TEACHING IN FORMATION COURSES OF TEACHERS WHO TEACH MATH: WHAT DOES RESEARCHES REVEAL?

DOCÊNCIA NOS CURSOS DE FORMAÇÃO DE PROFESSORES QUE ENSINAM MATEMÁTICA: O QUE AS PESQUISAS REVELAM?

LA ENSEÑANZA EN CURSOS DE FORMACIÓN PARA PROFESORES QUE ENSEÑAN MATEMÁTICAS: ¿QUÉ LAS INVESTIGACIONES MUESTRAN?

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ABSTRACT: This article aims to analyze the results found in Brazilian researches on teacher formation courses in the period 2014-2018. As guiding question of this investigation, we will answer: what aspects are pointed out in Brazilian research in relation to teaching in formation courses for teachers that teach mathematics? For this a survey of investigations in the platform of dissertations and theses of Capes using the keywords taken from the objective proposed here will be made. As a filter, the Science and Mathematics teaching area and the Mathematics Education concentration area will be used, in which only the theses that address the theme will be selected. Initially, the initial surveys made by reading the titles and abstracts point, in general, to the need to encourage research that addresses the issue of teacher formation, involving extension courses and other formative practices that allow to expand and deepen teaching professional knowledge.

KEYWORDS: Teaching. Mathematics Degree. Pedagogy Degree.

RESUMO: *Este artigo tem como objetivo analisar os resultados encontrados em pesquisas brasileiras sobre cursos de formação de professores no período de 2014-2018. Como questão norteadora desta investigação, buscar-se-á responder: quais aspectos são apontados em pesquisas brasileiras em relação à docência nos cursos de formação de professores que ensinam matemática? Para isso será feito um levantamento de investigações na plataforma de dissertações e teses da Capes utilizando as palavras-chave retiradas do objetivo aqui proposto. Como filtro será utilizado a área de ensino de Ciências e Matemática e área de concentração em Educação Matemática, no qual será selecionado somente as teses que abordam a temática. Preliminarmente os levantamentos iniciais feitos por meio da leitura dos títulos e resumos*

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apontam, de modo geral, a necessidade de incentivo em pesquisas que abordem a questão da formação do professor, envolvendo cursos de extensão e de outras práticas formativas que permitem ampliar e aprofundar o conhecimento profissional docente.

PALAVRAS-CHAVE: *Docência. Licenciatura em Matemática. Licenciatura em Pedagogia.*

RESUMEN: *Este artículo tiene como objetivo analizar los resultados encontrados en los cursos de formación de docentes de investigación brasileños en el período 2014-2018. Como pregunta orientadora de esta investigación, responderemos: ¿qué aspectos se señalan en la investigación brasileña en relación con la enseñanza en los cursos de formación docente que enseñan Matemáticas? Para ello se realizará una encuesta de investigaciones en la plataforma de disertaciones y tesis de Capes utilizando las palabras clave tomadas del objetivo aquí propuesto. Como filtro se utilizará el área de enseñanza de la ciencia y las matemáticas y el área de concentración en la educación matemática, en la que se seleccionarán solo las tesis que aborden el tema. Las encuestas iniciales preliminares realizadas al leer los títulos y los resúmenes generalmente señalan la necesidad de alentar una mayor investigación para abordar el tema de la educación docente que involucra cursos de extensión y otras prácticas formativas que permiten ampliar y profundizar el conocimiento profesional, maestra.*

PALABRAS CLAVE*: Enseñanza. Licenciatura en Matemáticas. Licenciada en Pedagogía.*

Introduction

The theme on teacher formation has been studied by educators from different areas of knowledge who seek to understand the factors that influence the quality of the educational action of the teacher who works or will work in Basic Education. Among the factors, we highlight the educator of teachers, who are the central agents of a cyclical process of the educational system. The question, therefore, that concerns us and urges us to investigate involves particularly the educator of the teacher who teaches mathematics in elementary school, that is, the educator who works in undergraduate courses in Pedagogy and Mathematics.

In this sense, teaching in higher education, both in Pedagogy and in the Mathematics Degree[4], needs to be rethought. Several authors, such as Fiorentini, Oliveira (2013), Curi (2005), Nacarato, Mengali, Passos (2014), Passos (2005), Gonçalves and Fiorentini (2005), Gonçalves (2000), among others, have emphasized issues related to formation and the identity of the educators, highlighting several aspects related to the teaching practice for teaching mathematics in Basic Education. In this sense, we argue the importance of the role of this professional - the educator - in preparing the teacher the function of teaching mathematical

[4] In this text the degree referred is the particular degree for teaching that is called "licenciatura" in the Brazilian Higher Education system, which differs from the Bachelor's Degree for encompassing several pedagogical disciplines in its curriculum.

concepts that favor the student's learning about this science and, in addition, to promote the development of thoughts that help in the construction of structures cognitive.

This aspect of the teacher's role leads us to consider the professional knowledge of teachers to act in the teaching of mathematics in Basic Education. According to Gatti (2014), mathematics degree programs generally consist of subjects with specific mathematics content and others focused on the pedagogical area and, in turn, Pedagogy degree programs, in addition to covering a wide variety of theoretical and practical subjects related to education, occasionally includes didactics or basic mathematics fundamentals. Anyway, both programs alone hardly manage to prepare the teacher to teach mathematics. In fact, the formation programs and practices are constituted in a dichotomized way between this pedagogical and mathematical knowledge (GATTI, 2014).

The integration of this knowledge, already defended by Shulman (1986; 1987), which results in the pedagogical knowledge of the specific content - in the case of mathematics, it is often dependent on the self-learning of the future teacher, since this focus on pedagogical knowledge of mathematical content is not always addressed in initial formation. In addition, we emphasize that the future teacher carries references of pedagogical practice based on the way he learned throughout his career as a student (TARDIF, 2002).

It is worth mentioning that the integration between pedagogical and mathematical knowledge requires the teacher to undergo a reconstruction process, that is, he often needs to deconstruct mathematical knowledge that involves automated procedures to deepen its nature and its conceptual interrelations in order to conceive it at the same time to curricular scope and student learning. Under this focus, the studies by Ball, Thames and Phelps (2008) show that the teacher's mathematical knowledge is specialized knowledge of the content that must go beyond mathematical knowledge. In this context, we agree with Almeida, Ribeiro and Fiorentini (2018), that a teacher who teaches mathematics, especially in the early years of elementary school, needs to "know how to describe and justify why the procedures work; point out which examples are more or less appropriate in each situation (and why?); and master a knowledge that allows him to mathematically justify affirmatives"[5] (ALMEIDA; RIBEIRO; FIORENTINI, 2018, p. 199).

Therefore, the formation of the mathematics teacher, as usually happens in the dichotomized perspective of knowledge and distanced from school practices, ends up

[5] "saber descrever e justificar porque os procedimentos funcionam; apontar quais exemplos são mais ou menos apropriados em cada situação (e por quê?); e dominar um conhecimento que lhe permita justificar matematicamente afirmações"

weakening the teaching practice, and with this it can both reinforce the teacher's practice for a reproductive focus of the way he learned, as well as instigate him to seek new learning in the direction of professional development. We believe that this search can favor the teacher in the search for participation in continuing education courses, communities of practice, study groups, or even evolving towards the development of research in *stricto sensu* courses, for example.

Anyway, the formation process has a dynamic and cyclical characteristic in the educational system and, therefore, must be seen as a social practice,

> being constituted of complex knowledge and relations that need to be studied, analyzed, problematized, understood and continuously transformed. This requires a formative practice that has as main axis of study and problematization about the multiple professional activities of the mathematical educator (FIORENTINI; OLIVEIRA, 2018).[6]

Thus, we organized our investigation presenting the data selection and later its analysis.

Methodological paths: how do we select research?

This research conducts a documentary investigation of the type of investigations on a given topic. Supported by Ludke and André (2013, p. 38), this type of research is relevant since, according to the authors, it is "little explored not only in the area of education but in other areas of social action"[7]. However, we consider that the documentary analysis, as in this study, "can constitute a valuable technique for approaching qualitative data"[8], considering that it can unveil new aspects on the investigated theme and favor the realization of future research.

For this survey, our search took place at the Bank of Dissertations and Theses of Capes, using as a search expression Higher Education Teaching and Pedagogy and Mathematics. We used as a filter the choice of the Sciences and Mathematics teaching area and the area of concentration in Mathematical Education. Only the theses were selected, in which we obtained 209 investigations.

From these selections, we read the titles and abstracts and selected eight theses that covered our theme. We are aware that this type of investigation is always inconclusive, as it depends on what the author defined in his production in terms of keywords, summary and title

[6] sendo constituída de saberes e relações complexas que necessitam ser estudadas, analisadas, problematizadas, compreendidas e continuamente transformadas. Isso requer uma prática formativa que tenha como eixo principal de estudo e problematização acerca das múltiplas atividades profissionais do educador matemático (FIORENTINI; OLIVEIRA, 2018).
[7] "pouco explorado não só na área de educação como em outras áreas de ação social"
[8] "pode se constituir numa técnica valiosa de abordagem de dados qualitativos"

of the investigation, so that, in this investigation, some of the research in the area may not appear. However, we clarify that the eight theses that constituted our scope of study allowed us to reflect and discuss some aspects that pervade the theme of this research related to teaching in teacher education courses that teach mathematics.

Data analysis and discussion

As we seek more recent studies, we seek to investigate the theses published in the last five years. We reaffirm that we found eight studies developed involving the teaching theme in undergraduate courses for teachers who will teach Mathematics in Basic Education. Such studies are the results of doctoral research carried out at two institutions: Pontifical Catholic University (PUC/SP) - six theses - and Federal University of Pará (UFPA) - two theses, as shown in Table 1 presented below:

Table 1 – Researches selected for this study

Study	Title	Year	Institution
1.Silva (2014)	**Teachers of the mathematics degree course in the beginning of career in higher education**[9]	2014	PUC/SP
2.Pires (2014)	**Function: conceptions of teachers and students of secondary and higher education**[10]	2014	PUC/SP
3.Brito (2015)	**Teaching degree courses in pedagogy from state universities in Bahia: analysis of mathematical formation for early childhood education**[11]	2015	PUC/SP
4.Esquincalha (2015)	**Knowledge revealed by tutors in a continuing education course for mathematics teachers in the distance education modality**[12]	2015	PUC/SP
5.Meira (2016)	**Formation of Mathematics teachers: a study of the contributions of psychology**[13]	2016	PUC/SP

[9] Professores do curso de licenciatura em Matemática em início de carreira no ensino superior
[10] Função: concepções de professores e estudantes dos ensinos médio e superior
[11] Cursos de licenciatura em pedagogia das universidades estaduais da Bahia: análise da formação matemática para a educação infantil
[12] Conhecimentos revelados por tutores em um curso de formação continuada para professores de matemática na modalidade a distância
[13] Formação de professores de matemática: um estudo das contribuições da psicologia

6.Tinti (2016)	**Teachers' learning located in a community of practice constituted from OBEDUC[14]**	2016	PUC/SP
7.Belo (2018)	**Experiential cartographies of mathematics teachers educators: self-awareness and self-formation[15]**	2018	UFPA
8.Matos (2018)	**Conceptions of mathematics and its teaching: experiences and reflections of teacher educators in an integrated and interdisciplinary degree course[16]**	2018	UFPA

Source: Devised by the researchers

We note that all studies were the results of a doctorate and that, with the exception of 2017, in all other years we found two studies in each of them. In order to understand a little more the purposes and procedures used for each study, we elaborated Chart 1, as shown below.

Chart 1 – Description of the research and objectives of the selected studies

Thesis	Objective	About the research
Silva (2014)	Identify and problematize the challenges and difficulties of teacher educators at the beginning of their careers in higher education, as well as the forms of coping found to answer these demands.	Qualitative research with 14 teachers of undergraduate courses in Mathematics and Pedagogy, educators at the beginning of their careers at institutions located in São Paulo, Paraná and Rio Grande do Sul. They answered a questionnaire and participated in semi-structured interviews.
Pires (2014)	Investigate how teachers conceive the concept of function, how this concept is reflected in their work in the classroom in High School and Higher Education and how this notion is understood by both levels of education.	Qualitative Research with ten teachers from two state schools and a public university located in the interior of São Paulo and 28 students. Teachers were asked to create situations/activities related to the concept of function and an interview.
Brito (2015)	Analyze aspects related to teacher formation for mathematical knowledge, in the curricular structures of the Degrees in Pedagogy, from UEBa, taking into account three aspects: theoretical content on mathematics, specific	Documentary research, analyzed the flowcharts and the menus of the curricular components, which presented mathematical knowledge, as well as the professional profiles of the courses. The author analyzed the course and documentary structure through Content Analysis.

[14] Aprendizagens docentes situadas em uma comunidade de prática constituída a partir do OBEDUC
[15] Cartografias experienciais de formadores de professores de matemática: consciência de si e autoformação
[16] Concepções de matemática e de seu ensino: experiências e reflexões de professores formadores de professores em um curso de licenciatura de proposta integrada e interdisciplinar

	contents and Mathematical practices.	
Esquincalha (2015)	Investigate the knowledge revealed by tutors of a continuing formation course for mathematics teachers, offered in distance learning.	Qualitative research with 6 tutors participating in an in-service formation program. They were observed in action (analysis of the discussion forum) and answered two questionnaires and participated in focus groups that were analyzed based on data triangulation.
Meira (2016)	Investigate the contributions of Psychology in teaching professionalization, in its insertion in the Mathematics Degree course.	Bibliographical and documentary research that provided analysis of studies related to psychology, Mathematics Education and Teacher Formation and documents on Psychology subjects in the analyzed courses (Pedagogy and Mathematics).
Tinti (2016)	Identify and describe some teaching learning evidenced in a Community of Practice (CoP OBEDUC PUC-SP) to then analyze and discuss elements of the context of this CoP that revealed/ allowed such learning.	Participating research carried out in CoP composed of 25 components among undergraduate students (teaching degrees) of Mathematics and Pedagogy, teachers of the initial and final years of the EF; professor of the Postgraduate course; doctoral and master's students. The collection took place through recordings and collection of productions by CoP members.
Belo (2018)	Investigate the experiences of mathematics teacher educators, seeking to understand self-formative processes produced by the educators based on reflection on their experiences	Narrative research with two mathematics teacher educators at UFPA. Data collection took place through the monitoring and recording in audio and video of the subjects Calculus I and Introduction to Real Analysis, collection of the field diary and analysis of texts produced by the teachers. Based on this, the author proposed reflective dialogues with the participants regarding these experiences.
Matos (2018)	Understand the sense and meaning relations between conceptions of Mathematics and its teaching manifested by teachers who form teachers, involved in an interdisciplinary proposal for the formation of future teachers for the early years of Elementary Education and EJA (Youth and adult education) when reflecting on their formative, research and teaching practices.	Collective case study with five teachers who form teachers from the UFPA degree course. Data were collected through: interviews, video recording of classes and theses and/or dissertations produced by them.

Source: Devised by the researchers

In the researches from 2014 to 2016 selected here, it is possible to note that all of them were developed using the qualitative methodology. Regarding the studies that dealt with issues related to teacher formation courses that teach mathematics, two theses were written based on documentary research and aimed to investigate the insertion of Mathematics and Psychology in undergraduate degree courses in Pedagogy and Mathematics. The rest - six studies - were carried out with and about educators of teachers.

It is also possible to note that the authors Brito (2015) and Meira (2016) carried out their investigations in documentation from Universities. The researchers analyzed the menus of the course subjects, and Brito (2015) also looked for evidence in flowcharts and in the professional profiles of the courses. This author used these documents in the search to identify which aspects related to the content - theoretical about mathematics, specific and of mathematical practices - were present in the curricular structures of the Degree courses at the State Universities of Bahia - Brazil. Meira (2016) analyzed 258 undergraduate courses in mathematics and searched for traces in the syllabus of the subjects on how the teaching of Psychology is proposed in the investigated courses.

The other theses analyzed here investigated educators of teachers, two of which were developed as part of a continuing education process and three in initial formation. With regard to continuing education, Tinti (2016) developed a thesis within the scope of the Observatory of Education Project - OBEDUC and Esquincalha (2015) investigated tutors who worked in a continuing education course for teachers, however the two studies have some different characteristics. Esquincalha (2015) focuses the analysis on the study participants - tutors - and makes analysis through the responses given by the tutors to the questionnaires, through the participation in the focus group and interventions carried out in the forum, but they do not detail the training process. Tinti (2016), on the other hand, analyzes the formative process based on the learning evidenced by the teachers who are part of the study. As for the teachers who teach in the initial formation, the researches in general analyzed performance, thinking, conceptions and teaching knowledge: Silva (2014) and Pires (2014) investigated the participants' thoughts and conceptions and developed their studies by proposing questionnaires and interviews, Belo (2018) and Matos (2018) also used observation of practice and narrative.

When analyzing the theoretical framework of the theses investigated here, we highlight the studies that deal with learning, teaching knowledge and professional teaching knowledge, present in seven works, as shown in Chart 2. It is noteworthy that we did not find mention of the referential in the summary of Belo's thesis (2018).

Chart 2 - Theoretical framework used in the analyzed theses

Study	**Theoretical framework**
1.Silva (2014)	It was based, mainly in studies related to Education that discuss: • teaching in higher education, • educators of teachers, • early career in higher education and, • learning in teaching.
2.Pires (2014)	It was based, mainly in studies related to Mathematics Education and Education that discuss: • representation records, • teaching and learning of function and, • teacher knowledge.
3.Brito (2015)	It was based, mainly in studies related to Education that discuss: • professional teaching knowledge, • course components of the courses that combine theory and practice.
4. Esquincalha (2015)	It was based mainly on studies related to Education that discuss TPACK (Technological Pedagogical Content Knowledge), assuming that technological, pedagogical and mathematical knowledge are fundamental for the exercise of their functions.
5.Meira (2016)	It was mainly based on studies that relate psychology and education: • in the constitution of knowledge, • on issues related to teacher formation - teaching knowledge, reflection on practice.
6.Tinti (2016)	It was mainly based on studies related to Mathematics Education: • theory of Situated Learning; • CoP internships and, • knowledge of/for/in practice.
8.Matos (2018)	It was based on studies that discuss • issues related to conception about mathematics and its teaching • teacher knowledge.

Source: Devised by the authors

Concerning the theoretical basis of research indicated in the published investigations, we note that even considering the mention of research that deals with learning, teaching knowledge and teaching professional knowledge, the theoretical used was not the same in all of them:

- The Professional Teaching knowledge as proposed by Shulman was mentioned by Silva (2014), Brito (2015) and Meira (2016) - we highlight that Brito (2014) referred to Shulman's studies (1986) from the research of Mizukami (2004) and Silva (2010);
- Teaching knowledge and its nature, from Tardif, served as a theoretical framework for Silva (2014), Pires (2014) and Meira (2015);
- Technological Pedagogical and Content Knowledge - TPACK - as described by Mishra and Koehler (2006). These authors took Shulman's (1986) theory as a starting point, which

conceptualized the pedagogical knowledge of the content, thus characterizing a new knowledge exclusive to the professional teacher. From this theoretical construct by Shulman, researchers Mishra and Koehler added technological knowledge. Thus, the intersection of these three types of knowledge (content, pedagogical and technological) gave rise to TPACK. TPACK was cited by Esquincalha (2015);

- Knowledge of / for / in practice proposed by Cocharan-Smith and Lyte (2009) were the references used by Tinti (2016). These authors in 1993 also relied on Shulman (1993), but today they describe positions taken by educators who are part of investigative communities in relation to knowledge and its relations with their practice.

Analyzing what has happened, it is possible to note that Brazilian research on teaching in higher education conducted in the last five years has been dedicated to studying the mobilization of professional knowledge in teaching actions and most studies are influenced by the ideas of Shulman (1986) and of authors who expanded their studies. Shulman (1986) discusses the pedagogical knowledge of the subject to be taught to the student, investigating the "teacher's thought" and the "teacher's knowledge". Concerning the relevance of the studies of this author, we agree with Sztajn (2002) when she affirms that such research "boosted both the studies on the effectiveness of the teacher and those on the thinking processes of the teacher when considering the disciplinary issue and the particular aspects of teaching specific discipline"[17] (SZTAJN, 2002, p. 20). In this sense, we believe it is important to note that two studies brought investigations that broadened Shulman's (1986) initial ideas: Mishra and Koehler (2006), cited by Esquincalha (2015), and Cochran-Smith and Lyte (2009), referenced by Tinti (2016). Mishra and Koehler (2006) adds to the pedagogical knowledge of the content described by Shulman (1986; 1987) a new category, the technological knowledge that gave rise to Technological Pedagogical and Content Knowledge - TPACK; in Cochran-Smith and Lyte (2009), the author sought references on knowledge in and for practice built collectively by teachers. Another study referenced in three theses was Tardif. To justify such a choice, the theses show the author's discussions about the process of developing teacher knowledge in initial formation. They remember about the identity characteristics brought by future teachers. In this context, Tardif (2002) brings us elements to reflect on the articulation between time and learning from the act of teaching. The analyzed theses anchor the author's choice to this and other characteristics. Silva (2014, p. 81), for example, states that "time is an important ally in

[17] "impulsionou tanto os estudos sobre a eficácia do professor como aqueles acerca dos processos de pensamento do docente ao considerar a questão disciplinar e os aspectos particulares do ensino de uma disciplina específica"

the construction of the knowledge of teachers who serve as the basis for teaching work"[18], says Tardif and Raymond (2000).

In addition to these, other studies related to Education were also used as theoretical references in the analyzed theses: teaching in higher education, educators of teachers and the beginning of careers in higher education, reflection on the practice and the different stages of development in a Communities of Practice - CoP. In the context of Mathematical Education, the references in general occurred more timidly. The exception is the study by Pires (2014), which supported his analysis in Raymond Duval's studies on representation records, used research involving teaching and learning of function, such as the studies by Vinnes (1992), Sfard (1992) and Sierpinska (1992) and Norman (1992). Tinti (2016) also used studies related to Mathematics Education, since he considered the perspective of Situated Learning Theory (LAVE; WENGER, 1991), which argues that every activity (including learning) is situated in the relations between people, contexts and practices. Bearing in mind that a CoP can go through different stages of development (WENGER *et al.*, 2002), the organization of the data was structured considering the stages: potential, expansion and maturity.

What do Brazilian researches conclude about formation courses of teachers that teach mathematics?

Regarding teacher formation courses, Brito (2015) and Meira (2016) researched documentation from Universities. Brito (2015) sought to identify which aspects related to the content - theoretical on mathematics, specific and mathematical practices - were present in the curricular structures of the Degree in Pedagogy courses at the State Universities of Bahia - Brazil. The author observed, initially, that in the Pedagogy degrees investigated there is "an enormous distortion in relation to mathematical knowledge. The workloads assigned to them are extremely small and were between 1.63% ... and 3.75%" (BRITO, 2015, p. 89-90). Approximate indices were found in another Brazilian survey published at least fourteen years ago, by Curi (2005). The author, for example, already identified in the early 2000s that subjects related to mathematics were offered in Pedagogy with a small quantity, around 4% of the total charge of the course. In addition to this percentage, Brito (2015) also observed that, even with a reduced load, Mathematical knowledge was present in the eighteen Pedagogy courses analyzed, however in 15 of them the presence was in only one component and the rest presented

[18] "o tempo é um aliado importante na construção dos saberes de professores que servem de base ao trabalho docente

two curricular components related to Mathematics. This author claims to have found in pedagogy courses "[...] important and worrying gaps that transformed teaching degrees into 'generalist' and/or 'lightened' formations"[19] (BRITO, 2015, p. 124). In addition, this study pointed out that they did not perceive the existence of "[...] concern in articulating them [the contents], as expected, with the three aspects highlighted in this research - theoretical contents on mathematics, specific mathematical contents and practical contents of mathematics"[20] (BRITO, 2015, p. 124). The author comes to such a conclusion since she found fewer courses that presupposed to offer the three strands - theoretical on mathematics, specific and mathematical practices - in six of them. In the professional profiles, the author realized that issues related to teaching and management were found in all courses, but teaching for early childhood education is offered only in 12 of a total of 18 courses. Analyzing what happened, we agree with Nacarato, Mengali and Passos (2014): the lack of disciplines that discuss issues related to specific teaching for mathematical content can, in a way, hinder the paradigm shift of the teacher model formed in the Brazilian institutions investigated. The lack of experience related to the specific teaching of mathematics can impact the professional practice of future teachers formed in these courses, that is, these professionals start to reproduce the practice of their teachers in Basic Education, thus influencing their professional identity.

Meira (2016) analyzed 258 teaching degree courses in mathematics and searched for traces in the syllabus of the subjects on how the teaching of Psychology is proposed in the investigated courses. The author shows the relevance of providing future teachers with the opportunity to discuss and reflect on issues related to the psychology of mathematics education, and defends its insertion as a curricular component in teaching degree courses. The author realized that the curricular component linked to psychology was present in all teaching degree courses analyzed by her, and the terminology: "most common is Psychology of Education", however the study points to other denominations, such as: learning; theories and practices; learning concepts and current themes of adolescence and Youth, cognitive development; Human development and Learning. Psychology, Education and contemporary themes, among others. Regarding the workload, Meira (2016) evaluated that there was a variation between 30 and 180 hours, with the highest frequency of 80 hours. The average between the records is 77 hours and, in 33% of courses, the workload is equal to or less than 60 hours. Analyzing the

[19] "[...] lacunas importantes e preocupantes que transformaram as licenciaturas em formações 'generalistas' e/ou 'aligeiradas'"

[20] "[...] preocupação em articulá-los [os conteúdos], como esperado, com a três vertentes destacadas nesta pesquisa- conteúdos teóricos sobre a matemática, conteúdos matemáticos específicos e conteúdos práticos da matemática"

menus, the author observed a tendency for teaching to occur in a generalized manner, without presenting "a specific direction of psychological knowledge aimed at the formation of mathematics teachers"[21] (MEIRA, 2016, p. 203). At the end of the study, the author recommends that the proposition of Psychology as a curricular component needs to be considered

> [...] in the concept of teaching reflective practice, in an action research process, from a Piagetian view, that in Psychology, more than in other fields, the facts and interpretations are really only understood when the teaching is mediated by research practice. That is, through teaching practice that favors the construction of knowledge, through action research experiences, establishing a theory and practice relation (MEIRA, 2016, p. 203).[22]

This study allowed us to observe that although Psychology is present in the menus, it seems that it still does not appear interacting with the practice. On the insertion of the assumptions of this science, we also obtained in Ball, Thames and Phelps (2008), arguments to advocate in favor of the relevance of its insertion as a knowledge that comes to integrate the knowledge base. It is important that the future teacher also understands the process of learning mathematical knowledge by children, adolescents and adults, but it must go beyond that; according to Ball, Thames and Phelps (2008), he needs to be able to anticipate mistakes made by his students, to know what the common mistakes would be, to interpret incomplete thoughts in order to help his students to understand what is being discussed, and such actions they only occur if the education professional has, in addition to the knowledge of the mathematical content, pedagogical knowledge of that content, also the knowledge of the content and teaching that can be expanded by studying the psychology of education.

Brazilian researches conducted with teachers who teach in formation courses of teachers that teach mathematics

We reiterate that the research by Silva (2014), Pires (2014), Esquincalha (2015), Tinti (2016), Belo (2018) and Matos (2018) investigated educators of teachers, and: two of them were developed within the scope of a continuing formation process and three in initial

[21] "um direcionamento específico de conhecimentos psicológicos voltados para a formação de professores de Matemática"

[22] [...] na concepção de ensino de prática reflexiva, num processo de pesquisa-ação, a partir de uma visão piagetiana, de que em Psicologia, mais do que em outros campos, só se compreende realmente os fatos e as interpretações quando o ensino é mediado pela prática de pesquisa. Isso é, pela prática de ensino que favoreça a construção de conhecimentos, pelas experiências de pesquisa-ação, estabelecendo-se uma relação teoria e prática (MEIRA, 2016, p. 203).

formation. Below we present the results of the two investigations that were carried out in a formative process.

In-service formation and teaching in formation courses of teachers that teach mathematics

Tinti (2016) carried out his study within the scope of the OBEDUC Project and sought to identify and describe some teaching learning evidenced in a Community of Practice (CoP OBEDUC PUC-SP) to then analyze and discuss elements of the context of this CoP that revealed/allowed such learnings; Esquincalha (2015), on the other hand, analyzed the role of tutors who were educators in a continuing formation course for teachers. In this context, in Tinti's research (2016), the analysis of teaching learning will serve to investigate the formative process, but in Esquincalha's study (2015) the focus refers to the analysis of tutors.

Concerning the study by Tinti (2016), it was possible to evidence learning, for example: reflection and written record about the practice itself; the construction of concept maps; the feeling of belonging to a CoP; the opportunity to experience situations in which it is necessary to deal with the diversity of profiles and trajectories within the CoP; the opportunity to develop activities, individually and collectively, with a view to solving problems; opportunity to study and handle manipulable materials for teaching fractions. At the end, the author concluded that the "teaching learning mobilized in the Stages of development at CoP OBEDUC PUC_SP were multiple and that they converge to the knowledge of/for/in practice proposed by Cocharan-Smith and Lyte"[23] (2009).

The analyzes carried out by Esquincalha (2015) allowed him to conclude that affective-attitudinal components played a fundamental role in the exercise of tutoring in the context of continuing education of distance teachers and, in this sense, the author proposes the expansion of the theoretical framework TPACK, through the inclusion of a fourth type of knowledge, featuring the TPCK-OTE (Technological Pedagogical Content Knowlwdge - Online Teacher Education). It was possible to note that both the research by Tinti (2016) and Esquincalha developed formation aimed at teaching practice, favoring the confrontation of the challenges emerging from the school context. As for the characteristics of CoP, we found similarities with the study by De Paula and Cyrino (2018), who investigated dissertations and theses from 2006 to 2016 that analyzed professional identity. The authors observed that when

[23] "aprendizagens docentes mobilizadas nos Estágios de desenvolvimento na CoP OBEDUC PUC_SP foram múltiplas e que convergem para os conhecimentos da/para/na prática propostos por Cocharan-Smith e Lyte"

investigating the practice of CoP, the studies showed aspects "such as listening and sharing their experiences and desires with others, in addition to enabling the (re)negotiation of the members' roles, when learning to work differently with the mathematical discipline during the meetings and changes were perceived in their teaching practices"[24], also present in the study analyzed here.

Teaching in formation courses for teachers that teach mathematics

As for the teachers who teach in the initial formation, the researches observed here analyzed performance, thinking, conceptions and knowledge of teachers: Silva (2014) and Pires (2014) investigated the participants' thoughts and concepts and developed their studies through the proposal of questionnaires and interviews, Belo (2018) and Matos (2018) also used observation of practice and narrative.

Silva's research (2014) allowed us to draw the profile of educators of teacher at the beginning of their careers, who face pedagogical and institutional challenges. The novice educator is faced with new situations. One of the investigated teachers, for example, is concerned with her professional identity:

> My biggest difficulty is creating a profile. Create a university professor profile, stray from the elementary and high school teacher profile. Because the professors I see in college have a more rigid, more rigorous profile and I am more, perhaps, more humanitarian, more understanding (SILVA, 2014, p. 128).[25]

This study showed the need for these professionals to seek support from more experienced colleagues. This group of educators of teachers investigated by Silva (2014) was shown to feel valued since educators of teachers noticed that their students respected them, especially for their experience in teaching for basic education. The group considers that working in a friendly and supportive environment that allows the exchange of experience can favor the expansion of their knowledge. At times, educators of teachers at the beginning of their careers show evidence that not all difficulties are socialized, their identity is constituted in an isolated way when confronted with the dilemmas that present themselves. In this context, these

[24] "como o de ouvir e partilhar com o outro suas experiências e anseios, além de propiciar a (re)negociação de papéis dos integrantes, ao aprenderem a trabalhar de modo diferenciado com a disciplina matemática no decorrer dos encontros e perceberem modificações em suas práticas docentes"

[25] A minha maior dificuldade é criar um perfil. Criar um perfil de professora universitária, me desgarrar do perfil de professora do ensino fundamental e médio. Porque os professores que eu vejo na faculdade têm um perfil mais rígido, mais rigoroso e eu sou um perfil mais, talvez, mais humanitário, mais compreensivo (SILVA, 2014, p. 128).

professionals seek to face their daily learning challenges based on the analysis of their own practice. In this sense, the results of this study are close to Loughran (2014), which also describes particularities that are present in the professional development of the educator, that is, aspects related to: the nature of this formation, passage between being a teacher and being a teacher of teachers and research on their own practice. About this last characteristic, we find similarities with the research presented by Gonçalves and Fiorentini (2005).

Pires (2014) investigated the concepts made explicit by a group of teachers about function. For this study we expose the results presented by two teachers, GPS1 and GPS2; this is due to the fact that only these two participants teach for a degree in mathematics. Unlike the group that was analyzed by Silva (2014), the two teachers of future teachers investigated by Pires (2014) were experienced - 17 and 20 years of experience in Higher Education -, both had also taught basic education - 6 and 13 years of experience. As for formation, the two participants are PhDs in Mathematics Education. In the introductory situation presented to the researcher, GPS1 tried to select a contextualized situation and, therefore, chose a situation that involves concepts from Physics, GPS2 already planned an activity that favored the use of different representation records, and during the interview, the teacher quoted Duval. At the end of the study Pires (2014) concludes that a large part of what is done by the student of the teaching degree course proved to be a reflection of the teacher's practice, since several strategies used by the students are the same proposed by the teachers. According to the proposed classification Sfard (1992), the teachers' conceptions moved between the operational and the structural; the students of Higher Education, at the end of the study, concerning the answers given, the participants showed more security and awareness, which allowed the author to infer that their conceptions were not limited only to operational aspects.

Belo (2018) investigated the experiences of educators of mathematics teachers seeking to understand self-formative processes produced by the educators based on reflection on their experiences. The author defends the thesis that the motivation of the teacher self-formation process of educators of mathematics teachers can occur from the moment that the subject “becomes aware that his experiences have repercussions, constitute and integrate with his pedagogical practices”, favoring, thus, teaching in Higher Education in Mathematics, in the dialogical sense “assumed by them, as subjects of themselves and their pedagogical practices”. The author observed the existence of experiential nuclei that became base/guiding elements for the participants to interact with the triad: student, mathematical knowledge and evaluative practices. Belo (2018) also notes that the reflection on experiences lived by the participants favors the recognition of its relevance to their current practices. In this context, they reflect on

their entry into higher education teaching, and the study indicates that the postgraduate course was fundamental in the process of professional development. In addition, the two professors highly valued research.

Matos (2018) sought to understand the sense and meaning relations between conceptions about Mathematics and its teaching, manifested by educators of teachers at UFPA. At the end of the study, the author concludes that the conceptions about Mathematics made explicit during the investigation considered it as knowledge of human construction and, therefore, changeable and fallible. They conceived teaching as indispensable and that it was possible to articulate the knowledge of mathematical content to other areas of knowledge if there was dialogue, partnership and collaboration. The teachers gave evidence that they are experiencing a process of overcoming paradigms with which they built their practice. The author felt a certain "movement towards changes in conceptions and practices, demonstrating that they are in the process of building an understanding of the Integrated Teaching course proposal, in terms of the development of interdisciplinary practices and the anxiety that moves them beyond the borders of your field of knowledge"[26]. Thus, indicating that they are in the process of overcoming the paradigms from which they were formed. Analyzing the results presented in the theses that investigated teachers who work in initial formation, it is possible to observe that the relevance given by the participants to collaborative environments is consensus; this brings us to Ponte and Serrazina (2003), when they affirm that a successful collaborative work presupposes the existence of a good relation between the individual and the collective plan; for the authors, such a relation:

> [...] has to do with the establishment of common goals for the whole group that can not only be shared and assumed as their own by the different members but also made compatible with their own personal goals. It also has to do with the fact that the group establishes appropriate ways and rhythms of work according to the common objectives but that also help the development of the ways and rhythms of work for each of its members. In this way, the enhancement of individual capacities in favor of the group's work and the collective's virtualities for the development of each of its members appears as a decisive element for a group engaged in a joint collaborative work (PONTE; SERRAZINA, 2003, p. 54).[27]

[26] "movimentação no sentido de mudanças de concepções e práticas, demonstrando que estão em processo de construção da compreensão da proposta do curso de Licenciatura Integrada, em termos do desenvolvimento de práticas interdisciplinares e a inquietude a qual os move para além das fronteiras do seu campo de saber"

[27] [...] tem a ver com o estabelecimento de objectivos comuns a todo o grupo que possam não só ser partilhados e assumidos como seus pelos diversos membros mas também compatibilizados com os seus objectivos pessoais próprios. Tem a ver também com o facto do grupo estabelecer modos e ritmos de trabalho adequados em função dos objectivos comuns mas que também ajudam ao desenvolvimento dos modos e ritmos de trabalho de cada um dos seus membros. Deste modo, a potenciação das capacidades individuais a favor do trabalho do grupo e das

In this context, it seemed to us that in the theses analyzed here, the actors had experiences that allowed them to glimpse the search for common and particular goals, however the study by Silva (2014) indicated that many times the educator of teachers in early career finds himself solitary in this task and considers that the way is to investigate the practice itself. We also note that this characteristic seems to be accentuated in the Integrated Teaching Degree, researched by Belo (2018) and Matos (2018), which seeks to present an innovative structure, since it aims to combine theory and practice in teacher education,

> not as practice translated into internship activities developed in one or two semesters at the end of the course, but pedagogical practices anticipated to teaching as a significant step in the professional development of teachers, pedagogical practices that require the continuous learning of the specific knowledge of each discipline and the relations that integrate them, thus making possible the possible rupture of compartmentalized teaching (JARDIM, 2016, p. 38).[28]

Final considerations

This article analyzed the results of eight theses that addressed formation courses for teachers that teach mathematics in the period 2014-2018, and among them, seven studies were identified that discussed issues related to professional teaching knowledge, teaching knowledge and knowledge of/for/in practice.

It is interesting to note that one of the theses addressed the professional teaching knowledge from the perspective of TPACK, thus showing the need to integrate technologies in teaching practice, which requires the teacher to have knowledge resulting from the articulation between pedagogical, technological aspects and mathematical content.

In relation to the knowledge of/for/in practice, we emphasize the importance of creating study groups in the context of the school or communities of practice that can enable teachers to become aware of their pedagogical practice, awakening them to search for new learnings that lead him to reconstruct his own teaching practice.

As for the research that addressed mathematical learning in Pedagogy courses, they demonstrated that discussions and reflections related to mathematical content and teaching are

virtualidades do colectivo para o desenvolvimento de cada um dos seus membros afigura-se como um elemento decisivo para um grupo empenhado num trabalho colaborativo conjunto (PONTE; SERRAZINA, 2003, p. 54).

[28] não como prática traduzida em atividades de estágio desenvolvidas em um ou dois semestres no fim do curso, mas práticas pedagógicas antecipadas à docência como etapa significativa do desenvolvimento profissional docente, práticas pedagógicas essas que exigem o contínuo aprendizado dos conhecimentos específicos de cada disciplina e as relações que as integram, possibilitando, assim, a possível ruptura do ensino compartimentado (JARDIM, 2016, p. 38).

not prioritized. This is a worrying fact, as this future professional will work with students in the stage of developing cognitive structures. Mathematical ideas are essential to be worked on in this phase of intellectual development. In addition, the teacher who teaches mathematics for the initial years and his educator need to realize that the focus of mathematical learning in formation must be in the perspective of the specialized knowledge of the teaching professional. Likewise, this also happens in the Mathematics Degree courses where the future teacher will work in Elementary and High School. In this situation, discussions and reflections on pedagogical content are not prioritized, which are generally treated as an appendix to the process. In this way, it seems that a virtuous circle takes place, one being the cause of the other, tending to impair the quality of learning of students of teachers who have had such formation. In view of this reality of formation, we note that new proposals for extension courses and projects for continuing education and study groups have emerged with the purpose of overcoming gaps in initial formation. Of course, such proposals are important and necessary, however, if the initial formation is revised, as well as the role of the educator, such formative processes could focus on boosting research, for example, awakening to new discoveries and development of creativity. Here, then, new questions that this study suggests to us: how has teacher formation in Brazil been involving extension courses and other formative practices? Have such courses favored expanding and deepening the professional knowledge of teachers?

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