

Impacts of a continued Mathematics Education program on teaching practice in public schools of Jaguariaíva, Paraná

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2238-0345 

10.37001/ripem.v14i1.3631 

Received • 19/09/2023

Approved • 31/01/2024

Published • 18/03/2024

Editor • Gilberto Januario 

Abstract: This article investigates the effects of a continuing education program in Mathematical Education for early elementary school teachers in Jaguariaíva, Paraná. The research, carried out within the Postgraduate Program in Science and Mathematics Teaching at Lutheran University of Brazil, adopted a qualitative approach, using questionnaires, reports, and observations. The training program, grounded in the National Common Curricular Base (BNCC) and school demands, emphasized playfulness and the use of digital technologies. The results showed positive impacts on teaching practices, including the acquisition of skills for remote teaching during the Covid-19 pandemic. The importance of the BNCC and continuous education to enhance pedagogical practice and the curricular of initial education courses is highlighted.

Keywords: Continuing Teacher Education. Mathematics Education. Elementary School. Teaching Practice. BNCC.

Impactos de un programa de formación continuada en Matemáticas en la práctica docente en escuelas públicas de Jaguariaíva, Paraná

Resumen: Este artículo investiga los efectos de un programa de formación continua en Educación Matemática para profesores de los primeros años de Educación Primaria en Jaguariaíva, Paraná. La investigación, realizada en el marco del Programa de Posgrado en Enseñanza de las Ciencias y las Matemáticas de la Universidad Luterana del Brasil, adoptó un enfoque cualitativo, utilizando cuestionarios, informes y observaciones. El programa de formación, basado en la Base Nacional Común Curricular (BNCC) y en las demandas escolares, enfatizó la ludicidad y el uso de tecnologías digitales. Los resultados mostraron impactos positivos en las prácticas docentes, incluyendo la adquisición de habilidades para la enseñanza remota durante la pandemia de Covid-19. Se destaca la importancia de la BNCC y de la formación continua para mejorar la práctica pedagógica y los currículos de los cursos de formación inicial.

Palabras clave: Formación Continua de Profesores. Educación Matemática. Educación Primaria. Práctica Docente. BNCC.

Impactos de um programa de formação continuada em Matemática na prática docente em escolas públicas dos Anos Iniciais de Jaguariaíva

Resumo: O presente artigo investiga os efeitos de um programa de formação continuada em Educação Matemática para professores dos anos iniciais do Ensino Fundamental, em Jaguariaíva, Paraná. A pesquisa, realizada no âmbito do Programa de Pós-Graduação em Ensino

de Ciências e Matemática, da Universidade Luterana do Brasil, adotou uma abordagem qualitativa, utilizando questionários, relatórios e observações. O programa de formação, pautado na Base Nacional Comum Curricular (BNCC) e na demanda escolar, enfatizou a ludicidade e o uso de tecnologias digitais. Os resultados mostraram impactos positivos nas práticas docentes, incluindo a aquisição de habilidades para o ensino remoto durante a pandemia de Covid-19. Ressalta-se a importância da BNCC e da formação continuada para aprimorar a prática pedagógica e os currículos dos cursos de formação inicial.

Palavras-chave: Formação Continuada de Professores. Educação Matemática. Anos Iniciais. Prática Docente. BNCC.

1 Introduction¹

The year 2019 was considered the "Year of Mathematics" in the city of Jaguariaíva, in the state of Paraná, Brazil. During this period, a continuing education program for teachers was instituted, with the purpose of refining their didactic and methodological skills in Mathematics. This article, derived from research conducted in the *Programa de Pós-Graduação em Ensino de Ciências e Matemática* (PPGECIM) at the *Universidade Luterana do Brasil* (ULBRA), aims to present the results of the investigation. The research, conducted by the first author and guided by the second, explored the impacts generated by the continuing education on teaching practice.

The continuing education program analyzed was carried out in 2019 by the city with the aim of promoting the improvement of Mathematics teaching in the Elementary School through teacher education. The target audience was teachers working in that stage of education, in the municipal network. The program was structured in six face-to-face meetings, with a total workload of 48 hours, covering topics such as: the guidelines of the *Base Nacional Comum Curricular* (BNCC) for teaching Mathematics; innovative pedagogical practices using games and playful activities; and integration of digital technologies in teaching. The methodologies involved group dynamics; case studies; analysis of teaching materials; and collaborative construction of teaching proposals. The program development sought to promote a critical reflection on teaching practices and the improvement of Mathematics teaching strategies.

The program was instituted after the identification, in an internal evaluation, of the need for specific improvement in training in Mathematics Education, especially in areas such as teaching methodologies and integration of digital educational technologies. Adopting a qualitative, *ex-post-facto* approach, the research evaluated the contribution of continuing education to changing teachers' pedagogical practices, including during remote teaching, derived from the Covid-19 pandemic. Various instruments such as questionnaires and observations formed the empirical basis for this evaluation.

Preliminary results suggest that the continuing education had a significant didactic-methodological impact, inserting in the teachers' practice the tools necessary to face the challenges of the pandemic (Padilha Junior, 2023). However, it is essential to note that the research was contextualized in the experiences of teachers in Jaguariaíva, between 2019 and 2021, which may limit its generalization to other contexts.

In addition to presenting the research results, this article aims to contribute to the body of literature on teacher education in Mathematics in Brazil, together with other research, such as those carried out by Berneira (2021), Pertile and Justo (2020) and Rodrigues and Groenwald (2018).

¹ This article is part of the master's thesis defended in the *Programa de Pós-Graduação em Ensino de Ciências e Matemática*, at *Universidade Luterana do Brasil*, written by the first author and supervised by the second author.

The study highlights the importance of robust continuing education programs, capable of promoting reflection, innovation and adaptability in the face of contemporary educational demands. The results can also be a valuable contribution for policy makers and educators in the development and implementation of effective continuing education programs in Mathematics Education.

The article structure was organized to include a brief theoretical background of the research, exploring aspects of initial and continuing teacher education, with the contribution of authors such as Gatti (2009), Tardif (2020), Imbernón (2021) and D'Ambrosio (1993). Next, the methodology used in the research is presented, the results obtained from course participation questionnaires, observations, document analysis, reports and semi-structured interviews conducted with the participating teachers. Finally, we culminate in the final research considerations.

2 Theoretical Foundation

Teacher education, in its various nuances, has been the object of study and reflection in the educational context. Gatti (2009) highlights the importance of teacher education as a fundamental aspect of formal educational processes. The author emphasizes that education is a cultural process, inserted in a culture and in lifestyles. Tardif (2020) reinforces this view by stating that the teaching profession requires teachers' own knowledge, which transcends technical knowledge and is based on identity, life experience and professional experience. The author also highlights that teacher knowledge involves social practices and is susceptible to changes over time.

Both authors agree that teacher education needs to be rethought and improved. Gatti (2009) emphasizes the importance of effective and constant training practices in training institutions and highlights the precarious working conditions faced by teachers. In addition, the author emphasizes the need to integrate, in educational practices, elements that transcend mere technical knowledge, advocating a holistic approach to teacher education:

The perspective is that of an integrative vision that can outline the fruitful combinations of educational activities in the direction not only of important learning in a given context, but also of the development of attitudes and behaviors that allow coexistence, sharing, tolerance, within the limits of consensus/dissent, as well as in the direction of personal development of each student. (Gatti, 2009, p. 164, our translation).

This perspective highlights the importance of teacher education that addresses both pedagogical skills and the human and social development of students, reflecting on how teachers can be agents of change in this context.

Thus, in the Brazilian context, Gatti (2009) highlights the relevance of considering the cultural and social heterogeneity of students and teachers during the training process. Tardif (2020) emphasizes the need to consider teaching knowledge as social knowledge, built throughout the career. The authors agree that teacher education and career must be thought of in an integrated way, highlighting the centrality of the teacher in the educational process.

With regard to the continuing education of teachers, the dialogue between Imbernón (2021), Tardif (2020) and Gatti (2009) brings reflections on teacher education in the 21st century. Imbernón (2021) highlights the need for changes in the training model, considering current challenges and influences of globalization. He criticizes the continuing education

programs of recent decades for the lack of effective changes, thus advocating training integrated into the work context and improvements in working conditions:

No que se refere à formação continuada de professores, o diálogo entre Imbernón (2021), Tardif (2020) e Gatti (2009) traz reflexões sobre formação docente no século XXI. Imbernón (2021) destaca a necessidade de mudanças no modelo de formação, considerando os desafios atuais e as influências da globalização. Ele critica os programas de formação continuada das últimas décadas pela ausência de mudanças efetivas, defendendo, assim, uma formação integrada ao contexto de trabalho e aprimoramentos nas condições laborais:

the permanent training of teachers will be essential that the method is part of the content, that is, what is intended to be taught will be as important as the way of teaching [...] we cannot separate training from the work context or we will be mistaken in speech [...] everything that is explained does not work for everyone or everywhere (Imbernón, 2021, p. 9-10, our translation).

Gatti (2009), Tardif (2020) and Imbernón (2021) agree that training should go beyond the transfer of knowledge and consider current complexity. They highlight the importance of reflection, valuing the profession, and changes in the education system.

Tardif (2020) highlights the articulation between theory and practice, as well as the valorization of teaching knowledge. Gatti (2009) complements by addressing the need for effective policies and investments. In turn, Imbernón (2021) criticizes decontextualized models and advocates reflective and contextualized training. In short, it is essential to have training that recognizes and values teaching knowledge, promotes critical reflection, and takes into account the challenges teachers face in their work. This comprehensive vision is essential to improve education and professional development.

Considering the training of teachers who teach Mathematics, according to D'Ambrosio (1993), it is necessary to understand Mathematics as an investigative discipline, in which progress occurs through research and problem solving. The author emphasizes that teachers need to understand that the Mathematics studied should be useful for students, helping them understand and organize reality. In addition, she advocates changes in teacher education programs, aiming at investigative and meaningful teaching of the discipline.

D'Ambrosio (1993) shares the same idea as the other authors cited in this section, emphasizing the importance of teachers experiencing practical classroom experiences during their training. In addition, according to the author, it is necessary to historically analyze the development of Mathematics and reflect on its constantly evolving character. The proposal to maintain contact with basic education from the beginning of training also converges with other perspectives.

Thus, D'Ambrosio's (1993) conceptions of teacher education dialogue with the views of Gatti (2009), Tardif (2020) and Imbernón (2021), emphasizing the integration between theory and practice, for effective and relevant Mathematics Education. It is crucial to investigate how these theories manifest themselves in the continuing education of teachers, as detailed in the Results and Discussion section.

3 Methodology

This study, which deals with the effectiveness of continuing education for Mathematics teachers, adopted a qualitative approach, with the aim of understanding the complexity and meanings attributed by teachers to their experiences. It was a descriptive and applied research,

seeking to establish relationships between continuing education and its impacts on pedagogical practice.

Ludke and André (1986) characterize qualitative research in education as one that emphasizes the interpretation of meanings attributed by subjects to their experiences and practices. This approach is essential when one intends to understand educational problems in all their complexity and in their real context, which corresponds to the purpose of this study. The authors further emphasize that qualitative studies in education allow portraying the participants' perspective, their values, beliefs, opinions and meanings, elements that are central to the research carried out.

In this scope, qualitative research, as described by Richardson (1999) and Denzin and Lincoln (2006), is essential to describe the complexity of specific problems, examine the interaction of variables, and understand dynamic processes experienced by social groups. Such research allows an in-depth and detailed approach, involving the use and collection of a variety of empirical materials. This focus was particularly suitable for the study, which sought to understand the impacts of continuing education on the pedagogical practice of Mathematics teachers, an area that involves nuances and complex variables in its educational context. The qualitative methodology allowed capturing the richness and depth of the teachers' experiences, offering valuable contributions about their perceptions, attitudes, and practices, which would not be possible through traditional quantitative methods.

With regard to the applied research aspect, the focus is on generating knowledge for the practice and solution of real problems (Minayo, 2001). In this sense, the adopted methodological approach is consistent with the applied nature and objectives of the research, seeking to produce knowledge about a practical problem (teacher education) and its real context (the participating schools).

Ten elementary school teachers who had participated in the continuing education program in Mathematics in 2019 were interviewed. They were intentionally selected based on criteria such as: participation in the teacher education, classroom teaching, and availability.

The teacher training program was structured in six meetings, namely: February 1, with 241 participants; February 16, with 91 participants; March 16, with 67 participants; April 27, with 52 participants; May 18, with 55 participants; and July 27, with 207 participants, totaling 48 hours of course load, so that each of the meetings had specific objectives.

In the first, "Alternative Methodologies for Teaching Mathematics", emphasis was placed on the transition between Early Childhood Education and Elementary School, addressing Mathematical Literacy and the thematic units of the BNCC. The second meeting focused on the theoretical foundation and adaptation of content to the local reality of teachers, culminating in the proposal of a practical task.

In the third and fourth meetings, the training focused on interactive discussions and practical workshops. Through conversation circles, everyday situations and their relationship with the BNCC and the Curriculum Framework were addressed, encouraging reflection on the difficulties and facilities encountered in educational practice. This process resulted in the creation of an activities portfolio, reinforcing the practical application of concepts. The fifth meeting, an extension of the practical workshops, included the "Practice Fair", in which teachers shared strategies, activities and games developed, highlighting the application of acquired knowledge.

The sixth and final meeting revisited the theme of "Alternative Methodologies for Teaching Mathematics", but with a focus on practices for Early Childhood Education and Early

Elementary School. Through interactive activities and practical demonstrations, teachers were encouraged to apply concepts in different areas of Mathematics, such as counting and sorting. This meeting synthesized the learnings from the previous ones, reinforcing the integration of theory into practice and highlighting the importance of continuous updating in the teaching of Mathematics.

Data collection was done through individual semi-structured interviews, which allowed an open discussion about the teachers' experiences. The interviews were recorded, transcribed, and analyzed following the steps of Discursive Textual Analysis (DTA): unitarization, categorization, and meta analysis. The criteria used for selecting interviewees were: "participation in at least one class of the training program, working in elementary school classes in the Network and working as a classroom teacher in the period between 2018 and 2021, in at least one year" (Padilha Junior, 2023, p. 30, our translation).

The collected data were analyzed using the DTA following the theoretical-methodological guidelines of Moraes and Galiuzzi (2016), which allowed the identification of emerging themes and patterns. DTA seeks to understand the meanings attributed by the researched subjects to their experiences and practices, so it involves unitarization, categorization, and production of analytical metatexts. Through DTA, it was possible to identify recurring thematic categories in the teachers' statements and interpret them in light of the research objectives and theoretical assumptions.

In our investigation, the categorization was carried out based on the careful reading of the participants' speeches, seeking to identify the central terms and ideas present in each sentence. Then, sentences with similar terms and meanings were grouped together, generating initial categories. These categories underwent refinements, being regrouped until reaching the final categories. For example, sentences mentioning that initial training does not adequately prepare for teaching Mathematics were gathered into the same category, which are discussed in this article. The process involved careful analysis of speeches, comparison between them, and synthesis through categorization, following the principles of DTA.

The final categories therefore condense the main senses shared by the participants in relation to each investigated aspect, such as: the challenges of initial education; the contribution of continuing education; and changes in attitude and posture after teacher education. These categories emerged inductively from the speeches and their progressive semantic grouping.

Based on the methodological description presented here, the study sought to answer questions about the didactic-methodological impacts of continuing education, the use of knowledge acquired during the pandemic, and the robustness of teacher education in pre- and post-pandemic periods. Despite the methodological care, the study has limitations, such as the small number of participants and the focus on a single educational context, which restricts the ability to generalize results. Further research with larger samples and in multiple contexts is recommended.

The study was approved by the Research Ethics Committee with Human Beings of the *Universidade Luterana do Brasil*, under the number: 58596422.0.0000.5349, in addition to the funding, through the *Programa Suporte à Pós-Graduação IES Particulares* (PROSUP), *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES), demonstrating ethical rigor and institutional support. The methodology adopted allows an in-depth exploration of a complex problem, bringing valuable contributions about the impacts of continuing education on teaching practice in Mathematics.

4 Results and Discussion

The final stage of our research was dedicated to understanding the role of teachers in the transition and adaptation of education in the city of Jaguariaíva, including in the face of the challenges imposed by the Covid-19 pandemic. This period, which extended from 2020 to 2022, was marked by a series of transformative events in the educational sphere.

In 2019, the training program was applied, followed by the introduction of the *Base Nacional Comum Curricular* (BNCC), the new Municipal Education Guidelines and the guiding document of the curriculum, known as Rights and Learning Objectives. All these reforms played a crucial role in shaping the pedagogical practice of teachers. However, the first weeks of classes in 2020 brought with them the challenges of the pandemic, which required significant changes in the approach and pace of work of educators.

The gradual return to in-person classes in the second half of 2021 presented a new dynamic for teachers. Still confronted with the risks of overcrowding in school environments, the continued use of protective masks and the need for intensified hygiene, teachers found gaps in the academic development of students. Such challenges became particularly evident in the areas of Languages and Mathematics, requiring significant pedagogical interventions on the part of educators.

Given this scenario, the interviews conducted in 2022 sought to understand to what extent the training received in 2019 - the last to take place in person and the most relevant in terms of familiarization with the BNCC and Mathematics teaching practices - was instrumental for teachers. In particular, the goal was to discern how this training influenced the critical posture of teachers towards teaching and interaction with students, encompassing pedagogical practices aligned with Mathematics Education and the use of innovative and meaningful strategies. This investigation focused both on the period before the pandemic, during remote teaching and in the subsequent phase of return to in-person classes until the end of the first half of 2022.

In addition, the research sought to dialogue with teachers about their training, both initial and continuing, and understand how the 2019 training impacted their practices in Mathematics. The attitudes of teachers in relation to teaching Mathematics in the midst of the pandemic and the return to in-person classes were also explored. The detailed discussion of these issues and their respective analyzes will be addressed below.

4.1 Initial education

The first issue addressed in the interviews was the initial education of teachers and their preparation for teaching Mathematics. The results revealed that, unanimously, the participants consider that initial education does not adequately prepare teachers for teaching this subject.

This finding is consistent with previous studies, such as those by Gatti (2009) and Tardif (2020), which point out significant gaps in initial teacher education courses. The interviewees emphasized that it is professional practice, experiences outside the workplace and pedagogical assistance that shape teaching knowledge and skills, especially in Mathematics. In addition, some teachers mentioned the occurrence of negative experiences or fear in relation to teaching this subject, which can impact their approach in the classroom.

Such evidence was observed in the teachers' narratives, as according to P2: "the practice for teaching Mathematics took place from daily life in the classroom"; for P6: "it is practice that shapes our practice, especially in Mathematics"; and P8 stated that: "initial education did not provide enough practice for teaching Mathematics". Regarding initial education, teachers'

reports showed that it is considered fragile, depending on pedagogical support from colleagues and coordination. The evidence could be noted in the phrases of P3, P9 and P10, respectively:

Initial education is fragile. The teacher depends on pedagogical assistance throughout his career as a way of complementing it.

For many years I taught the subjects as my teachers taught them in school.

At the beginning of my career I taught Mathematics the way I learned it in school.

The word "fear" appeared in P7's story:

My experience with Mathematics was very frustrating and I created 'fear' with the process of teaching this subject.

The research also revealed that the curriculum of Pedagogy courses, according to the Gatti and Nunes (2009) study, is fragmented and poorly connected to teaching practices. The specific disciplines of professional education emphasize the "why" of teaching, but neglect the aspects of "what" and "how" to teach. This leads to a lack of adequate development of the skills necessary for teaching.

Tardif (2020) argues that teachers must have autonomy over their training, regardless of where it takes place. Therefore, it is essential to consider the knowledge acquired by teachers during their training and professional experience when defining content and education methods, both in initial and continuing education. To reinforce this information, it was possible to verify in the narratives of the interviewed teachers such evidence.

P1 mentioned that initial education:

Provides an insufficient basis for what is developed on a daily basis.

For P4:

Pedagogy did not provide sufficient basis for practice.

In turn, P8 stated:

I learned more from my work than in college.

It is concluded, therefore, that the initial education of teachers needs to be improved to adequately prepare them for teaching Mathematics. Greater alignment between theory and practice is necessary, as well as greater emphasis on specific professional knowledge. Collaboration between education specialists and teachers is essential to promote quality initial education that meets the demands of teaching practice.

4.2 Continuing education

The data analysis revealed that continuing education is seen by teachers as an opportunity to access new information and experiences, allowing the exploration of different teaching methodologies and promoting significant changes in teaching practice. This

perspective is aligned with Imbernón's (2021) criticisms of generic training models, which do not consider the specific problematic situations faced by teachers.

However, it is important to emphasize that the continuing education offered to the researched teachers was personalized and contextualized, focusing on the reflection on teaching practice and the development of new skills and competencies. The teachers' reports indicate that they were able to absorb new approaches and teaching techniques, adapting them to their realities and achieving positive results in their practices. The interviewees' narratives demonstrate this aspect, as P6 reported:

With continuing education there is a lot of transformation in our practice and it provides moments of reflection and significant changes in the direction of our work.

For P9, the continuing education allowed him to understand the paths to teaching Mathematics:

I was able to understand simple processes involving the understanding of Mathematics and I took that to the classroom.

In P1's conception, training was a sharing point:

In continuing education we have access to different teaching methodologies, dialoguing with trainers and colleagues and exchanging experiences.

This distinct approach to continuing education is in line with Imbernón's (2021) proposals, which advocates the need to discuss problematic everyday school situations and involve teachers as active protagonists in their own education process. The author emphasizes the importance of individual and collective reflection on educational practices and the need for teachers to become reflective and researchers.

Also according to Imbernón (2021), continuing education must be comprehensible, so that its objectives are clearly explained and it contributes to the professional improvement of teachers. When training is perceived as arbitrary imposition and of little use, it can generate resistance and not prove effective in promoting significant changes.

In our investigation, in terms of the teachers' narratives, the effectiveness of the education program executed was evident, as reported by P3 and P4:

During the continuing education I have access to information and application of techniques that I would never have imagined would work.

From the continuing education in Mathematics, I learned that there are other ways to work to achieve the same goal.

The research results show that personalized and contextualized continuing education, which addresses problematic everyday school situations, has the ability to promote significant changes in teaching practice. Teachers reported that the training provided them with access to new information, the development of new skills and competencies, as well as a more reflective and collaborative approach to teaching Mathematics. The contributions of the interviewees account for this, as P8:

The continuing education in Mathematics made me understand how children learn things like numbers, because I understood that it was necessary to change the approach so that learning was effective.

And P10, highlighting her change in posture:

In the training classes we developed many games that I started using with my students. I was encouraged by the training to research resources and practices, which helped solve many conflicting situations I had with this area.

Therefore, it is essential to rethink traditional models of continuing education, prioritizing more personalized and contextualized approaches that take into account the needs of teachers and the challenges they face in their specific context. In addition, it is necessary to foster reflection and research as an integral part of the training process, empowering teachers to be active agents in their own training and promoting effective changes in educational practice.

4.3 Relationship with Mathematics before the education program

The data analysis revealed that the interviewed teachers had superficial knowledge of the BNCC in the area of Mathematics before participating in the education program in 2019. They reported that access to the BNCC occurred through third parties, indicating that they were not familiar with the content and guidelines proposed in the document. In addition, the teachers' accounts indicated that their practices regarding the teaching of Mathematics were traditional, focused on the transmission of knowledge, memorization and mechanical processes, without using playful strategies.

These results corroborate previous research, such as those by Berneira (2021), Rodrigues (2018), Pertile (2019) and Medeiros (2019), which also highlighted the teachers' lack of familiarity with the BNCC and the concern regarding the changes proposed in the document. Furthermore, the research by Gasperi, Martins and Emmel (2022) points to the existence of different rationalities among teachers regarding the BNCC, with some interpreting it as a technical prescription and others seeking to adapt it to their local contexts.

Analyzing the results of research with themes similar to our own was essential to compare with the data constructed throughout our investigation. For this excerpt, some narratives from the interviewees stood out, such as P2 who pointed out:

It was difficult to understand the BNCC proposal and how it would impact our work in the classroom.

For P6, some doubts arose initially:

When it was first presented to me I still asked: will I have to work with all of this? It seemed like another world compared to what we were already used to.

In turn, P8 emphasized the role of training in contributing to his change of view regarding the BNCC:

We had participated in studies at the school, but in a superficial way. I really understood it from the 2019 training, which dealt with this subject.

The teachers' lack of intimacy with the BNCC and the traditional practices regarding the teaching of Mathematics may be associated with the negative attitudes towards the subject, stemming from frustrating experiences lived by the teachers themselves during their initial education or in the school. Studies show that negative attitudes related to Mathematics can lead to avoidance behaviors and hinder the effective transmission of knowledge to students (Gonçalez, 1995; Brito, 1996; Moraes & Pirola, 2015).

It is important to highlight that attitudes and affectivity with regard to Mathematics have a direct influence on learning the subject (Justulin & Pirola, 2007). Therefore, the lack of teachers' intimacy with the BNCC and traditional teaching practices can negatively impact the teaching and learning process. These points were demonstrated in the teachers' narratives, such as those from P4 and P7:

Before the training, my relationship with Mathematics was very basic. My classes were very based on the scripts present in the teaching material, lots of repetition and memorization activities;

I participated in some previous training that helped change my way of teaching Mathematics, but still in a very superficial way, unable to achieve satisfactory results.

For P10, his teaching approach before the training did not bring effective results with students:

I always liked Math, but my practice was very based on memorization. I didn't imagine how much games could help me with the difficulties.

For P5, fear was something that was part of his relationship with Mathematics:

I knew the basics to convey and was very afraid to teach a concept and the child not understand it.

After the 2019 education program, teachers reported a change in their view and understanding of the BNCC. They highlighted that the training provided a greater understanding of the document's proposals and the need to adapt their classroom practices. This change in perspective can be attributed to contact with trainers and reflections made during continuing education.

These results demonstrate the relevance of continuing education for teachers, not only to acquire knowledge about the BNCC, but also to promote changes in attitudes and practices regarding the teaching of Mathematics. Personalized and contextualized continuing education, which allows reflection on teaching practice and the development of new skills and competencies, emerges as an effective strategy to overcome existing gaps in teachers' initial education and promote a more up-to-date and meaningful approach to teaching Mathematics in the Early Years of Elementary School.

Considering the research results and theoretical discussions presented, we can conclude that continuing education plays a fundamental role in updating teachers in relation to the BNCC and improving their teaching practices in Mathematics. The teachers' lack of familiarity with the BNCC and traditional practices in relation to teaching the subject reveal the need for training interventions that promote a deeper understanding of the document and encourage the adoption of innovative pedagogical approaches.

It is important to emphasize that continuing education must be personalized and

contextualized, taking into account the needs and realities of teachers and the contexts in which they work. In addition, training must promote reflection on teaching practices and the development of new skills and competencies, in order to overcome existing gaps in teachers' initial education.

Through continuing education, teachers can acquire a deeper knowledge of the BNCC, understanding its guidelines and objectives, adapting them to their classroom practices. Training can also contribute to the development of positive attitudes towards Mathematics, encouraging the use of playful and innovative strategies that promote meaningful student learning.

In this sense, it is essential to invest in quality continuing education programs, which provide teachers with the necessary tools and resources to update their pedagogical practices. In addition, it is essential to promote spaces for reflection and dialogue among teachers, encouraging the exchange of experiences and the collective construction of knowledge.

In summary, continuing education plays a key role in the teachers' relationship with the BNCC and in improving the teaching of Mathematics. It is through continuing education that teachers can acquire new knowledge, transform their practices and promote quality Mathematics Education. Investing in teacher training is investing in student development and improving the quality of education as a whole.

4.4 Relationship with Mathematics after the education program

The continuing education in Mathematics had a significant impact on the teachers' relationship with teaching the subject. The interviewees reported a change in attitudes regarding Mathematics, developing a more positive and less fearful view. The training allowed them to see Mathematics in a more comprehensive way and understand the importance of teaching the subject for students' cognitive development.

In addition, the continuing education provided teachers with the development of new strategies for teaching Mathematics. The use of recreational resources, such as games and practical activities, made the classes more attractive and facilitated students' understanding of the content. The incorporation of digital technologies also played a relevant role, allowing teachers to use audiovisual and interactive resources to make the teaching process more dynamic and engaging.

The change in teachers' pedagogical practices was also evidenced. After the continuing education, teachers adopted a more reflective and personalized approach to teaching Mathematics. They began to think of differentiated strategies to answer students' questions, adapting teaching according to individual needs. The emphasis on problem solving and the development of critical thinking was one of the changes observed in teachers' practices.

The highlighted narratives below demonstrate the change in attitude and relationship with the teaching of Mathematics.

After participating in the training, teacher P1 mentioned that his perception of Mathematics was transformed:

After the continuing education I was able to see Mathematics even better, especially at the time of playfulness and games where the child learns without the famous 'suffering' and they begin to understand that Math is not a villain.

P3 emphasized the incorporation of digital technologies in the professional development

of teachers. He noted how this inclusion made educational practice more aligned with students' reality, improving the teaching and learning process. In addition, the teacher noticed that the implementation of these tools in the classroom improved his teaching methodologies, providing students with a clearer understanding of the topics discussed, which encouraged them to form their own interpretations:

The classes stopped being ready-made, with ready answers, causing the children to investigate and go after answers to the problems presented. [...] The use of technologies also facilitated the process, as I was able to understand at what times and in what way I can bring these resources to the classes.

In turn, P4 stressed a significant transformation in his teaching methodology after the training, mentioning an increase in confidence when answering students' questions. The teacher explained that he now uses various strategies to clarify doubts, with the aim of ensuring students' understanding of the content taught:

Today, when students ask a question, I feel more confident in answering that question, and not in just one way, but I think of different strategies to resolve a doubt so that the student understands how to do it.

The teachers' reports demonstrate that participating in a continuing education program in Mathematics resulted in significant changes in attitudes and practices regarding teaching the subject; they felt more confident and prepared to teach, adopting more creative and effective approaches. The training contributed to the optimization of student learning, providing a more stimulating and conducive teaching environment for the development of mathematical skills.

These results corroborate the theories of Tardif (2020) and Imbernón (2011), which emphasize the importance of continuing education for the improvement of teaching work and for improving the quality of education. Continuing education in Mathematics allows teachers to acquire more in-depth and up-to-date knowledge about the subject, developing specific skills that directly impact pedagogical practice.

In short, participating in a continuing education program in Mathematics resulted in significant changes in teachers' attitudes and practices regarding teaching the subject. The training provided the development of positive attitudes towards Mathematics; the improvement of teaching skills; the use of innovative strategies; and the use of technological resources. These changes contributed to improving the quality of Mathematics teaching in the Early Years of Elementary School, promoting more meaningful and motivating learning for students. Therefore, investing in continuing education programs in Mathematics is essential to strengthen teaching practice and improve the Mathematical Education offered to students.

4.5 Students Attitude

The adoption of differentiated strategies and the abandonment of traditional practices were also mentioned by teachers as factors that contributed to the change in students' attitudes towards learning Mathematics. The teachers reported that by stopping the use of knowledge transmission-centered approaches and adopting more interactive and participatory practices, students started to engage more actively and autonomously in the construction of mathematical knowledge.

Through the use of differentiated strategies, such as solving contextualized problems, exploring everyday life problem situations, and carrying out practical activities, students were able to perceive the applicability of Mathematics in their lives and the importance of developing

mathematical skills to solve real problems. These approaches enabled students to achieve more meaningful learning, stimulating critical thinking, creativity, and the ability to solve problem situations autonomously.

The change in the students' attitude was also observed with the abandonment of traditional practices, such as memorizing formulas and algorithms, in favor of a more investigative and exploratory approach. The teachers reported that by adopting a more guiding and mediating posture, the students started to feel more encouraged to express their ideas, ask questions, and seek solutions on their own. This contributed to the development of students' autonomy, confidence, and self-esteem regarding Mathematics. As recorded in the dissertation resulting from the investigation, “teachers P1, P4, P6, P7, P8, P9 and P10 reported that students started to engage more in Math classes with the adoption of new strategies, such as the use of games and playful activities” (Padilha Junior, 2023, p. 128, our translation).

P9's narrative revealed that: “today children interact in the classroom in a fun way” leading us to conclude that a positive and motivating posture in teaching mathematics can favor successful learning. For P4, the change in students' posture became evident:

They started to participate much more in classes when they realized they could be fun. That's what I acquired from the training and the students loved it. Involvement increased.

One experience was reported by P7:

The other day I worked on a game called Ghost Train, which consisted of solving algorithms in a different way. They got so involved they didn't even notice the time go by. And I see the result later: the learning. And learning Math this way is lighter and more fun. The kids themselves comment on it.

It is important to emphasize that the change in students' attitudes in response to changes in teachers' attitudes did not occur immediately and uniformly. Some students initially resisted the new approaches, especially those accustomed to more traditional teaching. However, over time, most students adapted to and appreciated the new pedagogical practices, recognizing the benefits in terms of learning and motivation.

These results are consistent with the theories of Mello and Brito (2022), who highlight the importance of a more interactive, contextualized, and investigative approach in teaching Mathematics. These approaches stimulate interest, participation, and student engagement, promoting more meaningful and lasting learning.

In short, the analysis of teachers' responses revealed that the change in attitudes towards teaching Mathematics had a positive impact on students' attitudes towards learning the subject. The adoption of differentiated strategies, the abandonment of traditional practices, and the development of positive attitudes contributed to greater student involvement, interest, and autonomy in the Mathematics learning process. These results reinforce the importance of quality continuing education that promotes reflection and transformation of pedagogical practices to improve the teaching of Mathematics. Teachers play a key role in promoting meaningful and motivating learning, and continuing education can empower teachers to adopt innovative and effective approaches.

Based on the results of this research, it is possible to affirm that continued training in Mathematics had a positive impact on changing the attitudes of teachers and students towards learning the subject. Teachers reported greater student motivation, involvement and interest, as well as an improvement in the quality of teaching.

These results are extremely relevant for the field of Education, as they highlight the importance of investing in continuing education programs that promote the updating and improvement of teachers. Continuing education in Mathematics should include not only deepening specific knowledge of the subject, but also developing pedagogical skills, differentiated strategies and the use of technological resources.

It is essential that teachers are prepared to adopt more interactive, playful and investigative approaches that stimulate active student participation and promote meaningful learning. In addition, it is important that teachers are encouraged to abandon traditional practices and constantly seek new ways of teaching Mathematics, appropriate to the needs and realities of students.

This research contributes to the advancement of knowledge in the field of Mathematics Education, providing empirical evidence on the effects of continuing education on teaching the subject. The results show that continued training in Mathematics can promote significant changes in the attitudes of teachers and students, resulting in an improvement in the quality of teaching and student learning. However, it is important to emphasize that continuing education in Mathematics is not an isolated process, but rather continuous and dynamic. Teachers should be open to new ideas, research and pedagogical practices, always seeking to improve their practice and keep up to date with advances in the field.

Thus, through an interactive, playful and investigative approach, teachers can stimulate student engagement, motivation and autonomy in learning Mathematics, contributing to quality education and developing students' mathematical skills.

4.6 Pandemic

The Covid-19 pandemic imposed unprecedented challenges for the teaching of Mathematics, leading to the need to adopt remote teaching as an emergency alternative. In this context, continuing education in Mathematics played a key role in preparing teachers to face the challenges of remote teaching and ensure an effective learning process for students.

The use of digital technologies was pointed out as one of the main categories of analysis in the teachers' responses. The adoption of virtual platforms, applications and digital resources allowed the continuity of Math classes, providing students with access to content, activities and interactions with the teacher and classmates. Digital technologies enabled the creation of virtual learning environments in which students could develop mathematical skills, solve problems and carry out practical activities.

The importance of continuing education was also highlighted by teachers as an essential factor to ensure quality teaching during the period of remote classes. Teachers who participated in continuing education programs in Mathematics demonstrated greater confidence and skill in the use of digital technologies, adapting content to the remote format, and creating pedagogical strategies suitable for the virtual context. Continuing education empowered teachers to face the challenges of remote teaching and promote meaningful learning even from a distance. In the teachers' narratives it was possible to observe the relevance of training for this period of remote classes.

P2 emphasized the importance of continuing education to be able to face the challenge of remote teaching: "I want to emphasize that the 2019 training was essential in my professional performance as a teacher, because with the use of the knowledge acquired it helped me a lot with remote teaching classes. Grateful for everything".

For P6, the training was essential for Mathematics to be taught in a way that avoided

traditional methods: "during the pandemic it was very important to remember the concepts and techniques of teaching Mathematics. If it were done in the traditional way, the result would not be what we managed to achieve, even with the difficulties".

The appreciation of playfulness also proved to be an important factor in ensuring student engagement and motivation during remote teaching. Teachers reported the use of games, recreational activities and mathematical challenges as strategies to make classes more dynamic and attractive. Playfulness provided a more relaxed and enjoyable learning environment, contributing to the development of students' mathematical skills.

However, it is important to recognize that emergency remote teaching presented challenges and limitations, especially with regard to social and digital inequality. Not all students had adequate access to technological resources and the internet, which generated exclusion and difficulties in participation. In addition, remote teaching required extra effort from teachers in adapting content and promoting interaction and collaboration among students.

In this sense, the reflections of Nakano, Roza and Oliveira (2021); Libâneo, Suanno and Almeida (2022) and Santos (2020) make relevant contributions to understanding the context of emergency remote teaching and its impacts on education. Remote teaching highlighted social and educational inequalities, requiring measures and policies to guarantee inclusion and equity in access to education. In addition, teacher education and the revision of pedagogical practices are fundamental to face the challenges of remote teaching and promote quality education.

Given this scenario, it is essential that governments and educational institutions invest in policies and resources to guarantee access to technology and the internet for all students, reducing digital inequalities. In addition, it is necessary to promote the continuing education of teachers, empowering them to use digital technologies and create effective pedagogical strategies in the context of remote teaching.

Playfulness should also be valued in remote teaching, as a way to stimulate student participation and motivation. Through games, recreational activities and mathematical challenges, it is possible to create a more attractive and engaging virtual learning environment, promoting the development of students' mathematical skills.

However, it is important to emphasize that remote teaching should not be seen as a definitive solution, but rather as an emergency alternative in crisis situations. The return to face-to-face classes is essential to promote social interaction, direct contact with classmates and teachers, and provide a complete learning experience.

In conclusion, continuing education in Mathematics played a key role in the context of emergency remote teaching during the Covid-19 pandemic. The use of digital technologies, the appreciation of playfulness and the promotion of continuing education were essential aspects to ensure quality teaching and promote student engagement and motivation. However, it is necessary to continue investing in policies and resources that guarantee equity in access to education and improve pedagogical practices to effectively and inclusively face the challenges of remote teaching.

5 Conclusions

In conclusion, the results of this research demonstrated the importance of both initial teacher education and continuous teacher development for teaching Mathematics in the Early Years of Elementary Education. Initial teacher education presented considerable gaps, which reinforces the need to review the curricula and methodologies of Pedagogy undergraduate courses, in order to prepare future teachers in a more complete and integrated way. In addition,

continuous training proved crucial to promote significant changes in teaching practice, encouraging the use of innovative strategies, the development of socio-emotional skills and reflection on pedagogical practices.

The analysis of the results also highlighted the importance of valuing playfulness and the use of digital technologies in teaching Mathematics. The introduction of playful activities, such as games, as well as the use of technological resources, enabled more attractive and motivating teaching, stimulating student engagement and promoting more meaningful learning. These pedagogical approaches should be considered in teacher education, providing them with tools and strategies to make the teaching of Mathematics more effective and enjoyable.

In addition, the research emphasized the importance of understanding and applying the BNCC in the context of teaching Mathematics. Teachers highlighted the need for a more in-depth approach to the BNCC during initial education, as well as the involvement of teachers in its periodic review and updating. The adaptation of the BNCC to the needs and realities of schools and students is essential to ensure the relevance and effectiveness of the Mathematics curriculum.

Therefore, it is essential that educational policies are aligned with the needs of teachers and students, promoting quality initial and continuing education that values playfulness, the use of technologies and understanding of the BNCC. It is also necessary that there is a more effective integration between theory and practice, encouraging teachers to actively participate in their own training and to reflect on their pedagogical practices.

However, initial and continuing teacher education plays a fundamental role in improving the teaching of Mathematics in the early years of Elementary Education. It is necessary to invest in education programs that meet the specific needs of teachers, promoting the development of technical and socio-emotional skills, as well as encouraging reflection and pedagogical innovation. Only in this way will it be possible to provide quality mathematical education, capable of training critical, creative students prepared for the challenges of the contemporary world.

Finally, despite the valuable contributions obtained from this research, there is room for future research that can expand the understanding of teacher education programs. It would be relevant to explore education programs in other stages of Basic Education, such as the final years of Elementary School, to see if the findings of this study are consistent across different stages. In addition, increasing the number of participants and including teachers from different cities could provide a broader and more diverse view of pedagogical practices and challenges faced in different educational contexts. These additional studies would be critical to identifying best practices and recommendations that can be applied in a variety of educational settings, further strengthening teacher training across the country.

Acknowledgements

To the Municipal Education of Jaguariaíva, in the person of Teacher Andreia Aparecida Valentim, who was the important link for the development of the Continuing Education Program. Also to CAPES for granting the financing scholarship.

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