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The didactic-pedagogical training of mathematics teachers

ARTICLE

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Abstract
This article discusses the didactic-pedagogical training of future Mathematics teachers from an exploratory descriptive perspective, highlighting the importance of specific and pedagogical disciplines regardless of the teaching method. It is considered that recent changes in Basic Education in Brazil present significant challenges, such as the need for an improved understanding of the student, the educator's role, and new teaching and assessment approaches. These changes require a reevaluation of traditional mathematical concepts and procedures, aiming for a critical and contextual understanding of Mathematics as a social practice. The article argues that the current educational scenario demands competencies from teachers that are not being sufficiently developed in their training, pointing to the importance of a theoretical and practical foundation that meets the needs of professional knowledge in the field of Mathematics Education.
Keywords: Teacher Training. Professional Knowledge. Mathematics Education.

A formação didático-pedagógica do docente de matemática

Resumo
Este artigo aborda a formação didático-pedagógica de futuros professores de Matemática através de uma perspectiva descritiva exploratória, destacando a relevância das disciplinas específicas e pedagógicas independentemente do método de ensino. Considera-se que as recentes mudanças na Educação Básica no Brasil trazem desafios significativos, como a necessidade de uma compreensão aprimorada sobre o aluno, o próprio papel do educador e novas abordagens de ensino e avaliação. Tais mudanças demandam uma reavaliação dos conceitos e procedimentos matemáticos tradicionais, visando uma compreensão crítica e contextualizada da Matemática como prática social. O artigo argumenta que o atual cenário educacional exige dos professores competências que não estão sendo suficientemente desenvolvidas em sua formação, apontando para a importância de uma base teórica e prática que atenda às necessidades do conhecimento profissional na área de Educação Matemática.
Palavras-chave: Formação de Professores. Conhecimento Profissional. Educação Matemática.

1 Introduction

"Training is much more than just preparing students to perform skills, and why not also mention the almost

obstinacy with which I talk about my interest in everything that concerns men and women." (Paulo Freire)

The act of teaching is one of immense responsibility, and teaching mathematics is not simply a matter of pouring knowledge into students and expecting them to master the subject. Is the mathematics discussed in the courses adequate for the demands of practice? What mathematics should be taught in initial mathematics teacher training courses? How should it be taught? What aspects of mathematical knowledge should be discussed? These, among other questions, make up the proposal presented here, which aims to investigate the mathematical training of undergraduate teachers. A great deal of creativity and knowledge of didactic-pedagogical practices is needed to capture the students' attention, so that they can be leaders, show confidence and point out content, because, for the most part, students are demotivated by the excessive transmission of knowledge. It is believed that one of the teacher's tasks is to transform the lesson into a vehicle that leads the student to seek answers to all their questions, exercising their capacity for reasoning. In this way, discussing the process of training mathematics graduates, their competencies/skills and their attitude towards the profession are aspects of social relevance.

The teacher training process is currently facing an identity crisis, characterized by the fragmentation of its curriculum and discontinuity in the education of elementary school students. There is a significant gap between the institutions responsible for teacher training and the basic education systems, contributing to inadequate preparation of future educators. This scenario is aggravated by the superficial approach to syllabus content, which often neglects the essential interconnection between subject-specific knowledge and its didactic adaptation. This results in a disintegration between pedagogical foundations and the specific content to be taught, including a notable absence of specialized didactics in mathematics.

In addition, teaching practice is often relegated to the end of the course, under the heading "Teaching Practice", severely limiting students' exposure to fundamental practical experiences. Academic research, which is essential for improving educational practice, is

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also insufficiently addressed. Another significant gap is the lack of integration of information and communication technologies into the curriculum, as well as the failure to take into account the particularities of the various levels and modalities of teaching in basic education and the specificities of the areas of knowledge.

Interdisciplinarity and transdisciplinarity, although provided for in the curricular structure of basic education, require a thorough review of the traditional disciplinary approach to teacher training. It is imperative to develop competencies that encompass all facets of the teacher's professional activity, from a commitment to the values that underpin a democratic society, through an understanding of the social role of the school, to mastery of content and pedagogical knowledge, including the ability to conduct research that refines pedagogical practice and the management of continuous professional development.

In this respect, it is essential to ensure that the learning of the knowledge provided for basic schooling is aligned with the National Education Guidelines and Bases Law (LDBEN) and the National Curriculum Guidelines. This provides a solid basis for the continuous improvement of education professionals, in line with the contemporary and future demands of society and the education job market.

Considerations on the Professional Constitution of the Math Teacher

> *Reading is not just decoding words or understanding a sentence or a story. Reading is understanding the meaning of a word within a context. Why and what the sender intended when using it. (Santos, Coqui and Neto, 2022, p.13)*

Studies on the continuing training of math teachers emphasize that the interventions carried out between the 1970s and 1990s proved to be "ineffective in changing knowledge, conceptions and pedagogical practices in educational institutions" (Fiorentini; Nacarato, 2005, p. 8). It is believed that both initial and continuing training play a crucial role in shaping, structuring and articulating the various types of teaching knowledge which, in an integrated way, are manifested in the teaching process, that is, in the daily practices of pedagogical practice.

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There is frequent criticism of the excessively theoretical focus of training programs and the neglect of practical teaching knowledge, resulting in a significant gap between academic training and practical application in schools and teaching methodologies. There is a recurring perception among teachers in training, or those who have recently graduated, that course curricula fail to cover the mathematics they need to teach their students, without establishing connections between the mathematics covered in universities and that which is essential for basic education. It should be emphasized that the relevant professional knowledge for teaching is acquired through practical experience, with its respective mistakes and successes.

More up-to-date research emphasizes the importance of a continuous training process in which educators see their practice as an object of investigation and reflection. In this context, theoretical foundations are not merely handed over to teachers, but are sought out as needed, with the aim of enriching understanding and jointly developing strategies to face pedagogical challenges in schools (Fiorentini; Nacarato, 2005, p. 9).

This approach underlines the need for teachers to experiment with methodologies, skills and didactic organizations that they want to reflect in their teaching practices. It is essential to offer training that enables them to appropriate the fundamental components of teaching knowledge, allowing them not only to master the mathematical content, but also to transform it into mathematical knowledge applicable to the school context. Consequently, studies highlight the need for mathematical content to be constantly reviewed and reassessed, considering the perspective from which this review should take place (Nacarato; Paiva, 2008, p. 14).

In addition, research recognizes the school and collective collaboration as essential pillars for teacher development, providing an environment for continuous training, exchange of experiences and collaborative resolution of the challenges emerging from everyday school life (Nacarato, 2005). In this way, math students can

> not only through teaching, but also through continuous projects of extension and coexistence with research under the guidance of teachers in the field of

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> mathematics education, develop other conceptions about mathematics, its formative, cultural and social value (Muniz, 2008, p. 25).

Despite the efforts of mathematics education researchers, many degree courses in this area still fail to include a link between technical-scientific knowledge and pedagogical knowledge in the curriculum.

For Ponte (1992), the study of conceptions is of a cognitive nature and refers to a process of personal and selective understanding on the part of the teacher. In turn, Roseira (2010) ponders:

> By referring to teachers' conceptions of mathematics and its teaching, I intend to address their particular philosophy with regard to mathematics as a body of knowledge and their teaching-learning process as conceptual and methodological pedagogical forms that seek access to this body of knowledge. It's about the way each teacher conceives, understands, represents, imagines, accepts and explains, and the assumptions that are implicit in the ways each one refers to and acts in relation to mathematics and its teaching (IBID. p. 74).

When speaking about mathematics and its conceptions, a discussion is revealed about an area of scientific knowledge that has profoundly marked the history of most people who have studied mathematics in a school context. For centuries, mathematics has fed stereotypes related to the fear and difficulty of learning it, as it is still seen by many as a subject that stands out from the rest, from early childhood education to high school.

> In this context of the pedagogical tradition, the concept of a didactically perfect lesson is one in which the didactic contract stipulates that the teacher presents and conducts the lesson and the reasoning in a clear, logical and as precise a manner as possible, and it is up to the students to follow along, retain the teachings through repetitive exercises and then return them in the test (Santos, 2005, p. 107).

This way of conducting learning is measured through quantitative and repetitive results, in which we do little to evaluate the student's reasoning and participation in learning. This way of learning is repeated at all levels, from basic education to higher education, because this is how we are "trained", it is how we learn and thus reproduce.

There is another problem that can be expressed: what mathematics should teachers know in order to teach young people and children in elementary school in a meaningful way?

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Shulman (1986) does not argue that graduates should have inferior or simpler mathematics than undergraduates. If it is enough for the undergraduate to have a technical-formal training in mathematics, this is not enough for the future teacher. They need to know the historical significance, production and negotiation of meanings, as well as knowing and evaluating the educational potential of mathematical knowledge. This will help them to explain why concepts are important, to problematize and to mobilize the students' understanding in the most appropriate way, while observing the school reality and the relative pedagogical objectives.

Therefore, in order to be a math teacher, it's not enough to have mastery of the content, concepts and procedures, it's necessary to know the epistemological foundations, its historical evolution, social application, and relationship with everyday life and reality in order to better understand the students. Therefore, the didactics of mathematics is necessary throughout the training process, so that the graduate, in a dialectical movement between specific mathematical knowledge and didactic knowledge, is able to produce knowledge that will be essential in the organization and execution of pedagogical work, the purpose of which is to teach and learn mathematics.

Varizo (2008) also draws attention to the importance of promoting, during the training period, a link between the subjects of mathematics didactics, mathematics teaching practices and supervised internships. According to the researcher, "it is difficult to detach research in the field of specific didactics from the issue of teaching practice and the teacher's action in the classroom" (Varizo, 2008, p. 49). However, most graduate courses work on the supervised internship separately.

As pointed out by Melo (2005, p. 38), the knowledge acquired through teaching experience constitutes an articulated wisdom that is intertwined with content, pedagogy, teaching and the curriculum as a whole. Fiorentini and Castro (2003, p. 126) reinforce this concept, arguing that educators' experiential knowledge does not emerge in isolation, but rather from the intertwining of their experiences in school practice and the knowledge acquired through study and dialog with educational literature and other agents in the field of education.

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The discussion about teacher training, especially in the field of mathematics education, emphasizes the importance of active participation during initial and continuing training processes, enabling teachers to express their concerns and reflections. Pérez Gómez advocates an approach that transcends an encyclopedic or merely technical view of mathematics, favoring a broad understanding that encompasses its various dimensions: logical, epistemological, semiotic and historical.

Fiorentini *et al*. (1998, p. 316) point out that this in-depth understanding is crucial for teachers to have the intellectual autonomy needed to create their own curriculum, effectively acting as a mediator between historically consolidated mathematical knowledge and that to be constructed interactively by students.

By diagnosing the sociocultural reality of their students, the educator must draw up teaching plans that reflect the peculiarities of each student and community, making it possible to adapt and restructure the proposed curriculum. The proposal of a Neuropsychopedagogical Protocol aims to equip the teacher with tools to identify, characterize and evaluate the Mathematical Learning process, considering aspects such as perception, attention and memory, as highlighted by Luria (1981) and Malloy-Diniz *et al*. (2008, p. 198).

Furthermore, in order to enrich the training of math teachers, it is essential to explore examples of neuropsychological and psychopedagogical batteries, even though a validated Neuropsychopedagogical Protocol is not available in the academic world for the diagnostic assessment of Mathematical Learning, as indicated by Bastos (2006, 2007). This approach allows teachers to understand the complexity of their students' mathematical learning development and to select theoretical-methodological strategies aimed at mitigating difficulties and democratizing access to essential mathematical knowledge.

In the adverse context of Brazilian education, with multiple battle fronts for its improvement, the vision of a pedagogy geared towards a pleasurable learning experience may seem utopian (Assmann, 1988, p. 23). Assmann (1988) reiterates the importance of a post-modern pedagogy that values knowledge as a balance between certainties and

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uncertainties, reinforcing the need for a pedagogical approach that is flexible, creative and committed to ethical and social development.

There is therefore a need to rethink the training of mathematics teachers in Brazil, recognizing the National Curriculum Guidelines and promoting alternative methodologies that are more in line with the demands of the teaching degree, as suggested by Souza et al. (1995) and ratified by the National Curriculum Guidelines for Mathematics Courses (Brazil, 2003). In this panorama, the educator is conceived as an agent of transformation, capable of fostering an innovative and stimulating pedagogical environment, where learning becomes a creative and rewarding journey. What is interesting is the form of relationship, attitude and policy that guides and promotes the learning process. This point of view is itself the result of an effective learning process. "It's about learning how to learn" (Kastrup, 2001).

We are living in a technological society, where the advance of new technologies has affected many aspects of human life, transforming production and relationships. This has accelerated communication and the changes that are being announced in the organization of work are already being felt and understood by those responsible for public education policies. These changes also affect the development of the cultural domain in various areas, especially education. Some measures have been taken in relation to the teacher training process, a central and important character in the dissemination of knowledge.

Parcianello and Konzen (2011) point out that in education, technology is gaining strength with the intention of facilitating the teaching and learning process, but it can also become a villain among teachers when they are not encouraged to know, understand and take advantage of its benefits. Undergraduate teachers are the main targets for the use of these new tools.

It is inevitable to think about how much technology favors the educational process at all levels of learning, from basic education to academic training.

> Access to it allows educators and students to broaden their concepts and strengthen their physical and virtual relationship. What is learned in the classroom, in terms of the specifics of a given subject, can easily be studied in a larger context,

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> in which other aspects or variables of the same subject become apparent. This means that technology becomes an extension of the classroom in the search for more knowledge, since new ways of learning and teaching can be proposed. (Parcianello e Konzen, 2011, p. 10)

These two authors cite the textbook as a form of technology that can be considered outdated. The teaching-learning method, when applied solely on the basis of books, makes the lesson a mere didactic transposition, in which the teacher, using the reflexive movement, transmits the content and it is simply absorbed by the student, without much interactivity. This is reminiscent of Paulo Freire's banking school methodology, in which the teacher deposits his or her knowledge daily in the student like a savings account and then collects it through an assessment. The successor, never the replacement, of the book is the Internet. It has changed some habits and attitudes in the way we teach.

In order to effectively verify how higher education teachers behave in relation to new technologies, a survey on the subject was carried out at the Pan-American Education Union - Unipan in Cascavel/PR. The aim was to identify the reasons for the use, or not, of new technological communication tools in the training of graduate teachers.

All of this reinforces the need for in-depth analysis of the ways in which teacher training is theoretically conceived and institutionally implemented in conjunction with school teaching practice.

Conclusions

Educating must transcend the mere transmission of predefined content, representing the art of cultivating meaningful experiences in the process of acquiring knowledge. Educational institutions must transcend the role of mere distributors of finished knowledge, positioning themselves as environments conducive to fostering autonomous and continuous learning. In this context, flexibility becomes a crucial attribute of knowledge in contemporary times, requiring an adaptable and reflective pedagogical approach. The discussion around math teacher training, due to its intricate complexity, emerges as a particularly challenging area for education professionals.

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In the current scenario, marked by the constant expansion and evolution of knowledge, the traditional instructional approach to education is proving insufficient to cover the vast amount of information available, even within specific spheres of knowledge. Thus, there is a need for a transition from a pedagogy based on certainties and fixed knowledge to a pedagogy centered on the ability to navigate and access information critically and selectively.

In view of this, those responsible for training educators are called upon to undertake in-depth research into both the didactic-pedagogical processes associated with teaching and learning mathematics and the expansion of teachers' mathematical culture. This should be done from a broad perspective, incorporating the historical and epistemological dimensions of this discipline. In this way, by linking theoretical knowledge with pedagogical practice, teachers develop fundamental knowledge for their work, promoting teaching that is meaningful and relevant.

Excellence in teaching lies in the educator's ability to inspire pleasure in creative expression and knowledge, which is the essence of the educational process. This paradigm reinforces the importance of teacher training which, in addition to covering the technical mastery of mathematics, involves the development of an in-depth and contextualized understanding of the subject. This enables teachers to stimulate in their students a taste for active, reflective and creative learning.

Furthermore, it is imperative to recognize that the field of teacher education in mathematics, although extensively explored, remains full of unexplored territory and potential lines of research that can further enrich our understanding and pedagogical practices. The constant technological evolution, the emergence of new teaching and learning methodologies, as well as the recognition of students' cultural and cognitive diversity, are just some of the variables that demand a continuous and adaptive investigative approach from researchers.

Therefore, the academic community is encouraged not only to continue studying these complex issues, but also to break new ground that can contribute to the transformation of mathematics education. This joint effort will not only enrich the repertoire

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of pedagogical strategies available to educators, but will also ensure that teacher training is in line with the emerging needs and challenges of our society, promoting more inclusive, engaging and effective mathematical learning.

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