacerbated these issues, exposing the precarious working conditions of many teachers and the necessity of public policies that invest in improving these conditions.

Another significant challenge is the lack of familiarity with digital technologies. Many teachers reported difficulty adapting their teaching practices to an online environment, particularly when creating interactive activities and assessments. This lack of preparation reflects gaps in initial training and the absence of ongoing training that consistently, practically, and reflectively addresses the potential and limitations of digital technologies in education.

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Effective implementation of Blended Teaching requires a collaborative effort between public policies, educational institutions, and teachers. Therefore, it is essential to create conditions that enable teachers to proactively and innovatively address the challenges of blended teaching. This requires investments in technological infrastructure, revisions to teacher training curricula, and promotion of pedagogical practices integrating different methodologies and technological resources. Only then can we build a more inclusive, personalized education system that aligns with the demands of a constantly changing society.

Finally, this State of Knowledge overviews the inclusion of blended teaching in the initial training of mathematics teachers and highlights the need for new research articulating these fields, particularly regarding pedagogical practices based on blended teaching by mathematics teachers in basic education and the formative itineraries these teachers follow.

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