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(RE)CONSTITUTION OF THE MATHEMATICS TEACHER'S PROFESSIONAL PRACTICE

(RE)CONSTITUIÇÃO DA PRÁTICA PROFISSIONAL DO PROFESSOR QUE ENSINA MATEMÁTICA

(RE)CONSTITUCIÓN DE LA PRÁCTICA PROFESIONAL DEL PROFESOR QUE ENSEÑA MATEMÁTICAS

Eduardo Pereira de Oliveira Rossa
Master in Mathematics Education (UNESPAR)
Teacher of Basic Education in the state of Paraná
eduardoporossa@gmail.com

Everton José Goldoni Estevam
PhD in Science Teaching and Mathematics Education (UEL)
Adjunct Professor at the State University of Paraná (UNESPAR)
Professor of the Graduate Program in Mathematics Education (PRPGEM/UNESPAR)
evertonjgestevam@gmail.com

Abstract
This bibliographic study aims to investigate aspects that influence the constitution and modification of the mathematics teachers' practice. By carrying out two searches on the Capes Periodicals Portal, one with the terms future teacher and mathematics and the other with teacher practice and mathematics, 24 articles were selected whose inductive analysis of keywords and objectives gave rise to three themes: i) Pre-service and In-service teacher education; ii) Collaborative environments; and iii) Didactic and technological resources. The results suggest that collaborative environments, in which teachers and prospective teachers can interact and share knowledge, beliefs and experiences, compose the essence of the processes of constitution and change of the teacher's practice. It is concluded, therefore, that collaborative actions should be promoted in the initial and continuing education of Mathematics teachers, because they allow us to rethink aspects of teaching practice and the very meaning of Mathematics, in a social perspective of professional teaching learning.
Keywords: Pre-service teacher education. In-service teacher education. Professional teaching practices. Professional learning.

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Resumo
Este estudo bibliográfico tem como objetivo investigar aspectos influenciadores na constituição e modificação da prática do professor que ensina matemática. Com a realização de duas buscas no Portal de Periódicos da Capes, uma com os termos futuro professor e matemática e outra com prática professor e matemática, foram selecionados 24 artigos cuja análise de palavras-chaves e os objetivos originaram indutivamente três temáticas: i) Formação inicial e continuada de professores; ii) Ambientes colaborativos; e iii) Recursos didáticos e tecnológicos. Os resultados sugerem que ambientes colaborativos, nos quais professores e futuros professores podem interagir e compartilhar conhecimentos, crenças e experiências, compõem a essência dos processos de constituição e mudança da prática do professor. Conclui-se, assim, que ações colaborativas devem ser promovidas na formação inicial e continuada de professores que ensinam matemática, porque permitem repensar aspectos da prática docente e o próprio sentido da matemática, em uma perspectiva social de aprendizagem profissional docente.
Palavras-Chave: Formação inicial. Formação continuada. Práticas profissionais docentes. Aprendizagem profissional.

Resumen
Este estudio bibliográfico tiene como objetivo investigar aspectos que influyen en la constitución y modificación de la práctica del profesor que enseña matemáticas. Mediante la realización de dos búsquedas en el Portal de Periódicos de la Capes, una con los términos futuro docente y matemáticas y otra con práctica docente y matemáticas, se seleccionaron 24 artículos cuyo análisis inductivo de palabras clave y objetivos dio lugar a tres temas: i) Formación inicial y continua del profesorado; ii) Ambientes colaborativos; y iii) Recursos didácticos y tecnológicos. Los resultados sugieren que los ambientes colaborativos, en los que docentes y futuros docentes pueden interactuar y compartir conocimientos, creencias y experiencias, componen la esencia de los procesos de constitución y cambio de la práctica docente. Se concluye, por lo tanto, que se deben promover acciones colaborativas en la formación inicial y continuada de los docentes que enseñan matemáticas, porque permiten repensar aspectos de la práctica docente y el sentido mismo de las matemáticas, en una perspectiva social del aprendizaje docente profesional.
Palabras clave: Formación inicial. Formación continua. Prácticas profesionales docentes. Aprendizaje profesional.

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1 INTRODUCTION

In the teaching profession there are many challenges, whether related to professional training or the exercise of the profession. With regard to Mathematics Education, the report published by the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2016) presents challenges related to teaching in both quantitative and qualitative dimensions.

The quantitative challenges refer to the difficulty in recruiting students and training teaching professionals in mathematics, an aspect related to the attractiveness of the profession (salary and social image). This scenario worsens in developing countries, where students – and even trained teachers – end up looking for opportunities in other countries with better prospects. Possibilities for overcoming such challenges involve improving teachers' working conditions (access to resources, training, and collaboration) and social recognition of the teaching profession, according to its real importance.

In turn, the qualitative challenges refer to the quality of the training of teaching professionals. There are countries in which most teachers, especially those who teach in the early years of Basic Education, report difficulties in their own mathematical learning. This is normally due to the polyvalent teaching, with little depth of mathematical concepts during training. In addition, training in mathematics sometimes does not give future teachers the opportunity to reflect on new needs for teaching mathematics in Basic Education and its relationship with other areas.

Thus, considering the demands regarding overcoming the challenges in relation to the training of teaching professionals, this bibliographic study seeks to investigate aspects that influence the constitution and modification of the practice of mathematics teachers and future teachers, through research results in the area of Mathematics Education.

It should be noted that the considered practice corresponds to the actions and reflections arising from the experience when planning and carrying out teaching proposals to, thus, contemplate the actions of future teachers, especially in the mandatory supervised internships[1], since it does not seem coherent to admit the latter as a professional practice due to the formative character of the actions in the degree courses.

In this sense, this article is structured in a methodological referral section, followed by the results section of the review undertaken, which are linked to broader studies related to the

[1] In this study, the term refers to the carrying out of internship actions provided for in the curriculum of initial training courses (as the term *mandatory* term), particularly guided and supervised by professors from the university and from the internship fields.

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theme in the discussion section. These notes support the conclusions presented in the last section of the text, which also includes some considerations and implications of the study.

2 METHODOLOGICAL REFERRAL OF THE RESEARCH

In this research, the systematic literature review was used as a methodological approach, understood as one of the possibilities of literature synthesis in bibliographic studies, whose objective is to identify, evaluate, and synthesize relevant studies in order to answer a particular question or perform the synthesis of literature around a delimited purpose (BARBOSA, 2018).

In this sense, in April 2021, two searches were carried out on the Journal Portal of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes)[2], which used the platform's advanced search tool, with the intention of obtaining more accurate matches. This tool has two fields for entering search terms, in addition to the possibility of selecting the type of material, publication period, and language. In the searches performed, three terms were used that should be included in the titles of the works, the type of material was restricted to articles and there was no restriction regarding the year and language of publication.

The first search aimed to identify studies that dealt with discussions about the practices of future teachers. For this, the words *future teacher* were used – considering that, in this case, the word practice could not characterize the actions of future teachers, particularly in their internships – and the word *mathematics*, seeking to delimit the area focused on in this research. Using such criteria, 6 (six) works were obtained.

For the second search, the words *teacher practice* were used, in reference to the professional practice of the teacher trained and active in the teaching of mathematics, and the word *mathematics*. Twenty-four (24) works were obtained, indicating a much higher number in this search compared to the first one.

Even restricting the search for articles with the advanced search tool, when analyzing the materials obtained, the presence of abstracts of theses and dissertations was identified which, due to their simplified characteristics, do not present depth about the discussions that are proposed here, being disregarded for this review 1 (one) abstract of the first search and 5 (five) abstracts of the second search. Thus, 24 (twenty-four) articles constitute the analytical corpus of this review, in terms of the procedures and criteria used.

[2] The CAPES platform used underwent updates from the period of carrying out the searches for this research until the publication of this article, so that the results obtained when redoing the searches may not be coincident.

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In Table 1, the articles from the analyzed corpus are listed, so that the indication FT# refers to articles that fall into the category of future teachers (first search), while T# refers to articles that fall into the category of active teachers (second search). The articles were arranged in chronological order of publication and cover the period from 2009 to 2021 (without *a priori* chronological delimitation). The presentation begins with articles from the category of future teachers, followed by articles from the category of active teachers.

Table 1 - Articles selected to compose the analytical corpus of this literature review

Ind.	Authors	Title[3]	Year
FT1	VISEU, F.; PONTE, J. P.	Desenvolvimento do conhecimento didático do futuro professor de Matemática com apoio das TIC	2009
FT2	OLIVEIRA, R.; SANTOS, M. V.	Inserção inicial do futuro professor na profissão docente: contribuições do estágio curricular supervisionado na condição de contexto de aprendizagem situada	2011
FT3	SILVA, G. H. G. S.; PENTEADO, M. G.	Geometria dinâmica na sala de aula: o desenvolvimento do futuro professor de matemática diante da imprevisibilidade	2013
FT4	FIORENTINI, D.; COSTA, P. K. A.; RIBEIRO, M.	As tensões vivenciadas na construção da identidade profissional do futuro professor em um curso de licenciatura em matemática à distância	2018
FT5	VALENTE, W. R.	Que matemática para formar o futuro professor? História do saber profissional do professor que ensina matemática	2019
T1	BITTAR, M.	A abordagem instrumental para o estudo da integração da tecnologia na prática pedagógica do professor de matemática	2011
T2	MISKULIN, R. G. S.; PENTEADO, M. G.; RICHIT, A.; MARIANO, C. R.	A prática do professor que ensina matemática e a colaboração: uma reflexão a partir de processos formativos virtuais	2011
T3	SANT'ANA, C. C.; AMARAL, R. B.; BORBA, M. C.	O uso de softwares na prática profissional do professor de matemática	2012
T4	ALBUQUERQUE, L. C.; GONTIJO, C. H.	A complexidade da formação do professor de matemática e suas implicações para a prática docente	2013
T5	SILVA, M. G. M.; GONÇALVES, T. O.; MALHEIRO, J. M. S.	A prática (in)formada por evidências face a formação do professor de matemática	2014
T6	MENEZES, M. B.	Um olhar para a prática em sala de aula do professor de matemática da escola do semiárido paraibano	2014
T7	NEVES, T. G.; BITTAR, M.	Análise da prática de um professor no ensino da matemática: possíveis reflexões em um processo de integração de tecnologias	2015
T8	ZABEL, M.; MALHEIROS, A. P. S.	A formação inicial do professor na modalidade a distância para o uso das tecnologias digitais no ensino de matemática: o caso de uma disciplina de prática de ensino	2015

[3] We have kept the titles of the texts in Portuguese because they are published in this language.

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T9	SOUZA, A.; SILVA, M.	Do conceito à prática da autonomia do professor de matemática	2015
T10	CYRINO, M. C. C. T. C.; BALDINI, L. A. F.	Ações da formadora e a dinâmica de uma comunidade de prática na constituição/mobilização de TPACK	2017
T11	TURÍBIO, S. R. T.; SILVA, A. C.	A influência do livro didático na prática pedagógica do professor que ensina matemática	2017
T12	TEIXEIRA, I.; COSTA, C.; CATARINO, P.; NASCIMENTO, M. M.	Prática de ensino de um professor de matemática relativa a sistemas de equações	2018
T13	BELMAR, C. C.; WIELEWSKI, G. D.	A formação do professor como educador de jovens e adultos: uma investigação nos projetos pedagógicos de cursos presenciais de licenciatura em matemática de instituições de ensino superior públicas da região amazônica	2018
T14	JANUARIO, G.	Análise de livro didático e a prática pedagógica do professor que ensina matemática	2018
T15	LANGWINSKI, L. G.; BASSOI, T. S.	A prática do professor no ensino de álgebra e os Registros de Representação Semiótica	2019
T16	MACHADO, E. F.; MENDES, I. A.; GONÇALVES, T. O.	Contribuições de um professor de matemática identificado com a docência no cárcere como prática humanizadora	2020
T17	LIMA, A. P. B.; BORBA, R. E. S. R.	Comunidades de prática e a formação do professor que ensina matemática revisitando teses e dissertações	2021
T18	LIMA, F. H.; ARAÚJO, J. L.	Em direção a uma caracterização da intervenção docente: ações de um professor em uma prática de modelagem matemática	2021
T19	OLIVEIRA, L. G. S.; PECHLIYE, M. M.	Relação entre teoria e prática e o significado de ser bom professor para participantes do PIBID	2021

Authors' own elaboration. Source: Capes Journal Portal.

In a preliminary process of inductive content analysis, with the observation of the titles, keywords and objectives present in the abstracts of the articles obtained in the two searches, common themes of discussion were identified, grouped as follows:

i. *Pre-service and In-service teacher education*: involves initial training, mandatory internships, and ongoing training (online and in-person courses and actions);
ii. *Collaborative environments:* involve training devices, study groups, virtual training processes, and online courses;
iii. *Didactic and technological resources*[4]*:* involve mathematical tasks, software and textbooks.

Then, the results of each article were analyzed, coded, and grouped, considering their relationships with each of the three established themes. In this sense, articles were identified that permeate more than one theme. After grouping the results with the established themes, the

[4] They refer to resources in a more general understanding of technology, not restricted to digital technologies.

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articulation between the discussions was carried out, in the sense of looking for similarities, differences, or complements in relation to the identified results. In line with the discussions in the articles (Table 1), elements of the literature on the practice and knowledge of the teaching professional are incorporated into the discussion section to promote articulations, with emphasis on Cochram-Smith and Lytle (1999), Shulman (1987), Tardif (2002), Ponte and Oliveira (2002), Roldão (2007), and Ponte (2012). In this sense, the following section presents the signs of constitution and changes in the practices of (future) teachers who teach mathematics, which are articulated with the broader literature in the discussions that follow it.

3 DATA ANALYSIS

From the review of the material obtained, we sought to describe what was identified in the studies in relation to the systematized themes.

3.1. PRE-SERVICE AND IN-SERVICE TEACHER EDUCATON

Regarding the training of future teachers in mathematics, historically, the disarticulation between the disciplinary fields of Mathematics and Pedagogy (FT5) is identified. The Brazilian Society of Mathematics Education (SBEM, 2003) also emphasizes the absence of research discussions in the area of Mathematics Education in the initial and continuing education of mathematics teachers (T4). This disarticulation of the areas of Mathematics and Pedagogy has implications for initial training, especially in the mandatory supervised internship, by promoting the understanding that the school is the place of application of university learning. In this context, the university is considered solely responsible for initial training (FT2).

The supervised internship is the moment when theoretical studies are confronted with practical aspects, which provides opportunities for conducting, analyzing, and developing strategies related to educational processes. Generally, however, teaching practices are offered at the end of the courses, with little reflexive actions that dissociate theory and practice, having little effect on the professional training of future teachers (T4). Even considering such problems in the initial training, however, the supervised internship is considered a moment of constitution and training of the professional due to the direct contact with the school environment, which offers the future teacher a practical knowledge of the exercise of the profession (T4).

The concept of applying, in the internship actions, the knowledge obtained during the initial training, seems to accentuate the misunderstandings and difficulties of future teachers. As FT4 highlights, even having experience in teaching in another discipline, when carrying out

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actions that favored procedural aspects, the professor participating in the research reports that he had difficulties and realized the need to have a more in-depth mathematical knowledge to mobilize conceptual aspects in his classes, considering that the Mathematics degree course did not meet the needs of reflection on its practice in the internship actions. Possibly, this is due to the structuring of training courses around a curriculum that prioritizes the development of content and internship practices that are not aligned with the demands of the classroom (T13), which shows that only pedagogical knowledge is not sufficient and needs to be articulated with other knowledge.

With this training process, it is likely that future teachers will continue to teach in the way they learned during their schooling. This is reinforced in FT1, who, when analyzing the practice of a future teacher in the internship actions, noticed that, initially, their practices were very close to those they experienced as a student, with a predominance of exercises focused on the application of knowledge. Likewise, in T15, the teachers were concerned with preparing the student for the use of algorithms and algebraic properties, giving examples focusing on procedures and rules when they noticed that students showed difficulties or did not understand the exercise.

On the other hand, knowing the content or mastering mathematics, both conceptual and procedural, is not enough. It is necessary to know different ways of making these contents understandable for students, knowing their teaching histories, social uses, different languages, and their relationship with reality (FT4), which indicates that, in pedagogical practice, there is a need to mobilize knowledge beyond of the mathematical. Likewise, there are aspects of the didactic knowledge of the teacher who teaches mathematics that develop and gain meaning with the teaching experience, such as the ability to select and use tasks and other resources in the classroom (FT1; T19). These notes highlight the need for the articulation of the different knowledge mobilized by the teacher in their pedagogical practice.

Considering this scenario, the inclusion of disciplines in the field of Mathematics Education in the curriculum of mathematics teacher training courses is presented as a possibility, such as the discipline of Didactics of Mathematics. They can articulate specific knowledge and didactic knowledge in the training process, so that the graduate is able to produce, organize, and execute pedagogical work focused on teaching and learning mathematics (T13). In the same way, the Teaching Practice subject can contribute to the constitution of the future teacher's practice with regard to the use of different resources, in

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particular technological resources, insofar as it articulates theoretical and practical knowledge and discusses the possibilities of resources used in the school context (T8). Possibly, articulations between disciplines could promote discussions aimed at training also for professional performance in alternative modalities to regular education, considering that these are aspects identified as rarely addressed in training courses (T13; T16).

To overcome training weaknesses and build their knowledge of practice, professors seek alternatives in refresher courses, research groups, or university projects with more specificities for their field of activity. These spaces constitute possibilities for discussions about didactic and pedagogical aspects, taking advantage of the sharing of the teacher's practice in collaborative environments (T2), as well as promoting reflections and discussions about elements of the teaching professional path (T14). In the same way, evidence-based practice[5] constitutes a possibility of continuing education by promoting: self-training, professional judgment on issues related to one's own practice and practices arising from scientific research, knowledge of didactic processes and tools, the inquiry for the acquisition of knowledge, and the strengthening of the Basic Education teacher's relationship with systematic research in Mathematics Education, which contributes to triggering reflections for the construction of new practices (T5).

Thus, studies T13 and T16 indicate the need to carry out continuing education courses as they allow identifying that there is a deficiency in relation to the construction of knowledge of the professional training of teachers in initial training and the resources and curricular objectives to act in teaching modalities. In turn, T2, T5, and T14 suggest some alternatives to overcome difficult situations in initial and continuing education through collaborative actions that involve the sharing of practice and discussions about the teaching trajectory, as well as the study and discussion about of research carried out in the area of Mathematics Education.

Therefore, in the sense of professional training, initial and continuing training become favorable scenarios for the teacher and future teacher to (re)constitute their pedagogical practices, even if they are not the only ones responsible for the construction of the teacher's knowledge. Such construction is carried out from the experiences lived in the degree course and in the classroom, exerting great influence on the perception, construction and organization of various teaching knowledge (T4; T14).

[5] In the educational context, evidence-based practice refers to teaching as a profession informed by research and evidence in order to improve the quality of education.

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3.2. COLLABORATIVE ENVIRONMENTS

With regard to aspects of collaboration related to teaching practice, collective work among future teachers is pointed out as a means in which support is found to act in the face of unforeseen events, in the risk zone, while individual action generally contributes to the teacher to remain in the comfort zone (FT3). In addition to collaborating in the preparation and implementation of the practice, participating in study groups brings contributions to the undergraduates with regard to professional training, as it expands didactic knowledge and provides opportunities for exploring digital technological resources with students (FT3). Likewise, in the interaction with advisors and other colleagues, future teachers changed aspects of their practice, starting to propose other types of tasks and to integrate digital technological resources with a focus on the manipulation of materials by the students (FT1).

Considering FT1 and FT3, possibly because there is greater fragility in relation to practical aspects, future teachers sought support in research and in the planning carried out to obtain better conditions to deal with different situations that could emerge in the classroom. However, even with planning, unexpected situations occur and lead future teachers to reflect on their actions, opposing the planning and the practice carried out, the knowledge acquired in the initial training, and their experiences as students (FT1; FT3). These reflections allow you to reformulate your understanding of the nature of the proposed tasks, the resources used, and the way in which they are explored, as well as aspects of communication in the classroom. Thus, there is evidence of the importance of the articulation between theoretical and practical aspects for the reformulation and expansion of the teaching knowledge of future teachers.

The studies also point to the importance of future teachers' collaboration with Basic Education teachers, by recognizing these professionals as producers of educational knowledge. They suggest that the insertion and participation of the future teacher in the classroom internship actions should focus on collaboration and joint work between the experienced professional and the apprentice of the profession. In this context, professional learning is not carried out only by observation and imitation, and the role of the teacher (supervisor) is not restricted to observing and criticizing (FT2). Learning/training occurs through activities and involvement in situations, implying alternative realities to the model centered on observation-participation-conducting.

Considering the space provided by digital technologies, studies show that online continuing education courses promote mathematical learning through collaboration, collectivity, and argumentation (T3). In addition, they find that the virtuality in the environment

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of online courses promotes a training space for teachers, in which collaboration emerges as an essential factor for the construction of meanings and sharing of experiences about teaching practice (T2). Likewise, participants in the group investigated in T1 became more critical when they began to discuss the tasks prepared, the objectives of their proposals, and the potential of using digital technologies for these proposals.

In this sense, collaboration is highlighted as a driver of professional development, through which the group becomes the context in which opportunities are created for the teacher to explore and question their knowledge and practice, as well as the possibility of getting to know the experience and practices of other teachers (T4). By getting to know the other's experiences better, we look in a new way at our own practice in order to qualify it (T5). Likewise, collaboration is identified as an important factor for the formation of teaching knowledge, as it constitutes a space of support and search for possibilities to escape the captures of individualities, in which there is a struggle against unwanted subjectivation, considering the participants' beliefs and conceptions. (T9).

Similar aspects are presented in article T10, when identifying that the practice of a community[6] that subsidized the investigation provided an opportunity for interaction and exchange of experiences between teachers and future teachers, in a relationship of complementation and negotiation of meanings, especially with regard to the integration of digital technologies and didactic-pedagogical issues, in an environment of mutual learning with trust and respect among the participants. Such spaces are an alternative to traditional continuing education programs, whose foundations are training or knowledge recycling, as they enable the professional development of teachers, future teachers, and researchers, with or without the use of technologies (T17). The basis for this is the collaboration and participation of its members, noting that initial training is not enough for the professional development of the teacher, based on the perspective that the teacher is in permanent training, based on collective study, reflection, and discussion.

Another aspect related to collaborative environments involves the particularities in relation to the understandings of each participant and the incorporation of knowledge into their practices. This aspect is verified by identifying that teachers, especially participants of

[6] According to Lave and Wenger (1991), Community of Practice is characterized by the combination of elements that involve the reason for the individual's participation in the community, the encouragement of interactions and relationships based on respect and trust, discussing structures, ideas, tools, stories, and documents directly linked to community practice.

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continuing education courses with emphasis on the use of digital technologies, have varied uses in their practice, making it impossible to identify a pattern of frequency and use of software (T3). Similarly, the discussions throughout a course – which also focused on digital technologies – provided opportunities for new learning, producing different schemes[7] for each participant, which placed them at different stages regarding the use of technology (T1).

The variation in the frequency of use (T3) and the different stages of use (T1) of digital technological resources in the classroom reveal that each participant assimilates knowledge in a particular way, appropriating it in individual ways, an aspect resulting from experience, life stage, personal history, and particular characteristics (FT3).

Regarding the issue of individuality, in order to preserve and exercise their conceptions and particularities, the teacher needs to maintain, in their practice, the attitude of truth, that is, the teacher interprets the different situations from their experiences and theories through which exposes themselves and, based on that, carries out their practice in a particular way, using their own perspectives, their "truths" (T9). This conception is reinforced in T1, when it is highlighted that one cannot want the participants, even working together, to have the same position regarding a certain knowledge, but one must consider what each one incorporates in their action from the work performed (T1). In the same sense, aspects of particularity in relation to the understanding of theories and their integration into teaching practice are identified in T18, when it is noticed that the teaching intervention in modeling activities in Mathematics Education does not follow exactly the sequence indicated by some authors, suggesting that teachers develop their practices according to their own intervention routes.

3.3. DIDACTIC AND TECHNOLOGICAL RESOURCES

When analyzing a practice carried out in the 90s, T12 identifies that the school manual was the central and practically unique element for planning, preparing, and carrying out the practice in the classroom. In this action, the expository teaching style based on the book and the resolution of exercises predominated. In turn, when carrying out a comparative analysis between textbooks from 1989 and books, at the time, more current used by teachers (collection published in 2012), T11 identifies changes in the structure and presentation of contents, considering that, in the most current books, there is more articulation of the units with the geometry. Despite this, it was observed that, because teachers follow the curriculum based on

[7] Concept of Instrumental Genesis, related to the ways in which an artifact is used by the subject, transforming it or not into an instrument.

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textbooks, they end up skipping certain subjects (mainly geometry content) because they do not have affinity, do not have the knowledge to teach them or because the contents are present at the end of the book (T11). These notes reveal a scenario with few changes, considering that, until the present day, this model has great influence on the current education system.

In addition, despite being a widely used resource, the textbook does not always consider the local specificities when considering the contextualization of the contents and the reality of the students. Thus, the study T6 emphasizes that it is unlikely to think of textbooks that meet the demands of the whole country, so that the most relevant change must be in the teacher, when seeking to promote practices focused on the context of each reality, as they are the link closer to the student and their learning. Thus, it is considered that a class cannot be based exclusively on books and research that are disconnected from the reality of the students, since each one of them brings their knowledge of the world, which must be shared and managed in search of improving learning.

In this sense, an alternative to the use of textbooks is to analyze the approach of these materials, an action that contributes to the teacher's pedagogical practice in the perspective of mediation of mathematical learning processes. Actions of this nature promote the development of a critical and investigative look in the process of selecting teaching materials, problem situations, and elaboration of tasks, relating them to their own practice (T14).

This reflective dimension on the teacher's practice is also evident when they realize that the difficulty in keeping students attentive and engaged in mathematical activities may be related to the proposed tasks and the way they are explored (FT4). Likewise, reflections on aspects of the task and its conduction are highlighted, considering, for example, that those with a more open structure – such as those of an investigative nature – favor cooperative work and communication in the classroom (FT1).

On the other hand, carrying out practices different from traditional ones is not a simple change. In article T7, a teacher who accepts to use digital technologies in their classes experiences difficulties due to the circumstances, which ends up discouraging the use of the computerized environment as a teaching resource. Among such circumstances, the teacher highlights the need for preparation to carry out proposals with dynamic geometry software and more investment in training that meets the specifics of the teacher for the classroom.

In this sense, a factor pointed out that can contribute to the adoption of technological resources in the teacher's pedagogical practice is the offer of disciplines – or even conducting

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courses – in the form of distance learning. They enable constant contact with digital technologies as a means of communication, interaction, and learning, since, in this context, the teacher uses such resources to produce their own knowledge (T8). Likewise, the contact with theories and research can be a relevant factor for the change in the teacher's practice, making it possible to find the meaning of the teaching practiced (T14). The argument that research discussions can support and modify the practice is highlighted in T3, when finding the low evasion of teachers from continuing education courses and the use of studied and discussed tasks and software, even after seven years after the completion of the courses. Likewise, changes were identified in the actions of teachers in relation to the use of digital technologies in mathematics classes, with the aim of seeking ways to provoke learning and lead students to build their knowledge (T1).

The results of T8, in turn, suggest that training that promotes discussions, reflections and experiences regarding digital technologies, in the teaching and learning processes, can be an alternative for them to actually reach math classes. This participation is also highlighted when considering that training that provides opportunities for such actions to teachers tends to make them capable of building new knowledge and re-signifying them throughout their professional trajectory, offering conditions for their development through experiences with teaching and learning (T4).

This change in practice has great possibilities of occurring when teachers recognize their own needs, with the search and realization of what they believe to be the best and not only what is required of them (T9). For example, in the case of T7, the reflection of the participating teacher, when carrying out practices using digital technological resources, was made possible when the video episodes were analyzed, highlighted as critical events of the teacher's practice. In this reflection on their actions, the teacher revealed insecurities and indecisions, which provided the opportunity to restructure his strategies.

From the notes of the studies, it is possible to perceive that, even with changes over the years in relation to its structure and approaches, the textbook is still one of the main resources used by teachers to conduct their practices (T11; T12). These changes in the books, however, do not seem to directly impact the teaching and learning processes, since teachers make selective use of the contents of these materials (T11). In this sense, the importance of investing in the initial and continuing training of teachers is highlighted, in order to provide opportunities for reflections emerging from practice regarding the tasks that are proposed (FT4) and, also,

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the involvement of students with regard to collaboration and communication (FT1), as well as promoting discussions about research and experiences involving the use of different resources, especially digital technological resources (T1; T3; T8).

4 DISCUSSION

The disarticulation in the training courses of the disciplinary fields of Mathematics and Pedagogy and the absence of research discussions in the area of Mathematics Education reveal problems in the curricular organization that do not make it clear what the profile of the professional to be trained is (IZA et al. , 2014). In the same sense, this lack of definition generates implications for initial training, particularly in the mandatory supervised internship. The research notes indicate the predominance of the technical rationality model, related to the conception of *knowledge for practice* (COCHRAM-SMITH; LYTLE, 1999), in which the teacher's praxis is based on formalized and systematized knowledge by specialists (researchers and professors of universities). This model is criticized by Tardif (2002), because it considers the classroom only as a space for the application of technical knowledge acquired during graduation and, thus, disregards the potential of reflective practice for professional learning, as well as ignoring the teacher. as a producer and validator of scientific knowledge (SCHÖN, 1983; LEMES; EVANGELISTA; ANUNCIATO, 2020).

The reviewed articles emphasize that, in addition to mathematical knowledge, the teacher needs to know different ways of making content accessible to students, also emphasizing that aspects of this knowledge develop with teaching experience. Thus, knowledge alone does not seem to be sufficient for professional teaching practice, which suggests that experiential knowledge is fundamental for validation and reflection, in the sense of building and reconstructing the knowledge of teacher practice (TARDIF, 2002), but must be deepened and articulated with other teaching knowledge. In a similar way, studies indicate that knowledge from pre-service teacher education, even if fragile to some extent - possibly due to an excessive focus on academic knowledge (PONTE; OLIVEIRA, 2002) -, as well as reflection from the practice carried out in the actions of internship, are fundamental moments for the constitution of the teacher's practice and allow changes regarding the understanding of aspects necessary for the teaching action, articulating the theoretical knowledge and the performed practice (IZA et al., 2014), which characterizes the formation of professional knowledge (PONTE; OLIVEIRA, 2002). On the other hand, continuing education makes it possible to improve the teacher's knowledge, by meeting the specificities and needs that emerge from the practice,

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considering the teacher and the dilemmas they experience as essential aspects for discussions and advances regarding the reconstitution of teaching practice (TARDIF, 2002). In this sense, it is confirmed that, like students, teachers learn from their activity and from the reflection they carry out on it, through participation in social practices whose depth is directly influenced by collective support and their personal involvement. (PONTE, 2012).

Considering this context, collaboration emerges, in the analyzed articles, as a means to act in situations of unpredictability in the classroom, by involving groups of professionals who aim to solve common problems (PONTE, 2012). Collaboration also stands out for making it possible to build and reformulate teaching knowledge through the interaction between future teachers, teachers working in Basic Education, and university professors - in processes of action and reflection on the practice carried out and with the sharing of experiences – from an inquiry as stance (COCHRAM-SMITH; LYTLE, 1999; PONTE, 2012). The integration between university and school is an important point for teacher education (IZA et al., 2014), whose exchange and appreciation of the classroom experience with the university has the potential for training and experienced teachers to rethink teaching practice, as well as producing, transforming, and mobilizing knowledge and theories (TARDIF, 2002). Spaces with this focus gain particular relevance when taking into account Shulman's (1987) notes regarding the wisdom of practice, considered as the source of the teacher's knowledge base that is less studied, lacking records and studies with the involvement of peers. However, the "[...] knowledge resulting from practice does not refer to the legitimation of any practice, but to the knowledge that results from the analytical reflection of competent teachers" (ROLDÃO, 2007, p. 99).

In this sense, interaction environments provide opportunities for discussions that improve theoretical knowledge in relation to training, with a view to preparing for professional practice (SHULMAN, 1987). Likewise, knowledge of practice is shared and discussed, in the sense of professional development (PONTE, 2012), aiming at learning based on the experiences of other teachers. Even with the promotion of collaboration spaces, however, it is not possible to assume that practices can be modified in a similar way by all professionals, since the understandings are private, as well as their incorporation into the teacher's practice (TARDIF, 2002).

Another emerging aspect in the review reveals the influence of didactic and technological resources in the teacher's practice. It indicates that, over the last decades, teachers continue to use the textbook as a central resource to guide the curricular and didactic

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organization of the practices carried out. In this way, teachers tend to repeat practices and reuse resources that influenced their own training.

The resources and the way they are used by teachers seem to be related to their understanding of teaching and learning processes and of mathematics itself. Thus, "[...] the way this understanding is communicated conveys to students what is essential and what is peripheral in the subject" (SHULMAN, 1987, p. 208). In this sense, the analyzed articles point out that classes should be guided by different resources that articulate with reality and with knowledge of the world brought by the students, with emphasis on the integration of technologies, especially digital ones.

Even identifying that using teaching resources different from the usual ones is not a simple change to be made, the analysis indicates that teachers (in training, beginners, or experienced) who engage in research, discussions and practices focused on the integration of different resources, start to re-signify their conceptions about aspects of teaching practice, such as the nature of tasks, student engagement, classroom communication, and student and teacher roles. Thus, the teacher produces new knowledge on the previously acquired through processes that go beyond communication but involve experimentation that allows them to operate and give meanings to the knowledge deriving from their own activity (TARDIF, 2002), guided by processes of experience and reflection on experience (PONTE, 2012), in reference to articulations between *knowledge in* and *for practice* (COCHRAM-SMITH; LYTLE, 1999; PONTE, 2012).

5 CONCLUSIONS AND CONSIDERATIONS

Based on the literature review carried out, it is possible to perceive that the teacher's pedagogical practice, with regard to actions in the classroom, is constituted and influenced by several factors, among which: their experience as a student; the knowledge acquired in initial training; the reflections provided in the mandatory supervised internship; collaborative actions in continuing education programs; discussions and reflections with colleagues and professors about scientific studies and practices carried out; participation in research groups; professional experience; resources used in practice; and the established curriculum.

Pre-service teacher education – by articulating supervised internship disciplines and practices – and In-service teacher education – guided by collaborative principle – although not sufficient, are essential spaces for the constitution and reconstitution of teaching practice, since they allow thinking and rethinking central aspects, such as tasks, resources, the role of the

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teacher, and the student. The knowledge mobilized in these spaces is linked to the teachers' experiences arising from Basic Education, permeating the pre-service teacher education and relating to in-service teacher education, which promote reflections and problematization of dilemmas arising from teaching practice (PONTE, 2012).

In this sense, collaborative environments (online forums, e-mail, study groups, and in-person and online courses), in which teachers and future teachers can interact, are promising to provide opportunities for collective discussions, sharing of knowledge, beliefs, dilemmas, and experiences, as well as the search for *solutions* (SHULMAN, 1986), composing the essence of the processes of constitution and change of the teacher's practice.

These considerations reveal a scenario that adheres to the conception of *knowledge of practice*, presented by Cochram-Smith and Lytle (1999) and revisited by Lemes, Evangelista, and Anuciato (2020), by assuming that, through collaboration between university and school, interactions between experienced and novice teachers are promoted which, supported by the practices developed and by the results that emerge from the investigation in the classroom, constitute factors that allow the reconstruction of knowledge for teaching practice. Particularly, in these research related to teaching practice, discussions that focus on didactic aspects and technology in mathematics teaching stand out, which show the strong influence of beliefs and conceptions in the application of knowledge in teaching practice, as well as references for the reflections of the teachers, in agreement with Ponte and Oliveira (2002).

The results also indicate that Tardif's (2002) knowledge categories or Shulman's (1986, 1987) knowledge categories are, in fact, relevant to the (re)constitution of teaching practice. By showing, however, the strong articulation with experiences arising from different spatio-temporal contexts, which, sometimes, support teachers' beliefs and conceptions and their respective unfolding in the practice they conduct (PONTE; OLIVEIRA, 2002), it makes sense to consider that professional teaching learning is not restricted to cognitive aspects, but reveals strong social influences, giving centrality to the social world of teachers and the practices they develop in it for the understanding of their professional learning (PONTE, 2012).

Thus, taking into account these results, it seems appropriate to promote training that consider the constitution of the teacher's professional practice in social terms, as advocated by Lave and Wenger (1991), and that, therefore, give it focus on actions; encourage the collectivity as a motto for engagement with this practice and for collaboration; and consider the

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mathematical knowledge to teach as what inspires the participants' engagement in the negotiated and developed actions (WENGER, 1998).

In this sense, learning can be understood as a process of negotiation of meanings, characterized by the combination of participation and reification processes (WENGER, 1998). This is because, according to Estevam and Cyrino (2019), while in the process of participation we recognize each other reciprocally because of the relationship with other individuals and experiences of meaning, in the process of reification we project our meanings onto the world, so that this projection assumes an independent existence. Based on this aspect, Vilas Boas and Barbosa (2016), focusing on participation, discuss teacher professional learning and define it as changes in the patterns of teacher participation in the practices they conduct, which is effective both from the classroom experience classroom, as well as external experiences that, in some way, affect what they do in the classroom.

It should be noted, however, that – considering the dual processes that support learning in social terms – both the changes in the practice carried out in the classroom and the meanings attributed to support it are indicative of learning, reverberating even in the identity of these professionals. In this way, we consider that changes in the patterns of teacher participation in the practices they conduct can manifest, beyond what they do, in what they say (and what they do not say) and, especially, in the meanings and interpretations that support their sayings and actions, which make use of knowledge, beliefs, and conceptions, as suggested by the review presented here. This conception of learning is, therefore, the one we consider when we reflect on the (re)constitution of the teacher's professional practice, particularly mathematics teachers, whose collaborative spaces allow it to be promoted in the context of practice and social and professional communities (according to the assumed approaches and associated constraints).

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