ACTA SCIENTIAE

ISSN: 2178-7727
DOI: 10.64856/acta.scientiae.8358

Professional knowledge developed by mathematics teachers involved in initial teacher education

Flávia Cristina Figueiredo Coura[a]
Hélia Oliveira[b]

a Universidade Federal de São João del-Rei, Departamento de Matemática e Estatística, DEMAT, São João del-Rei, Brasil
[b] UIDEF, Instituto de Educação da Universidade de Lisboa, Lisboa, Portugal

ABSTRACT

Background: Mathematics teachers need specific knowledge to perform their role in teaching mathematics. The Supervised Teaching Practicum (STP), the Institutional Program for Teaching Initiation Scholarships (PIBID), and the Pedagogical Residency Program (PRP) can represent a third space in teacher education. Few studies address the formative opportunities that STP, PIBID, and PRP provide to teachers working in basic education, connecting practical professional knowledge and academic knowledge. **Objectives**: Understanding the development of professional knowledge among mathematics teachers involved in initial teacher education. **Design**: Qualitative study based on life stories, according to the characteristics of narrative inquiry. **Setting and Participants**: Two mathematics teachers who acted as supervisors in the STP and in one of the other two contexts of initial teacher education that take place in schools (PIBID or PRP) in Brazil. **Data collection and analysis**: Biographical interviews, generating narratives. Paradigmatic analysis of narratives to articulate dimensions of life stories. **Results**: Working as a supervisor in initial teacher education contexts in schools (STP, PIBID, and PRP) allows mathematics teachers to develop the knowledge necessary to teach mathematics, especially pedagogical knowledge of mathematical content. **Conclusions**: Contexts of initial teacher education in schools, with characteristics of a third space, also contribute to in-service teachers' professional development.

Keywords: professional knowledge; mathematics teacher; practicum; PIBID; PRP.

Corresponding author: Flávia Cristina Figueiredo Coura. Email: flaviacoura@ufsj.edu.br

Conhecimento profissional elaborado por professores de Matemática envolvidos na formação inicial de professores

RESUMO

Contexto: O professor de Matemática precisa de conhecimentos específicos para desempenhar sua função de ensinar matemática. Estágio Curricular Supervisionado (ECS), Programa Institucional de Bolsas de Iniciação à Docência (PIBID) e Programa Residência Pedagógica (PRP) podem representar um terceiro espaço na formação de professores, conectando conhecimento prático profissional e conhecimento acadêmico. Poucos estudos abordam oportunidades formativas que ECS, PIBID e PRP proporcionam ao professor da educação básica que neles se envolvem. **Objetivo:** Compreender a elaboração do conhecimento profissional de professores de Matemática envolvidos na formação inicial. **Design**: Estudo de natureza qualitativa, realizado a partir de histórias de vida, segundo características da pesquisa narrativa. **Ambiente e participantes**: Dois professores de Matemática que atuaram como supervisores, no ECS, e em um dos outros dois contextos da formação inicial docente que ocorrem na escola (PIBID ou PRP), no Brasil. **Coleta e análise de dados**: Entrevistas biográficas, gerando narrativas. Análise paradigmática das narrativas para articular dimensões das histórias de vida. **Resultados**: Trabalhar como supervisor em contextos da formação inicial que ocorrem na escola (ECS, PIBID e PRP) proporciona a professores de Matemática desenvolver conhecimentos necessários para ensinar matemática, principalmente, os associados ao conhecimento pedagógico do conteúdo matemático. **Conclusões:** Contextos da formação inicial docente que ocorrem na escola, com características de um terceiro espaço, também contribuem para a formação dos professores da Educação Básica.

Palavras-chave: conhecimento profissional; professor de Matemática; Estágio; PIBID; PRP.

INTRODUCTION

The Supervised Teaching Practicum (STP), the Institutional Program for Teaching Initiation Scholarships (PIBID, in the Portuguese acronym) and the Pedagogical Residency Program (PRP) are contexts of initial teacher education aimed at the socialization of the profession, carried out with the participation of basic education teachers, who receive prospective teachers at school for supervision, in the STP and the PIBID, and/or as preceptors, in the case of the PRP. These programs aim to help prospective teachers learn the profession through pedagogical practice, guided by research in teacher education (e.g., Ponte et al., 2017). They can also serve as professional development opportunities for school teachers, as university academics can reflect on and problematize aspects of their practice and professional

knowledge, and together build new educational and curriculum possibilities for teaching mathematics (Jesus et al., 2020; Losano et al., 2022).

Studies that target the field of mathematics teacher education (Fiorentini et al., 2002; Fiorentini et al., 2016) and those directed to the STP in the mathematics teaching degree (ML) (Barbosa & Lopes, 2021; Lopes et al., 2017) show that, as expected, Brazilian investigations on the teaching practicum focus mainly on prospective teachers. However, there is a need for research that "analyses aspects of the teaching practicum supervisor (mathematics teacher who works in basic education), as well as groups involving undergraduates in mathematics, school teachers, and university professors" (Barbosa & Lopes, 2021, p. 17).

As for the PIBID and the PRP programmes—teaching induction programmes instituted in 2007 (Brasil, 2007) and 2018 (Brasil, 2018), respectively—the studies are more recent than those focused on the STP. They aim at the implications of the programs on the training of prospective mathematics teachers (Araújo et al., 2017; Nascimento, 2017; Tinti & Silva, 2022; Vanzuita & Guérios, 2025), but indicate that the PIBID contributes to their improvement and professional qualification (Rodrigues et al., 2017), as well as the PRP, which enables the constitution and reconfiguration of mathematics teacher's specialised knowledge (Rodrigues, 2024) and the mobilisation of didactic-mathematical knowledge (Souza, 2023).

The Brazilian research field in which the contexts under consideration are situated has addressed STP and, more recently, PIBID and PRP. However, research on mathematics teachers (MTs) who receive students from the mathematics teaching degree (ML) in these contexts remains limited, particularly regarding the implications of this participation for their professional development. The present study seeks to address this gap by examining the professional knowledge development among MTs who are collaborating in initial teacher education.

THEORETICAL FRAMEWORK

We will contextualize the STP, PIBID, and PRP as a third space situated at the boundary between initial teacher education and professional practice (Zeichner, 2010). We will present Josso's (1999; 2002) studies on the formative experience and its developmental process. We will finalise the theoretical framework by conceptualising the MT's knowledge as specialised, aligned with the mathematics teacher's specialised knowledge framework (MTSK) (Carrillo et al., 2018).

The STP, the PIBID, and the PRP as a third space in teacher education

In Brazil, initial teacher education for MTs occurs in higher-level ML courses, within which the STP is a mandatory component of the curriculum. Such courses were linked to the PIBID and the PRP programmes, teaching induction programmes promoted by the Coordination for the Improvement of Higher Education Personnel (CAPES, in the Portuguese acronym). The STP aims to prepare teachers as a bridge between the academic curriculum and the professional performance space of prospective teachers (Brasil, 2024a). It should be an initial learning and socialisation experience within the profession, in which teachers from basic education institutions and professors from higher education institutions (HEIs) collaborate. The school mathematics teacher, called the "supervisor", is the professional who welcomes, guides, and establishes a formative dialogue with prospective teachers.

PIBID (Brasil, 2007) aims to foster the initiation of teaching, thereby strengthening teacher education at a higher level (Brasil, 2010, 2022, 2024). It is one of the few basic education teacher education programs that remain continuous nationally (Gatti, 2021). The institutional projects approved by CAPES are developed by groups of undergraduate students under the supervision of basic education teachers and the guidance of professors from the HEIs. The school teacher, responsible for monitoring and overseeing the activities of pre-service teachers, is called a "supervisor," as in the STP, and is regarded as the prospective teachers' co-educator (Brasil, 2010, 2022, 2024).

The PRP was proposed as "a training activity carried out by a student regularly enrolled in an undergraduate programme and developed in a public school of basic education, called field-school" (Brasil, 2018, p. 28). Its last call mentioned the aim of fostering institutional projects of pedagogical residence implemented by HEIs, contributing to the improvement of the initial teacher education in undergraduate programmes (CAPES, 2022). Groups of advisors, preceptors, and residents carried out the activities of these programmes. The preceptor is a schoolteacher responsible for monitoring and guiding residents in activities developed in the field-school and is regarded in the PRP as a teacher whose experience should be valued (Brasil, 2022).

The three contexts of initial teacher education are carried out through the integration of prospective teachers in a basic education institution, with the participation of the school teachers and professors from HEIs, and guided by the principle of inseparability (Brasil, 2022; 2024a) or unity (Brasil, 2024) between theory and practice in teacher education. According to the principle

enunciated by Dewey (1904), as Diniz-Pereira (2011) points out, adequate teacher education is not exclusively theoretical but involves practice aimed at developing work habits with empirical rather than scientific approval.

Without treating practice as the only instance of teacher education, yet aligned with this principle, Zeichner (2010, p. 480) highlights the importance of establishing less hierarchical relationships between academic curriculum components and the part of the teacher education program that occurs in schools. The author uses the concept of *third space* in initial teacher education to propose the creation of a hybrid space, bringing together basic education teachers and higher education professors in new ways to improve prospective teachers' learning, with a more equal status among its participants and a more synergistic connection between professional practical knowledge and academic knowledge. These hybrid spaces are characterized by the incorporation of representations of teachers' practices in university courses, mediated instruction and field experiences, hybrid teacher educators, and the integration of knowledge from teacher professional communities into initial teacher education.

Such characteristics are present in the guiding documents of the STP, the PIBID, and the PRP, which can be understood as a third space in initial teacher education, as several authors have also defended (Felício, 2014; Monteiro et al., 2020; Souza Neto et al., 2019). We question whether, in a complementary way, they can serve as professional development paths for MTs from basic education schools engaged in these ML contexts.

Formative experiences: having, making, and thinking

Taking the teacher as the one who learns in the exercise of their professional activity, including when he/she is involved in initial teacher education, demands looking at experiential learning, that is, learning through experience, which, according to Josso (1999; 2002), means the process of integrating know-how-to-do and knowledge into a practice, and being able to solve problems even if ignoring their theoretical formulation and solutions. An approach to experiential learning through life stories allows us to understand developmental processes and learning, and treats formative experience as a process of knowledge.

According to Josso (1999; 2002), formative experiences are lived experiences embedded in the temporal continuity of our being with a particular intensity that imposes itself on our consciousness and from which we will extract valuable information for our transactions with ourselves and/or with our

human and natural environment. They serve as a reference to evaluate a situation, an activity, or a new event. According to the author, formative experiences enable experiential learning and reveal that what produces experience constitutes a process of knowledge formation.

To understand the construction of the experience, Josso (2002, p. 36, emphasis added) proposes three development modalities: "*having experiences* from which I was given to live, *making experiences* that propose to me to live, and *thinking* these experiences". The development modality of *having experiences* refers to those built a *posteriori*, after a lived experience that surprises us, because it interrupts a logic that, from then on, no longer allows integrating what happens into what is known. This first moment of the experience leads to the suspension of automatisms and an inner analysis of what was experienced, going through an attempt to name what happened and what we learned, to culminate in the integration of that experience with existing ones or the induction of a new series of experiences, to which those who experienced this elaboration process can later resort. In this modality, the subject experiences something he/she did not provoke.

Resulting from *making experiences*, the experience built *a priori* differs from the previous one in that it is mobilised by the person, based on what was previously formalised, named, or symbolised. The lived experiences are provoked by the subjects who, based on them, *make experiences* and mobilise the same process of development of the *a posteriori* experience. So, to *make experiences*, one must *have experiences*; that is, to act deliberately in search of formative experiences, it is necessary to have gone through situations and events that provided experiential learning without having provoked them.

The third development modality*, thinking experiences*, refers to a "set of lived experiences that have been successively worked on to become experiences" (Josso, 2002, p. 40). The work of the subject who thinks about the experiences —those he/she had *a posteriori*, and those he/she made *a priori*— is to reflect on them in order to extract knowledge and know-how from the set of these experiences. In short, to *think experiences*, one must *have experiences* and *make experiences*.

The author situates the process of developing an experience within contexts of interaction and transaction with oneself, others, and the natural environment and its objects, where the experiences given to us or that we propose to live unfold; that is, within them, the subject can *have* and *make experiences*. On the other hand, the contexts in which the subject can *think experiences* are formalised sociocultural references, such as the arts, sciences,

or methodologies. Thus, according with that framework, the STP, the PIBID, and the PRP are initial teacher education contexts as they foster interactions among participant —especially the MTs—, and with the others involved, the school, the academic and experiential knowledge, as well as by the possibility of experiencing within them the processes of elaborating experience (having, doing and thinking).

Mathematics teachers' professional knowledge

The mathematics teacher's specialised knowledge (MTSK) (Carrillo et al., 2018) is a model that explains the knowledge that teachers have of mathematics as an object of teaching and learning and that aggregates specific knowledge to perform their function, including lesson planning, the relationship with other teachers, teaching classes, and reflecting on them. This specificity is associated with the demands of teaching mathematics, which affect content knowledge and pedagogical content knowledge. To address this specificity, the model is organised into three domains: beliefs about mathematics and mathematics teaching and learning; mathematical knowledge (MK); and pedagogical content knowledge (PCK), of which we will address the last two.

Mathematical knowledge (MK) helps us understand mathematics as a network of knowledge produced and structured according to its own rules, enabling MTs to teach the content in an interconnected way. The MK comprises three subdomains: Knowledge of Topics (KoT), Knowledge of the Structure of Mathematics (KSM), and Knowledge of Practices in Mathematics (KPM). The KoT describes what the MT knows about the topics he/she teaches and how he/she knows them, and implies a deep knowledge of mathematical content, including examples, concepts, procedures, rules, theorems, and their meanings. The KSM refers to the connections among mathematical items, including sequencing, complexity, and relationships among mathematical concepts. Finally, the KPM focuses on the specific ways of doing mathematics beyond a particular content, such as knowledge of proofs and the different ways of producing them, the ways of establishing the validity of a generalisation, and the various strategies for solving problems.

The PCK is the domain of teachers' knowledge that is most related to classroom practice, as it informs and guides the teacher's decisions to teach. It is also organised into three subdomains: the Knowledge of Features of Learning Mathematics (KFLM) refers to theories of mathematics learning that focus on mathematical content, including the characteristics of each content that may offer learning advantages or, conversely, present difficulties, and the ways

students interact with it. Its source is the MTs' own experiences and research on mathematics education. The Knowledge of Mathematics Teaching (KMT) refers to the specific theoretical knowledge of mathematics teaching, including didactic resources, strategies and techniques that allow the organisation of teaching, and is based on the results of research in mathematics education or on the personal experience of teachers and reflection from their practice; finally, the Knowledge of Mathematics Learning Standards (KMLS) covers the sequence of topics to teach, the expected levels of conceptual and procedural development, and the expected learning outcomes.

METHODOLOGY

Participants and context

The study is qualitative (Creswell, 2014) and was conducted using life stories, given the importance of approaching teacher education from the learner's perspective (Josso, 1999). The participants are two MTs selected for their involvement in initial teacher education, their role as supervisors in the STP, and their participation in one of the other two ML contexts that occur at school (PIBID or PRP).

The two participants, teachers José and Liz, have graduated from the same ML where they also serve as supervisors. The undergraduate program was established in 2002 and has offered STP since then, in accordance with the legislation (Brasil, 2002). It also offered PIBID and PRP projects in the first public calls for each in 2007 and 2018, respectively. They completed their programs in 2007 and have worked as MTs for at least 15 years. Most of each individual's professional practice has occurred within the same public basic education institution where they received PMT. José has served as a supervisor in the PIBID, and Liz as a preceptor in the PRP.

Twelve years after completing his master's degree, José worked at PIBID on three of the five projects linked to the same ML, totalling about five years as a supervisor in the program, and received fewer pre-service teachers than PIBID students. Liz worked for four months on the second institutional project of the PRP offered by the ML and has supervised at least one pre-service teacher in the course each year for 10 years, since she has been a teacher at the same school where the PRP was developed. It should be noted that the names of the two participants are fictitious to maintain their anonymity, in accordance with process 68401123.0.0000.5151 of the Research Ethics Council.

Data collection and analysis

We take life stories as ways of approaching the relationship of the participants with the knowledge and recognition of the experience of participation in the STP, PIBID, and PRP as a formative experience (Josso, 1999), because the programmes allow the subjects to access and understand their inside world and can be used as a means to explore the process of self-formation from the individual's life (Bolívar et al., 2001). Life stories assume a reflexive stance toward life and represent a telling of oneself, usually at the demand of another person—a researcher or an interviewer. They always refer to the uniqueness of a life, but this refers to the broader social and professional group that, over time, shapes and influences this particular life (Bolívar et al., 2001).

These characteristics of life stories—to reflect on life itself in the person's time and context—allow us to understand them as narratives composed in the three-dimensional space of the narrative: temporal, social-personal, and spatial dimensions (Clandinin & Connelly, 2011). Therefore, the study was conducted in accordance with the guidelines for narrative research (Clandinin & Connelly, 2011).

The data were produced with biographical interviews, which consist of "reflecting or remembering life episodes, from which the person tells things about their biography, in an open exchange, which allows them to deepen their life through the questions and active listening of the interviewer" (Bolívar et al., 2001, p. 159). The interviews were conducted individually with each participant, and the guiding questions focused on school memories prior to higher education and the choice of profession; the undergraduate lived experience and the relationship with teaching; and professional teaching experiences, including those that occurred while they worked in the STP, PIBID, and/or PRP.

From the interview transcription, the data were systematised to produce life story narratives for each participant, which were analysed along two axes to articulate the individual and comparative dimensions of life stories (Bolívar et al., 2001). The biographical narrative of each teacher seeks to address the first dimension by identifying formative experiences and understanding their development through the modalities of *having*, *making*, and *thinking experiences* (Josso, 2002). Paradigmatic analysis of narratives (Bolívar, 2002) was also used to identify the subdomains of the knowledge revealed, using Carrillo et al.'s (2018) framework for MT's professional knowledge. The type of knowledge revealed in a paragraph or in an underlined excerpt is indicated

in square brackets. The second axis of analysis, which examines the comparative dimension, covers the two narratives to identify relationships between participants' trajectories and their initial teacher education contexts, with the aim of understanding how these factors contribute to the formation of MTs, as discussed in the results.

RESULTS

I consider PIBID a second graduation

Invited to reflect on the paths that led him to become a mathematics teacher and to serve as a supervisor in PIBID and STP, José chose his time as a student in public school as a starting point and emphasised the contributions of his teachers to his entry into higher education.

> I studied all my life in public schools. I was always a good student, I was never great, but I was good. I could handle things easily. (...) So, I had a base. I think, my teachers, when I talk about them, it's because they were important; they made me learn what I learned from high school and elementary school.

In 2004, he joined the ML, which he recalls as "a difficult undergraduate program", when he had to learn to study.

> So, as a result of public education, when I arrived at a very demanding public university with very demanding professors, I suffered a big blow. It took me some time to learn how to study. So, I only started succeeding in the subjects and being approved around the third, fourth scholar periods. (...) So, I think this first year was a period of adaptation in every way, both to live and to study. After I got the rhythm, I saw what it was like, then I went studying, I was successful, I was approved, and I managed to graduate.

The difficulties faced in ML are framed as *having experiences*, since they were not motivated by the teacher and required integrating such lived experiences with what he already knew—"I was a good student, I could handle things." This process of elaborating on the experience gave him confidence in his ability to teach mathematics and in his capacity to learn independently, which he understood as the teaching degree's contribution to becoming an MT.

> What guided me most on the issue of the teaching degree and professional practice was that I could not leave the course without knowing mathematics. So (...), I gained experience in really knowing mathematics [MK], and I became confident enough to enter into the classroom and say: "No, I know what I must teach. And if there is something I don't know, I know I can learn". Perhaps one of the greatest lessons was this, that I was able to learn by myself. [That is to] take a book, a text, a method, and unravel it without necessarily needing someone to explain it to me.

José points out the distance of the course in relation to the education he deems necessary to be an MT, as he understands that the education offered was focused more on the study of mathematics, as in a bachelor degree, than on the knowledge necessary to teach it —"(...) I am from the third group of the course, so it did not seem like a teaching degree course. It looked more like a bachelor degree". He also highlights the importance of addressing this gap when *thinking experiences* and making recommendations for PMT.

> I would tell them about the importance of knowing how to write well, the importance of doing readings, because it turns out that our program focuses a lot on the subjects on pure mathematics, to the detriment of those of education or statistics, etc. (…) But, nowadays, I think it's just as important as [a background in mathematics], because the situation has changed so much that, if we don't have a critical look, a critical perspective at public policies, at everything that's happening, we'll end up being used and left behind.

In 2008, while still a student at the ML, he began working as an MT, replacing teachers in public schools. He completed the course in 2009 and, in 2011, became supervisor of PIBID, a project linked to the course from which he graduated, before becoming a permanent teacher in the public school system in 2015. He sought the program motivated by the possibility of receiving a scholarship and by the rapprochement with the university – "I really went to get closer to the university and financially too". Using PIBID to get closer to the university indicates that he sought lived experiences that would enable him to mobilise a process of integrating them, as in ML; i.e., he sought to *make experiences* to integrate what he considered necessary to be an MT. This search for *making experiences* is confirmed when he equates the programme with an undergraduate course — "I consider PIBID for me a second degree. You know,

PIBID was very important to me as a professional education".

He takes PIBID as a reference to demarcate gaps in his initial teacher education, when he mentions collective work, involving classmates, the planning of teaching practice, and the opportunity for insertion in school before the effective professional exercise as important lived experiences for the education of the MT, provided by the programme, and which he did not have in the ML.

> And the demands of the programme itself: planning, sitting calmly, having a subject, seeing where a plan goes, class time, the type of intervention to be made, whether it is a video, an expository class, or a scavenger hunt [KMT]. So, I think PIBID provides this range of options because they sat down to make this movement and think about these interventions. So, there was nothing ready; they didn't get anything from the internet ready. So, they really thought, and this happened in all the public calls I worked on, which I helped to supervise, I realised [that]. And this, for sure, is a gain. So, the experience of working in a group, sitting down to plan, to create a lesson plan, and something that is rare, which I didn't have in my training, or if I did, it was very limited: thinking about a project, learning how to write a project proposal.

From the PMTs' lived experiences in PIBID, he can *think experiences* he had in ML. In his time as a supervisor at PIBID, he also highlights his own lived experiences, thereby bringing his education to the forefront. He describes a project to teach central tendency measures in high school, which he developed and implemented with ML students affiliated with PIBID.

> And realise how these students sat down to write this project and thought about the interventions and thought about the classes, in which class we are going to do this, in which class we are going to do that. Because sometimes we say: "Oh, they planned, but how did they plan?" There are so many nuances there. So, it is like this: this was planned class by class, intervention by intervention, in relation to the objectives. So, I think they also learned this: that when you go to make a lesson plan, you have a goal to achieve [KMT]. You are not planning just for having a structure, or for facilitating the [classroom] dynamics. So, thinking about the goal: what do we want to

> achieve with today's intervention and with this planning we are doing for this specific class? [KFLM] So, I think they could live the experience of all stages of writing, of executing a project [KMT]. Then, I think this is a very important thing too.

The collective planning of teaching practice, aiming at a teaching objective, was a lived experience in PIBID that he did not live in ML. This led to learning, including the possibility of exceeding the subject's limits and applying it, as well as the need to choose appropriate contexts and mathematical content for this.

> I think an interesting thing I learned from this statistics project is how transdisciplinarity can really happen [KMT]. Because sometimes we are a little reticent, saying: "Oh, but it's not everything that can be applied in everyday life". Or "if we decide apply it, it gets much more difficult". (...) But we end up using this argument to do nothing. So, I learned that it depends on the context and the subject. Thus, there are some subjects where we can work [on that perspective]. Statistics is a great tool; it's a great subject where we can permeate other discussions. We can also do a lot of this in geometry [KMT]. So, eliminating a little bit of prejudice and, sometimes, even laziness, and sitting down to think about a project, was something I learned. It's possible.

He realizes the possibility of working on projects, as opposed to an expository lesson, so that his students can learn mathematics with this way of teaching, and that not all of them adhere to a certain teaching approach in the same way.

> And one thing that is most important of all: students can learn through projects. Because I always had a little bit of prejudice with the project, yes. I used to say: "Oh, but I don't know, it is very far from the topic. Will that mathematics topic that I want to teach, will they really learn it?" [KFLM]. But one thing I also learned and realised is that the project is not a lifeline. In the same way that some students learn better with lectures, without much contextualisation, and others do not learn, when you are working on a project, you have the same thing. Some students will learn while others will not. Some will like it while others won't. So, the project is not unanimous, just as the

> lecture is not unanimous either. I also came to that conclusion. [KFLM].

Finding that there is no single way to teach so that all can learn gave him more freedom to decide how to approach the mathematical content in his teaching.

> And this, in a way, calms you down because sometimes, when you decide not to do a project, you think: "but I may be harming the students; they may stop learning". But if I choose the project, someone will also stop learning, because it requires a lot of the student's will and has *n* variables related to it. But at least it showed me that it's possible. It's possible to teach through projects. [KMT]

He associates his lived experience in the teaching project, written with the prospective teachers to put into practice, as a learning experience exclusively in PIBID: "In my undergraduate programme, I did not learn to write and adapt a project to practice. I lived this in practice, together with the PIBID members and wondering how we could do that".

PIBID can be understood as a context in which José could *make* and *think experiences*. If in the ML *having experiences*, that is, the significant lived experiences not caused by him are the difficulties of the course and his insufficiency in terms of the education necessary to be a MT, which allowed him to learn alone and feel confident about mathematics to teach, he resorts to what he had previously lived in initial teacher education and reapproaches the university through PIBID. With this, he seeks to mobilise a process of re-integrating the experience, as he did in the ML. That is, in PIBID, he seeks *to make experiences* to address the gaps in initial teacher education mentioned in the interview, among which he highlighted collective planning for teaching practice, especially in the form of a teaching project.

When *thinking experiences* (those he had in ML and those he made in PIBID), he argues in favour of the programme for an initial teacher education more aligned with the needs of the teaching profession, PMT, and himself. In this process, he relates his lived experiences in PIBID to his initial teacher education and highlights that he has learned an alternative approach to teaching that enables students to learn mathematics beyond expository lessons. It shows a new understanding when he states that "the project is not unanimous, just as the lecture is not unanimous either," which he applies when deciding how to teach a particular content, whether through projects or not.

Although it is not possible to access all of José's experiences from the interview, one excerpt reinforces the importance of having participated in PIBID, as a supervising teacher, from the point of view of the contributions to his professional development:

> PIBID was a second degree for me, because I learned things that I'm sure I wouldn't learn later, even with 20 years in the classroom. So, I would have had to go through that project, to be able to internalise certain things, change my thoughts a little bit, and everything.

Observing, seeing the other do, we learn a lot

Liz also used the school as a starting point to tell her journey as an MT, a supervisor at the STP, and later a preceptor at the PRP. Her lived experiences as a student made her feel insecure about becoming a teacher, even while attending the ML.

> So, I say that "I did not choose the profession; the profession chose me", because even when I was already attending college, I said, "I do not want to be a teacher". I was very insecure. Thus, school was a place where I had to work hard to move to the next grade. In my time, we suffered a lot, I studied too hard to move to the next grade.

When she started her teaching degree in 2003, she considered it difficult. To overcome the challenges, she studied and worked through many exercises, as she did at basic school.

> The time went by and I did not overcome de fear while things unfolded. But, like, then, then I thought it would be easier, but it was hard too. (...) I worked a lot. I remember drilling exercises until two o'clock in the morning, you know? To be able to handle the exercise lists. And I did, because I had to, I didn't have much of an option. I had to study.

During her ML, she faced difficulties that led her to *have experiences*—as she did not provoke them—but also made her integrate these lived experiences into what she knew from basic school: "I studied too hard to move to the next grade," and did the same in her teaching degree. This process of elaborating on the experience was not mobilised in the STP; it was done at the end of the course, and separated from the other curriculum components—"My

practicum was after I had already finished all the subjects. I left the semester only for the practicum".

When thinking about the contributions of the ML to her performance as an MT, she emphasises the reduced workload of the STP when comparing it to what she currently supervises: "Today, the practicum is longer. When I did mine, there were very few". She also highlights the importance of observing classes of other MTs, planning and carrying out her own classes, and having more knowledge than their students. However, it was necessary to "learn by doing" after completing the course and the practicum, during the exercise of the profession.

> Then, the programme gives you something extra. You end up having more knowledge than the boys and girls, you understand where many things came from [KoT]. (…) The practicum helps you; it helps a lot. But that's what we talked about; it was a short practicum, and it is a practicum of observation and conducting [classes]. But when you start teaching, when you take over the classes, that's not all of your participation in the school. There are the class diaries, the planning - we do planning in the practicum – but there is the didactics, the time [KMT], there are many things. Many things that you end up having to learn by doing later.

Liz reinforces that, in ML, she learned the content, but lacked depth as to ways of teaching.

> But, in didactics, we did some things, but I don't know if maybe we would have made better use of these contents, to go deeper into this part. [Namely] how to deal with didactics of the content [KFLM]. (…). Some things were superficial, others you end up deepening in everyday life, in the very exercise of the profession. It's like addressing, all of a sudden, some content that you do not quite know what to do. How to get to the content, with this approach [KMT]. Because we learn the content [KoT]. We don't learn... we must go deeper, maybe, because we go through didactics, but maybe deepen the way you get to some more abstract content [KFLM].

When *thinking experiences* lived in initial teacher education, she mentions that she learned the content, but that the ways of approaching it in teaching were insufficient; that is, what goes beyond the knowledge of the

content was learned after the degree, “deepening in everyday life, in the exercise of the profession.”

She majored in 2007 and, since 2010, has been working as an MT in public basic education, being appointed as a permanent teacher through a competitive exam in 2016. She seeks to improve her teaching practice by changing what does not work as she expected.

> And in my preparation, there were also moments when I, for example, prepared [classes] in a way, I worked [in classes] in a specific year. I started the year working one way, then I realised that the thing didn’t flow much. The following year, when I was in the same grade at [school], I tried to do something a little different. So, we also observe what does not work and what did not work and try to improve it. [KMT]

She mobilised the process of her degree years to prepare her classes: she studied the content, but she “studied to teach”. To supplement what the ML did not adequately provide, she seeks ways to teach by observing how others teach.

> So, for the content, I sat and studied to teach. I prepared, I did, I did everything with the content and exercises, prepared myself [KoT], but a lot of things we learn by seeing others do. That’s why I find this part interesting, when the pre-service teacher is teaching in a practicum or when the resident is teaching: you see... the person approached it differently; they spoke differently. So, like, you start to notice other ways to approach the content, other ways to do it [KMT]. So, I say that I learn even more than they do during the practicum, because I like to take advantage of that, of the other person’s way of doing things. How the other unfolds the topic and develops the content [KMT]. So, by observing and watching others doing, we learn a lot.

She had *to make experiences*; that is, she sought lived experiences to learn how to approach the content. To this end, she prepared her classes and sought to revise the teaching proposal when it did not work as expected. To expand her repertoire, she observed how others taught and perceived different approaches to teaching.

> But I like to observe, as I am telling you, so I can see how the other does it. So, for example, at the beginning of the year, we

> had the residents, we worked on the mathematics fortnight, and some people built the game. Some built..., inverted the content, from the exercise, they built the content, in groups, they worked in groups. So, I was able to perceive different ways, very different from one group to the other, of developing the content (...). It's where I say we learn, because you start to open your mind, you can do something. "They have managed to do something different", so, there's a way, right? So, the approach, the way of speaking, and the type of approach they used, all make a lot of difference [KMT].

Seeking *to make experiences*, Liz understands that if others succeed, she can do so differently and incorporate approaches that enable pre-service teachers and residents to engage with mathematical content in their practice. When *thinking experiences*, she highlights her openness to teaching with manipulative materials and games, for example, as a result of her lived experience as a preceptor in the PRP.

> Yes, this construction of solids: the group borrowed the set of solids from the university (…) So, [the school] bought the same set as the university, so we could work on the volumes, the solids, the nets. So, all of this contributed a lot. Some exercises they worked on, I was also able to reuse at another time, some of the exercises they worked on [KFLM]. And this idea of opening up more to games that helps you learn that come from the residency. I enjoyed it more, wanted it more, and I want to incorporate it into my classes [KMT]. So, this year I'm getting ready for that. I bought several games, MDF games, and multiplication tables. Now, I bought others there that need to be laminated, which I downloaded as PDFs. I have printed them all and am having them laminated little by little. So, games with geometric shapes, solids, equations, powers, and roots, as well as a variety of content that I intend to incorporate into my classes next year [KMT]. Let's see how it goes, but I expect it to work out.

Based on her lived experience in the PRP, she plans to develop additional teaching approaches, seek new didactic resources focused on mathematical content, consider her students' needs, and improve her classes.

> We notice this need among today's students to break the routine from time to time. But breaking the routine every now and then

> can't be done just any way. For example, I'm not going to take them to play dodgeball; it has nothing to do with my area, you know? So I say "you want a game, you will have a game", but it is a game within the area [of mathematics] [KFLM]. (...) You end up discovering that they even have other ways to build [things] differently. So, they start from what you put there, [but] the students still do something different [KMT]. So, I think it adds a lot, it contributes a lot. The expectation is to try to improve the didactics of my classes.

However, the expectation of improving the didactics of her classes is not strictly linked to adopting teaching methods other than the expository approach, as she does not consider this feasible for teaching all mathematical content.

> (...) In some subjects, you can improve the didactics, but in some others you can't. Working on the trigonometric cycle, I can't work on too playful, much concrete, it's a difficult thing... although I bought a game now... Because, now I'm like... I'm buying the game online and preparing myself. So, there is a domino that is a trigonometric cycle; this one will help me. But, for example, with geometric solids, you can work more on something more concrete; you can build solids. So, we start to see some possibilities for you to work, to prepare a different class, in which the kids participate and build [something], but that one I still find it hard, I'm still getting the hang of it. These are one-offs, but it is not my standard, it is not my normal standard, but in some content, I can do something, at least I try [KFLM].

The attempt to incorporate other forms of teaching reinforces her pattern, which involves students in a learning process similar to that she experienced as a student at school and at university: studying and exercising. Although she considers the process difficult, this opening has led to changes in how she sees and assesses students' work.

> My standard is the board, the textbook, exercise, explanation and exercise. This is my standard, of my generation: you explained, [they] learned, and practiced through exercises [KMT]. It is usually that way. This is the most usual thing to happen. Even the assessment questions... It's just that we [have] monthly, bimonthly, recovery assessments. So, I'm

> already thinking, for the next year, if there is some other possibility of assessment, other than just that, you know? (…) For example, if the kids have been building solids, you can assess what the child understands and what he/she is doing. The games I'm buying, all within the areas, and how they can develop the game, if they can understand the game, solve it, and develop it; I think I can assess them this way, too. So, like... I'm opening myself to forms of evaluation and ways of working on content, you know [KMLS]. But I think I still have a long way to go.

PRP and STP were contexts from which Liz could *make* and *think experiences*. In the ML, difficulties with the course and a less in-depth approach to teaching were not lived experiences she provoked; rather, they allowed her to *have experiences*. This process of elaborating on the experience led her to study extensively, a strategy she used when she entered the teaching profession to prepare the content for her classes, but which proved insufficient for teaching. To improve her teaching, she begins *making experiences* by analyzing and modifying her teaching and by observing how prospective teachers perform in the STP and in the PRP. From these lived experiences, she continues to seek to *make experiences* by opening herself to different teaching resources and other ways of teaching and evaluating. For this, she prepares herself by mobilising the same process of elaboration of the *a posteriori* experience, but using what was experienced in the STP and the PRP.

When *thinking experiences*—those she had in ML and those she made in STP and PRP—, she looks at herself. She analyses her own background, identifies gaps in the knowledge necessary to teach mathematics, and reinforces the expectation of improving her classes by diversifying the ways of teaching and evaluating. In this process, she shows a new understanding of how to approach mathematical content, how to access and evaluate students' productions, and how this relates to her standard teaching practice. She applies this new understanding to choose how to teach, drawing on approaches she knows while seeking others.

In the interview, Liz highlights the importance of the STP and PRP for her professional learning and that of prospective MTs, in addition to observing to learn how to do, when she expresses her interest in working with the pre-service teachers or residents from the planning to the lesson conduction:

> We should be more involved in the project. (...) So, let's assume it's a hands-on class. So, we would work together, they would

> be involved, but so would I. Because what happens is: either they're working or I'm working, you know? We would take turns. So, we would be working together...

Discussing the results

The two teachers shared similar lived experiences from their initial teacher education and from their ML contexts as MTs. In ML, the formative experiences—the course being challenging and insufficiently preparing them to be an MT—made them *have experiences*. The elaboration process mobilised by *having experiences* in initial teacher education led them to learn mathematics, as expected in ML, and to resort to studying to learn to prepare themselves. It was the same process of developing the experience that they later mobilised: to *make experiences*. At the level of knowledge necessary to teach, this result points out that *having experiences* in ML provided them with the knowledge of an MT in terms of mathematics as a scientific subject in an educational context, which Carrillo et al. (2018) associate with MK, especially with the knowledge of mathematical topics (KoT), the only identified subdomain of MK.

The gaps in the in the preparation for teaching provided by ML refer mainly to the knowledge necessary to guide them, such as teaching mathematics—organising time, lesson planning, how to approach the content, using of didactic resources, ways of evaluating students' knowledge—and were identified by teachers in the exercise of the profession, when they sought to *make experiences* to supply them. For this, José sought PIBID, and Liz drew on her experience as an STP supervisor and PRP preceptor; that is, for him, experience occurred in the context of initial education (PIBID), and for her, in STP and PRP contexts. When *making experiences,* they highlight that they have learned alternative approaches to teaching content, in addition to the expository lesson, such as teaching projects and interdisciplinary approaches (José), the use of games and manipulatives, and other forms of assessment (Liz). These results indicate a deficiency of the ML to provide the necessary PCK (Carrillo et al., 2018) and the possibility of developing it when involved in the contexts of the ML (STP, PIBID, and PRP), as occurred when they sought to *make experiments* and mention learning or findings that can be associated with the three subdomains of the PCK. This concerns mainly knowledge of mathematics teaching (KMT), which enables the organisation of teaching, and knowledge of the features of mathematical learning (KFLM), related to theories of mathematical learning, with a focus on mathematical content.

The *thinking experience*—which they had in the ML and which they drew on in and from those contexts—led each to analyse their teacher education, considering their lived experiences in the ML contexts in which they were involved. In this process of developing the experience, the new understandings are also directed to how to teach mathematics, more directly linked to the PCK (Carrillo et al., 2018), when they point out that they have realised that one can also teach and learn mathematics in ways different from those they experienced [KMT], which they can take into account when deciding how to teach [KFLM] with a view to students' learning according to the levels at which they teach [KMLS].

FINAL CONSIDERATIONS

The study points out that mathematics teachers (MTs) involved in initial teacher education, namely in the STP and PIBID or in the PRP, developed professional knowledge when living formative experiences (Josso, 2002) in these contexts and/or derived from them. This occurred through the experiences—collective planning of teaching practice (José), observation of how pre-service teachers teach mathematics, use of different didactic resources, and other ways of teaching and assessing (Liz)—that they themselves aroused (*a posteriori*) in their ML contexts (STP, PIBID, and/or PRP).

STP, PIBID, and PRP provided participants with living processes of experience elaboration, especially in *making* and *thinking* experiences, which generated new understandings different from those resulting from ML. These understandings are valuable for filling gaps left by initial teacher education in the knowledge required for MTs to teach mathematics, particularly those related to pedagogical content knowledge (PCK) (Carrillo et al., 2018). They are confirmed as contexts, as Josso (2002) defines, as they favoured the participants' interactions with themselves (their professional learning, their practices, and their knowledge), with the prospective MTs (guiding, observing how they teach, planning tasks to teach mathematics), with the school (rethinking the function as MTs, their relationship with students) and with academic and experiential knowledge (analysing their usefulness, seeking to develop and appropriate them).

These contexts were configured as a third space located on the border between initial teacher education and professional practice (Zeichner, 2010) because, by bringing the participants together with university professors and prospective teachers and enabling a connection between the professional practical knowledge of the MTs and academic knowledge, they allowed the participants to expand and develop the MTs' professional knowledge.

Therefore, organizing STP, PIBID, and PRP as a third space in initial teacher education also affects the professional learning of the MTs involved. This result confirms the gain for the MTs' professional learning when engaging with PIBID and/or PRP (Rodrigues et al., 2017; Rodrigues, 2024; Souza, 2023) and shows that the same occurs when it comes to the STP, expanding the results of studies on practicums (Barbosa & Lopes, 2021; Lopes et al., 2017).

These contributions can be considered by public policy makers and HEI faculty members when proposing and organizing teaching degree contexts that take place in schools. Nevertheless, given the qualitative bias of the study, the results may differ in research conducted in different contexts and/or with different teachers. Other limitations include the small number of participants and the specificity of the teaching degree (ML) contexts, as the two MTs graduated from the same programme to which the contexts are associated. New research should be developed with other participants in other teaching programmes, to expand knowledge on the theme, and to complement it, for example, with the analysis of the possible differences that STP and PIBID provide in the professional development of teachers who engage in each one, since the institutionally defined role for the mathematics teachers in each context is different.

ACKNOWLEDGEMENTS

This article was funded by the National Council for Scientific and Technological Development (CNPQ)—Process 403778/2024-7 and by Portuguese national funds through FCT—Foundation for Science and Technology, IP, within the scope of UIDEF—Research and Development Unit in Education and Training, UID/04107/2025, https://doi.org/10.54499/UID/04107/2025.

AUTHORSHIP CONTRIBUTION STATEMENT

FCFC collected the data and conducted an initial analysis. The three authors actively participated in developing the theory and methodology and in discussing the results and conclusions.

DATA AVAILABILITY STATEMENT

The data supporting the results of this study will be made available by the corresponding author, FCFC, upon reasonable request.

REFERENCES

Araújo, R. N., Passos, A. M., Passos, M. M., & Arruda, S. de M. (2017). Aspectos da identidade docente em licenciandos de Matemática no contexto do PIBID. *Acta Scientiae*, *19*(4), 601–618.

Barbosa, C. P., & Lopes, C. E. (2021). Uma análise da produção acadêmica brasileira sobre o Estágio Curricular Supervisionado nos cursos de Licenciatura em Matemática. *Revista De Educação Matemática*, *18*, 1-22. https://doi.org/10.37001/remat25269062v17id483

Bolívar, A. (2002). "¿De nobis ipsis silemus?": Epistemología de la investigación biográfico-narrativa en educación. *Revista Electrónica de Investigación Educativa*, *4*(1), 01-26.

Bolívar, A., Domingo, J., & Fernández, M. (2001). *La investigación biográfico-narrativa en educación*: *Enfoque y metodología*. Editorial La Muralla.

Brasil. (2002, 18 de fevereiro). Resolução CNE/CP nº 1, de 18 de fevereiro de 2002: Institui as Diretrizes Curriculares Nacionais para a Formação de Professores de Educação Básica, em nível superior, curso de licenciatura, de graduação plena [Resolução]. Conselho Nacional de Educação. Recuperado em 10 de fevereiro, 2025, de http://portal.mec.gov.br/cne/arquivos/pdf/rcp01_02.pdf

Brasil. (2007, 12 de dezembro). Portaria Normativa nº 38, de 12 de dezembro de 2007: Dispõe sobre o Programa de Bolsa Institucional de Iniciação à Docência – PIBID [Portaria]. Ministério da Educação. Recuperado em 10 de fevereiro, 2025, de http://portal.mec.gov.br/arquivos/pdf/portaria_pibid.pdf

Brasil. (2010, 24 de junho). Decreto nº 7.219, de 24 de junho de 2010: Dispõe sobre o Programa Institucional de Bolsa de Iniciação à Docência e dá outras providências [Decreto]. Recuperado em 10 de fevereiro, 2025, de https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/decreto/d7219.htm

Brasil. (2018, 28 de fevereiro). Portaria GAB nº 38, de 28 de fevereiro de 2018: Institui o Programa de Residência Pedagógica [Portaria]. Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES. Recuperado em 10 de fevereiro, 2025, de https://cad.capes.gov.br/ato-administrativo-detalhar?idAtoAdmElastic=130

Brasil. (2022, 27 de abril). Portaria CAPES nº 83, de 27 de abril de 2022: Dispõe sobre o regulamento do Programa Institucional de Bolsa de Iniciação à Docência (PIBID) [Portaria]. Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES. Recuperado em 10 de fevereiro, 2025, de https://www.gov.br/capes/pt-br/centrais-de-conteudo/documentos/diretoria-de-educacao-basica/28042022_Publicacao_no_DOU_1691532_PORTARIA_N__83__DE_27_DE_ABRIL_DE_2022.pdf

Brasil. (2024, 25 de março). Portaria CAPES nº 90, de 25 de março de 2024: Dispõe sobre o regulamento do Programa Institucional de Bolsa de Iniciação à Docência – PIBID [Portaria]. Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES. Recuperado em 10 de fevereiro, 2025, de https://cad.capes.gov.br/ato-administrativo-detalhar?idAtoAdmElastic=14542

Brasil. (2024a, 29 de maio). Resolução CNE/CP nº 4, de 29 de maio de 2024: Dispõe sobre as Diretrizes Curriculares Nacionais para a Formação Inicial em Nível Superior de Profissionais do Magistério da Educação Escolar Básica [Resolução]. Conselho Nacional de Educação. Recuperado em 10 de fevereiro, 2025, de http://portal.mec.gov.br/index.php?option=com_docman&view=download&alias=258171-rcp004-24&category_slug=junho-2024&Itemid=30192

Carrillo, J., Climent, N., Montes, M., Contreras, L. C., Flores-Medrano, E., Escudero-Ávila, D., … Muñoz-Catalán, M. C. (2018). The mathematics teacher's specialised knowledge (MTSK) model. *Research in Mathematics Education*, *20*(3), 236–253. https://doi.org/10.1080/14794802.2018.1479981

Clandinin, D. J., & Connelly, F. M. (2011). *Pesquisa narrativa: Experiência e história em pesquisa qualitativa* (Tradução). EDUFU.

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior. (2022, 29 de abril). Edital nº 24/2022 – Programa de Desenvolvimento da Pós-Graduação (PDPG) – Parcerias Estratégicas nos Estados (Edital nº 24/2022) [Edital]. Recuperado em 10 de fevereiro, 2025, de https://www.gov.br/capes/pt-br/centrais-de-conteudo/editais/29042022_Edital_1692979_Edital_24_2022.pdf

Creswell, J. W. (2014). *Investigação qualitativa e projeto de pesquisa*: *escolhendo entre cinco abordagens*. Penso.

Dewey, J. (1904). The relation of theory to practice in education of teachers. In *National Society for the Scientific Study of Education, Third yearbook* (Part I, pp. 9–80). Public School Publishing Co.

Diniz-Pereira, J. E. (2011). A prática como componente curricular na formação de professores. *Educação*, *36*(2), 203–218.

Felício, H. M. dos S. (2014). O PIBID como terceiro espaço de formação inicial de professores. *Revista Diálogo Educacional*, *14*(42), 395-414. https://doi.org/10.7213/dialogo.educ.14.042.DS05

Fiorentini, D., Nacarato, A. M., Ferreira, A. C., Lopes, C. S., Freitas, M. T. M., & Miskulin, R. G. S. (2002). Formação de professores que ensinam matemática: Um balanço de 25 anos da pesquisa brasileira. *Educação em Revista*, *36*, 137–160.

Fiorentini, D., Passos, C. L. B., & Lima, R. C. R. (Orgs.). (2016). *Mapeamento da pesquisa acadêmica brasileira sobre o professor que ensina matemática*: *Período 2001–2012* (pp. 17–42). FE/UNICAMP.

Gatti, B. (2021). Formação de professores no Brasil: Políticas e programas. *Paradigma*, *42*(e2), 1–17. https://doi.org/10.37618/PARADIGMA.1011-2251.2021.p01-17.id1044

Jesus, C., Cyrino, M. & Oliveira, H. (2020). Mathematics teachers' learning on Exploratory Teaching: Working on a Multimedia Case in a Community of Practice. *Acta Scientiae*, *22*(1), 112-133. http://doi.org/10.17648/acta.scientiae.5566

Josso, M. C. (1999). História de vida e projeto: a história de vida como projeto e as "histórias de vida" a serviço de projetos. *Educação E Pesquisa*, *25*(2), 11–23. https://doi.org/10.1590/S1517-97021999000200002

Josso, M. C. (2002). *Experiências de vida e formação*. Educa-Formação.

Lopes, A. R. L. V., Paiva, M. A. V., Pereira, P. S., Pozebon, S., & Cedro, W. L. (2017). Estágio curricular supervisionado nas licenciaturas em matemática: Reflexões sobre as pesquisas brasileiras. *Zetetike*, *25*(1), 75–93. https://doi.org/10.20396/zet.v25i1.8647637

Losano, A. L., Ferasso, T. de O., Paula, A. P. M. de, & Fiorentini, D. (2022). Experiências de lesson study híbrido de uma comunidade fronteiriça de professores que ensinam matemática. *Educação Matemática em Revista - RS*, *1*(23), 175-188. https://doi.org/10.37001/EMR-RS.v.2.n.23.2022.p.175-188

Monteiro, J. H. de L., Queiroz, L. C. de, Anversa, A. L. B., & Souza, V. de F. M. de. (2020). O programa residência pedagógica: Dialética entre a teoria e a prática. *HOLOS*, *3*, 1–12. https://doi.org/10.15628/holos.2020.9545

Nascimento, F. J., Castro, E. R., & Lima, I. P. (2017). Desenvolvimento profissional de professores de matemática iniciantes: contribuição do PIBID. *Revista Eletrônica de Educação*, *11*(2), 487-504. https://doi.org/10.14244/198271991962

Ponte, J. P., Santos, L., Oliveira, H., & Henriques, A. (2017). Research on teaching practice in a Portuguese initial secondary mathematics teacher education program. *ZDM - Mathematics Education*, *49*(2), 291-303. https://doi.org/10.1007/s11858-017-0847-7

Rodrigues, E. A. N. (2024). *Formação do professor de matemática sobre resolução de problemas: análise de um percurso formativo no âmbito do programa de residência pedagógica.* (Tese de doutorado em Educação, Universidade Estadual Paulista).

Rodrigues, M. U., Miskulin, R. G. S., & Silva, L. D. (2017). Potencialidades do PIBID/Matemática para formação de professores no Brasil. *Crítica Educativa*, *3*(2), 573–590. https://doi.org/10.22476/revcted.v3i2.119

Souza Neto, S. de, Cyrino, M., & Borges, C. (2019). The supervised teaching practice as a central locus of the professionalization of teaching. *Revista Portuguesa de Educação*, *32*(1), 52–72. https://doi.org/10.21814/rpe.13439

Souza, F. S. (2023). *Conhecimento didático-matemático mobilizado por preceptor e residentes no contexto do programa residência pedagógica: Uma proposta de trabalho para a educação estatística* (Dissertação de mestrado, Universidade Federal de Ouro Preto).

Tinti, D. S., & Silva, J. F. (2022). A pesquisa sobre a formação de professores de matemática na interface com o programa residência pedagógica. *Educação Matemática Pesquisa Revista Do Programa De Estudos Pós-Graduados Em Educação Matemática*, *24*(4), 1-32. https://doi.org/10.23925/1983-3156.2022v24i4p001-032

Vanzuita, A., & Guérios, J. (2025). Potencialidades e limites dos programas federais PIBID e Residência Pedagógica: Um estado do conhecimento. *Educação & Revista*, *41*, e40212. https://doi.org/10.1590/0102-469840212

Zeichner, K. (2010). Repensando as conexões entre a formação na universidade e as experiências de campo na formação de professores em faculdades e universidades. *Educação*, *35*(3), 479–504. https://doi.org/10.5902/198464442357