

LEARNING REGULATION IN PROFESSIONAL DIDACTICS: A SYSTEMATIC LITERATURE REVIEW

REGULAÇÃO DA APRENDIZAGEM NA DIDÁTICA PROFISSIONAL: UMA REVISÃO SISTEMÁTICA DA LITERATURA

LA REGULACIÓN DEL APRENDIZAJE EN LA DIDÁCTICA PROFESIONAL: UNA REVISIÓN SISTEMÁTICA DE LA LITERATURA



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ABSTRACT: Professional Didactics is a French-origin approach aimed at understanding adult development, emphasizing professional training and work analysis. This article presents a systematic literature review whose objective was to identify and analyze studies on the regulation of learning in Professional Didactics with a view to professional competence development. Eighty-three articles were found in six different digital repositories, of which 26 were analyzed according to the research guiding questions. The results indicate a predominance of analyses of professional practice in teaching, especially in Exact Sciences. However, most of the works are bibliographic research with few experiential reports. Based on the relevance of the topic and the discussions of this research, the literature lacks approaches that appropriately investigate explicit forms of regulation and the use of instruments for work analysis aimed at developing professional competencies.

KEYWORDS: Professional Didactics. Professional qualification. Work analysis. Learning regulation. Professional skills development.

RESUMO: *A Didática Profissional é uma corrente de origem francesa que visa compreender o desenvolvimento de adultos com ênfase na formação profissional e na análise do trabalho. Este artigo apresenta uma revisão sistemática da literatura cujo objetivo foi identificar e analisar estudos sobre a regulação da aprendizagem na Didática Profissional com vista à formação de competências profissionais. Foram encontrados 83 artigos em 6 diferentes repositórios digitais, dos quais 26 foram analisados de acordo com as questões norteadoras da investigação. Os resultados obtidos indicam a predominância de análises do exercício profissional na docência, especialmente na área de Exatas, entretanto, os trabalhos são majoritariamente pesquisas bibliográficas com poucos relatos de experiências. Embasado na relevância da temática e com base nas discussões desta pesquisa, considera-se que a literatura carece de abordagens que investiguem apropriadamente formas explícitas de regulação e da utilização de instrumentos para análise do trabalho voltados ao desenvolvimento de competências profissionais.*

PALAVRAS-CHAVE: *Didática Profissional. Formação profissional. Análise do trabalho. Regulação da aprendizagem. Desenvolvimento de competências profissionais.*

RESUMEN: *La Didáctica Profesional es una corriente de origen francés que tiene como objetivo comprender el desarrollo de los adultos con énfasis en la formación profesional y el análisis del trabajo. Este artículo presenta una revisión sistemática de la literatura, cuyo objetivo fue identificar y analizar estudios sobre la regulación del aprendizaje en Didáctica Profesional dirigidos al desarrollo de competencias profesionales. Se encontraron 83 artículos en 6 repositórios digitales diferentes, de los cuales 26 fueron analizados de acuerdo con las preguntas orientadoras de la investigación. Los resultados indican el predominio del análisis de la práctica profesional en la docencia, especialmente en el área de Ciencias Exactas, sin embargo, los estudios son en su mayoría revisiones bibliográficas con pocos relatos de experiencias. A partir de la relevancia del tema y de las discusiones de esta investigación, se considera que la literatura carece de enfoques que investiguen adecuadamente las formas explícitas de regulación y uso de instrumentos de análisis del trabajo dirigidos al desarrollo de competencias profesionales.*

PALABRAS CLAVE: *Didáctica Profesional. Formación profesional. Análisis del trabajo. Regulación del aprendizaje. Desarrollo de competencias profesionales.*

Introduction

Law No. 9.394 (BRASIL, 1996, our translation), which establishes the guidelines and fundamentals of national education, sets forth in Article 35, Section II, "the basic preparation for work and citizenship of the learner, in order to continue learning, so as to be capable of adapting flexibly to new occupational conditions or further refinement," and in Section III of the same article, "including ethical formation and the development of intellectual autonomy and critical thinking." Despite the concern for the critical formation of the learner so that their learning is not limited to the school environment but is adaptable to new needs and the professional environment, in Brazil, teaching predominating relies on expository lectures where the teacher assumes the role of knowledge holder, and students participate passively. The evaluation system often relies on replicating knowledge, making teaching experiences increasingly "generic" (MORÁN, 2015; DIESEL; BALDEZ; MARTINS, 2017). Educational institutions do not provide students with incentives for more reflective practices or guidance to engage in actions that promote better performance, such as managing and directing their learning process autonomously (DOMINGUEZ *et al.*, 2021).

Bragagnolo (2006) suggests new working methodologies in which students can cooperate mutually, recognizing the importance of learning for their professional and social lives. Students should be explicitly encouraged to take on the role of protagonists in building their competencies and skills (RODRIGUES, 2016). Berbel (2011) contextualizes the need to provide incentives for students to take a more active stance in their studies, promoting "learner autonomy and meaningful learning" (PAIVA *et al.*, 2016, p. 1, our translation). It is necessary to create means to extract the best from each learner and enable the development of criteria for adjusting and executing self-directed activities in different social aspects and daily activities (BRAGAGNOLO, 2006). Student autonomy is directly associated with skills and competencies in regulating their learning.

Zimmerman (2000) and Silva (2018) emphasize the importance of developing such skills to encourage student proactivity, assisting them in adopting a more active approach to their studies and monitoring, managing, and exerting efforts to achieve their intended objectives. The significance of self-regulated learning extends beyond the realm of education, as in professional endeavors, individuals are expected to undertake appropriate actions aligned with their goals, aiming to enhance task execution (BRAGAGNOLO, 2006). By learning to self-regulate, "as they leave school, students would continue to educate themselves, continuously employing their knowledge and becoming autonomous learners and proactive

protagonists in their learning" (SANTOS; ALLIPRANDINI, 2022, p. 3, our translation). Salema (1997) further asserts that students who fail to develop their competencies adequately and cannot manage their learning tend to exhibit subpar professional performance and, at times, face dismissal.

Emerging from three theoretical currents, Professional Didactics (PD) appeared in the late 1990s in France, intending to understand the professional development of adults (PASTRÉ, 2017). PD investigates phenomena related to learning, training, and the analysis of professional competence development, considering professional practice a complex activity where knowledge, not always conscious and articulated, is examined to diagnose situations to improve task execution more appropriately and efficiently. Despite being seemingly "distinct" and "disconnected" realms, the domains of education and the professional world constantly need adaptation and learning. Self-regulated learning can promote improvements in academic performance and contribute to developing professional competencies, just as it can foster increasingly tacit problem analysis, optimizing the efficiency of professional activities.

From this perspective and drawing on the authors mentioned earlier, this research establishes a connection and investigates the regulation of learning (SCHUNK; ZIMMERMAN, 2013) within Professional Didactics (PASTRÉ; MAYEN; VERGNAUD, 2006). This article is organized as follows: Sections 2 and 3 provide a brief description of the theoretical foundation, addressing, respectively, the regulation of learning and Professional Didactics. Section 4 outlines and characterizes the research methodology, including the guiding research questions, search strategy, and selected articles. Section 5 presents the research findings, detailing the identified trends. Section 6 offers discussions, and finally, Section 7 delivers the concluding remarks.

Learning Regulation

Learning regulation (WEINSTEIN; ACEE; JUNG, 2011; SCHUNK; ZIMMERMAN, 2013), as proposed by authors within the behavioral formative assessment framework, was initially associated with correction and adjustment strategies employed by teachers when they identified specific difficulties among students following a period of teaching and learning. These strategies can also be reinforced by those who successfully acquire knowledge. Regulation was initially viewed as a mere evaluative method but gradually assumed a more comprehensive aspect (FERREIRA, 2010). Learning regulation encompasses all intentional acts that influence learning mechanisms and contribute to the progression and redirection of learning (SANTOS, 2002). Santos and Alliprandini (2022, p. 3, our translation) believe that students' academic performance could be enhanced if they learned to "utilize effective strategies for studying, reading and comprehending texts, and self-regulating their learning."

The regulation process can be seen as individual, involving self-regulation when the student carries out regulatory actions and co-regulation when the process is related to the student's environment and context. According to Silva, Simão and Sá (2004), self-regulation is a multidimensional process that takes into account the student's active role with intentional action in learning, which occurs through various phases and psychological processes, such as the phase of anticipation and definition of pedagogical objectives and the selection of a strategy plan. In turn, Zimmerman (2000) identifies in self-regulation the thoughts, feelings, and actions directed towards defining strategies to achieve established goals appropriately. Albert Bandura (1996), the first to develop a theoretical model of self-regulated learning, explains self-regulated behavior through three processes, namely observation, judgment, and self-reaction. Zimmerman (1998), based on Bandura's concepts, established planning as a moment in which the student sets the goals they aim to achieve by considering what will be expended (e.g., time, materials) to reach a specific objective. The second phase occurs when executing the planning of the desired activity through techniques to assess performance during the task completion process. Finally, the third phase is self-reflection, during which self-judgment and self-reaction occur. At this moment, upon completing the stipulated activity, the student evaluates the process and examines the reasons for the results achieved, seeking improvement.

Co-regulation of learning refers more closely to the social environment in which the learner is situated and their context, which will determine certain elements that may influence the way new knowledge is acquired, whether problems or emotional factors that are part of the learner's life. This corresponds to a "joint operation" where participating individuals operate in

three ways: assessing learning in pairs, cooperatively, and collaboratively (ROLIM, 2014, p. 25). For Hadwin and Oshige (2010), co-regulation is essential as it supports individuals' self-regulation. This support occurs through exchanges among peers and teachers, meaning interactions, but it can also happen through resources and tools that assist the student in the self-regulation of tasks. According to Vygotsky (1978), co-regulation is a strategy for self-regulation, promoting the Zone of Proximal Development for the individuals involved. Co-regulation helps understand how the social context, the classroom, teacher mediation, and all interactions with classmates participate and contribute to the regulation process (JÄRVELÄ; JÄRVENOJA, 2011; PERRY *et al.*, 2002; ZIMMERMAN, 2008). For Whitebread *et al.* (2007), this different perspective on self-regulation processes (emphasizing different modes of regulating cognitive activity) highlights psychological processes' social and interactive dimensions.

Through metacognition, individuals can monitor and self-regulate their cognitive processes (JOU; SPERB, 2006). The importance of regulation is observed in stimulating students' organization, motivation, and commitment, as well as in establishing specific assessment processes for teachers, taking into consideration the teachers' purpose. The function of learning regulation in the context of assessment can be characterized as prognostic, summative, or formative (ALLAL, 1986).

Professional Didactics

Professional Didactics (PD) (PASTRÉ; MAYEN; VERGNAUD, 2006; PASTRÉ, 2008; VINATIER, 2009, MAYEN, 2012; ALVES, 2022c) is a perspective originating from France that emerged in the late 1990s to understand the professional development of adults in professional and vocational training contexts. Its aim is the development of professional competencies, contributing to the design of training devices for workers. Arising from the convergence of three major areas—Developmental Psychology, Cognitive Ergonomics, and Didactics—it is based on the idea that human life is organized in schemes composed of pragmatic concepts. Its core focus is the analysis of work for the development of professional competencies. The study of work serves as both a preliminary stage in formative construction and a fundamental resource that directly contributes to developing professional competencies.

PD is grounded in several principles, among which one can mention the relationship between activity and learning, which refers to "the desire to study learning at the very heart of

activity and, therefore, not to dissociate activity from learning, the analysis of activity from the analysis of learning" (GRUBER; ALLAIN; WOLLINGER, 2019, p. 24, our translation), and development, which seeks to understand how evolution is generated from productive and constructive activity. This approach is supported by three orientations: (i) the analysis of learning cannot be separated from the analysis of actors' activities, (ii) to analyze professional competencies, one must go to workplaces rather than schools, and (iii) to understand how activity and learning are articulated in a work context – how intelligence of action and in-action develops (PASTRÉ; MAYEN; VERGNAUD, 2006).

PD defines the concept of competence as something broader than merely assessing the outcome of an activity. It proposes to describe and analyze professional training organizations based on an appropriate theoretical and methodological framework. Another fundamental concept for this analysis is that of schema, understood as a dynamic functional totality and an invariant organization of activity for a defined class of situations (from a Piagetian perspective developed by Vergnaud), encompassing components such as (i) objectives or anticipations, (ii) rules of action, information search, and control, (iii) operational invariants (concepts-in-action and theorems-in-action), and (iv) inferential possibilities (GRUBER; ALLAIN; WOLLINGER, 2019).

Pastré, Mayen and Vergnaud (2006) differentiate the concept of activity/learning when classifying it as productive and constructive. Activity is deemed effective when the subject learns through action. It is intentional learning "in doing," meaning immersion during the performance of an activity – the subject acts by transforming the real (material, social, or symbolic). Constructive activity, on the other hand, is not intentional but is realized in the transformation of the subject during the transformation of the real – as the subject engages in the activity, they transform themselves. Constructive activity does not conclude at the end of the activity's execution; it continues, "circling back on itself" (subsequent actions come with new situations/constructions). The objective of action in activity is productive learning, and constructive learning is merely a consequence. Educational institutions primarily (and erroneously) focus on productive activity. While, on the one hand, learning tends to increase, and knowledge is easier to transmit, the subject does not acquire the experience or the ability to reorganize resources based on resources already developed through practice (constructive, unintentional activity). PD emphasizes the analysis of formative activity – the focus is on workplaces rather than schools, with a distinct concern for "the capable subject," characterized

by their power to act – which is not related to the acquisition of knowledge but to the resolution of activities in a situation that promotes learning (GRUBER; ALLAIN; WOLLINGER, 2019).

Through concepts – among other guiding foundations – such as schemas, constructive and productive activity, and knowledge in the operative and predicative form, PD seeks to identify and describe the "*saberes-fazer* (know-how)" of work practice, often implicit and automated. By identifying such knowledge, PD devises methods to guide the development of training devices to enhance acquired and developed competencies (ANTIPOFF; LIMA, 2017).

In light of the above, not many works in the literature on Professional Didactics and learning regulation analyze the law of developing professional competencies. There are various works on learning regulation (ANYICHIE; BUTLER, 2017; BASSO; ABRAHÃO, 2018; ARCOVERDE *et al.*, 2020; CEREZO *et al.*, 2020) and Professional Didactics (LIBÂNEO, 2012; PASTRÉ, 2017). However, systematic reviews that address both topics together are not found. To understand how learning regulation can occur in professional activity from the perspective of PD and to gain an overall view of research in this field, the following research questions were defined:

RQ1. What are the main thematic areas and professional domains investigated?

RQ2. Which professional competencies are investigated?

RQ3. What contexts and tools are used to regulate learning in professional practice explicitly?

Method

This work aims to systematically identify the state of the art in studies that analyze regulation in the process of developing professional competencies. As a procedure, a systematic literature review (SLR) was conducted using the protocol proposed by Kitchenham and Charters (2007). This protocol is widely used in systematic reviews in software engineering, and its adoption is crucial for defining the research process (identification, analysis, and interpretation), ensuring reproducibility and impartiality. Before the planning phase began, a preliminary search was conducted on Google Scholar, and no systematic review with this purpose was found.

Search Strategies

The sources for obtaining primary studies were the repositories *Web of Science*, *Scopus*, *Springer Link*, *Science Direct* and *Portal de Periódicos CAPES*, as they are the most commonly used in technology and learning research. Additionally, the ERIC repository was included to provide some articles from the field of Education. All selected databases offer access to eligible journals through the Federated Academic Community (CAFe), a digital platform the Coordination for the Improvement of Higher Education Personnel (CAPES) provides.

Initially, the terms used in the searches were "professional didactic" and "learning regulation"; however, no results were found in the databases. Therefore, it was necessary to expand the searches, first using the terms "professional didactic," then with "learning," and finally with "regulation." Thus, an additional step in the investigation was required to exclude articles found on learning that did not present forms of regulation. It is worth noting that some repositories had resources for optimizing searches through filters, while others had a simple search bar. The terms used in the warehouses are presented below:

1. **SCOPUS**⁴ (Accessed between November 2021 and January 2022), using two advanced searches:
 - i. *(title-abs-key ("professional didactic") or title-abs-key ("professional didactics")) and all ("learning")) and (limit-to (pubstage, "final")) and (limit-to (doctype, "ar") or limit-to (doctype, "cp")) and (limit-to (language, "english") or limit-to (language, "french") or limit-to (language, "portuguese") or limit-to (language, "spanish")) and (exclude (language, "german"))*
 - ii. *(title-abs-key ("professional didactic") or title-abs-key ("professional didactics")) and all ("regulation")) and (limit-to (pubstage, "final")) and (limit-to (doctype, "ar") or limit-to (doctype, "cp")) and (limit-to (language, "english") or limit-to (language, "french") or limit-to (language, "portuguese") or limit-to (language, "spanish")) and (exclude (language, "german"))*
2. **CAPES**⁵ (Accessed between November 2021 and January 2022), using advanced searches in Portuguese and English:
 - i. *title contains ("didática profissional") and any field contains ("aprendizagem) or any field contains ("aprendizagens") or any field contains ("aprendizado") or any field contains ("aprendizados")*⁶
 - ii. *title contains ("didática profissional") and any field contains ("regulação")*
 - iii. *title contains ("professional didactic") or title contains ("professional didactics") and any field contains ("learning")*
 - iv. *title contains ("professional didactic") or title contains ("professional didactics") and any field contains ("regulation")*
3. **Web of Science**⁷ (Accessed between January 2021 and February 2022), using two advanced searches:
 - i. *(TI=("professional didactic") OR TI=("professional didactics")) AND ALL=(learning)*
 - ii. *(TI=("professional didactic") OR TI=("professional didactics")) AND ALL=(regulation)*
4. **Springer Link**⁸ (Accessed between January 2021 and February 2022), using two queries through the field "where the title contains the words":
 - i. *where the title contains: "professional didactic" learning*
 - ii. *where the title contains: "professional didactic" regulation*
5. **Science Direct**⁹ (Accessed between January 2021 and February 2022), using queries through the fields "title, abstract or keywords" and "find articles with the terms":
 - i. *Title, abstract or author-specified keywords: "professional didactic" and find articles with these terms: "learning"*
 - ii. *Title, abstract or author-specified keywords: "professional didactic" and find articles with these terms: "regulation"*
6. **ERIC**¹⁰ (Accessed in January 2022), using two queries in a single search bar:
 - i. *"professional didactic" learning*
 - ii. *"professional didactic" regulation*

⁴ Available at: <http://www.scopus.com>. Accessed in: 10 Dec. 2022.

⁵ Available at: <https://www.periodicos.capes.gov.br>. Accessed in: 10 Dec. 2022.

⁶ The translation for *Aprendizagens*, *Aprendizagem* and *Aprendizado* is: Apprenticeships, Learning.

⁷ Available at: <https://www.webofknowledge.com>. Accessed in: 10 Dec. 2022.

⁸ Available at: <https://www.link.springer.com>. Accessed in: 10 Dec. 2022.

⁹ Available at: <https://www.sciencedirect.com>. Accessed in: 10 Dec. 2022.

¹⁰ Available at: <https://eric.ed.gov>. Accessed in: 10 Dec. 2022.

The *ERIC*, *Springer Link* e *Science Direct* databases do not provide advanced searches, so the queries were duplicated using singular and plural forms.

Inclusion and Exclusion Criteria

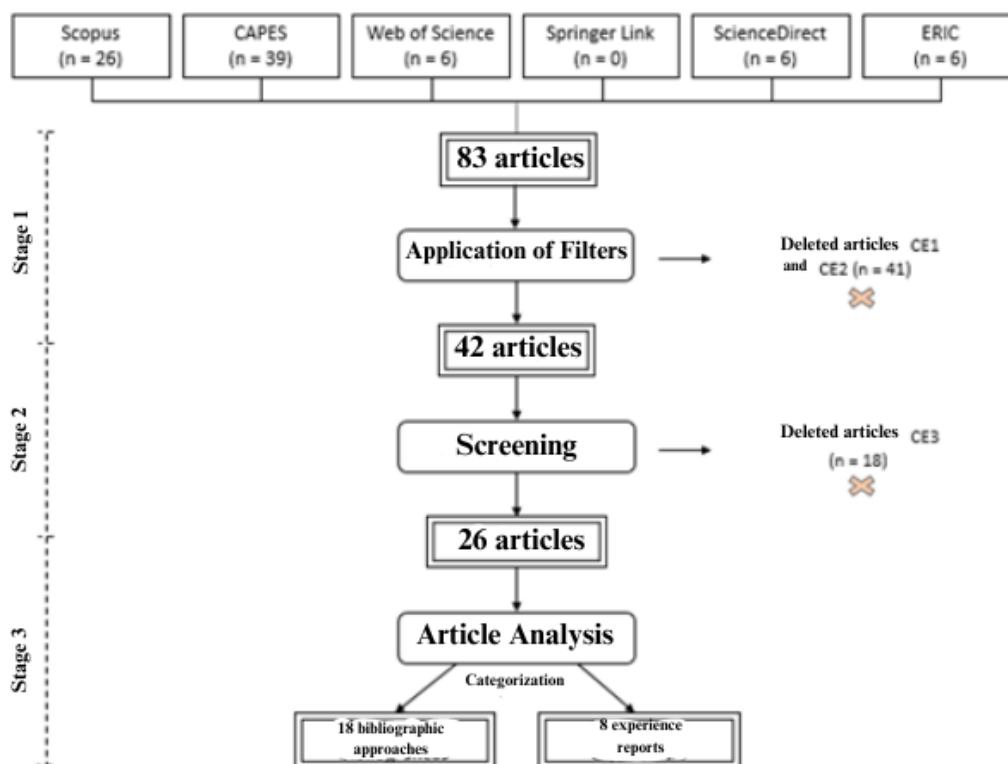
Based on the objectives of this study, Inclusion Criteria (IC) and Exclusion Criteria (EC) were defined. To be selected, a work had to meet all inclusion criteria:

- IC1: Journal articles or conference papers (*articles and conference papers*);
- IC2: Articles written in English, Portuguese, Spanish, or French. There is no restriction on the year of publication (no temporal cut-off). To be removed from the selection, works needed to meet at least one of the following criteria:
 - EC1: Unavailable or limited access article or technical tutorial;
 - EC2: Duplicate article;
 - EC3: Addresses the term didactics unrelated to "Professional Didactics" or only mentions the topic.

Selected Articles

In total, 83 works were found in the searches, with 26 positions in Scopus, 39 in CAPES, 6 in Web of Science, 6 in Science Direct, 6 in ERIC, and no articles in Springer Link. The data compilation process was divided into three phases, as presented in Figure 1.

Figure 1 – Phases of the article selection process



Source: Elaborated by the authors

Phase 1 excluded 41 works with duplicate titles (EC1), mainly due to translations of articles in another language and a summarized/technical tutorial format or works that could not be obtained (EC2) due to copyright issues or unavailability. An additional 18 jobs were excluded using EC3 in Phase 2, where 42 works were reviewed to identify those that effectively addressed "Professional Didactics" (French) and not the concept of didactics (teaching technique). Works that only mentioned Professional Didactics but did not use them effectively in their research were also excluded. Phase 3 involved categorizing the selected works, dividing the 26 articles into literature reviews (18) and experiential reports (8), i.e., distinguishing between those that provided a compilation on the topic and those that conducted new investigations with practical applications and case studies.

Many articles in Scopus (31.32%) and CAPES (46.98%) stand out when analyzing the found works. These percentages increase even further when considering the final selected papers, which are 38.46% and 61.54%, respectively. This is because these databases index a large portion of the scientific production in the investigated field and were the first databases consulted (articles found again in other repositories were not used due to duplication). Another contributing factor may be that the search terms used were more appropriate in Portuguese.

Of the articles found, 97.82% were published in the last 20 years. When comparing the published works (subarea in blue) with the selected works (subarea in red) after the screening process conducted in Phase 2, as shown in Figure 2, it is evident that publications follow a linear growth trend, indicating that researchers have been increasingly interested in this field.

Figure 2 – Distribution of published and selected works over the years



Source: Elaborated by the authors

It should be noted that the low number of works listed in the year 2022 in the graph is related to the date of selection of primary studies for this RSL (early February 2022). The 26 selected works follow the same trends mentioned above, with a more significant presence of articles published (73.07%) in the last three years.

Finally, as cataloged by Maroldi, Maia and Hayashi (2018), Table 1 presents the selected works at the end of the process, listing the identification number, author references, published journal, category, and year.

Table 1 – Selected works for analysis

| ID | Article | Journal | Category | Year |
|----|------------------------------------|---|-------------------|------|
| 1 | (ALVES, 2021a) | Trabalho & Educação | Literature Search | 2021 |
| 2 | (ALVES; ACIOLY-RÉGNIER, 2021) | Revista de Investigación Educativa de la REDIECH | Literature Search | 2021 |
| 3 | (ALVES; JUCÁ, 2019) | EDUCA - Revista Multidisciplinar em Educação | Literature Search | 2019 |
| 4 | (ALVES, 2020a) | Investigações em Ensino de Ciências | Literature Search | 2020 |
| 5 | (ALVES, 2020b) | Revista Ibero-Americana de Estudos em Educação | Literature Search | 2020 |
| 6 | (CIDRÃO; ALVES, 2019) | Revista de Educação Matemática | Investigation | 2019 |
| 7 | (ALVES, 2021b) | Revista Iberoamericana de Tecnología en Educación y Educación en Tecnología | Literature Search | 2021 |
| 8 | (ALVES; CIDRÃO, 2021) | Revista Ibero-Americana de Estudos em Educação | Literature Search | 2021 |
| 9 | (SILVA <i>et al.</i> , 2019) | Research, Society and Development | Literature Search | 2019 |
| 10 | (MORORO <i>et al.</i> , 2021) | Jornal Internacional de Estudos em Educação Matemática | Investigation | 2021 |
| 11 | (PASTRÉ, 2017) | Revista Brasileira de Estudos Pedagógicos | Literature Search | 2017 |
| 12 | (FONTENELE; ALVES, 2021) | Revista de Ensino de Ciências e Matemática-REnCiMa | Investigation | 2021 |
| 13 | (CAMILO; ALVES; FONTENELE, 2020) | Tear: Revista de Educação, Ciência e Tecnologia | Investigation | 2020 |
| 14 | (ACIOLY-RÉGNIER; MONIN, 2009) | Educação Unisinos | Investigation | 2009 |
| 15 | (SOUSA; ALVES; FONTENELE, 2020) | Revista da Sociedade Brasileira de Educação Matemática | Literature Search | 2020 |
| 20 | (ALVES, 2022) | The Mathematics Enthusiast | Literature Search | 2022 |
| 22 | (SOUSA <i>et al.</i> , 2021) | Revista Interuniversitaria de Formación del Profesorado | Literature Search | 2021 |
| 23 | (ALVES, 2021c) | Acta Scientiarum Education | Literature Search | 2021 |
| 26 | (SONNTAG, 2019) | Les Sciences de l'education-Pour l'Ere nouvelle | Literature Search | 2020 |
| 28 | (DAGUZON; MARLOT, 2019) | Education & didactique | Investigation | 2020 |
| 37 | (MUNOZ; SYLVESTRE; SOULARD, 2013) | Les Sciences de l'education-Pour l'Ere nouvelle | Literature Search | 2013 |
| 38 | (MAYEN; PIN, 2013) | Formation emploi. Revue française de sciences sociales | Literature Search | 2013 |
| 39 | (LACOMBLEZ, 2001) | Relations Industrielles/ Industrial Relations | Literature Search | 2001 |
| 41 | (MUNOZ; MINASSIAN; VINATIER; 2012) | Work | Investigation | 2012 |
| 44 | (PACQUOLA; MAGNOLER, 2019) | Congress of the International Ergonomics Association | Investigation | 2019 |
| 73 | (ALVES; CATARINO, 2018) | Revista Eletrônica de Educação Matemática | Literature Search | 2018 |

Source: Elaborated by the authors

The vast majority of publications (92.31%) were made in journals, with only two works (7.69%) published in conferences. The predominance was in national journals and international conferences. The most submitted areas of the journals were Education and Didactics.

When examining the language of the articles, 15 were written in Portuguese (57.69%), 7 in French (26.92%), 3 (11.53%) in English, and finally, 1 in Spanish (3.84%). It is inferred that the predominance of Portuguese is associated with the search in the *CAPES* repository, while French is the second with the most articles, possibly because Professional Didactics originates from this country. In addition, the citations of each article were also analyzed to establish their relevance in the literature, with the majority having fewer than 5 citations (73.07%). The studies with the most citations were, respectively: Pastré, Mayen and Vergnaud (2006), with 27 citations; Alves (2020b), with 22 sources; Acioly-Régnier and Monin (2009), with 20 mentions, and Mayen and Pin (2013), with 18 citations.

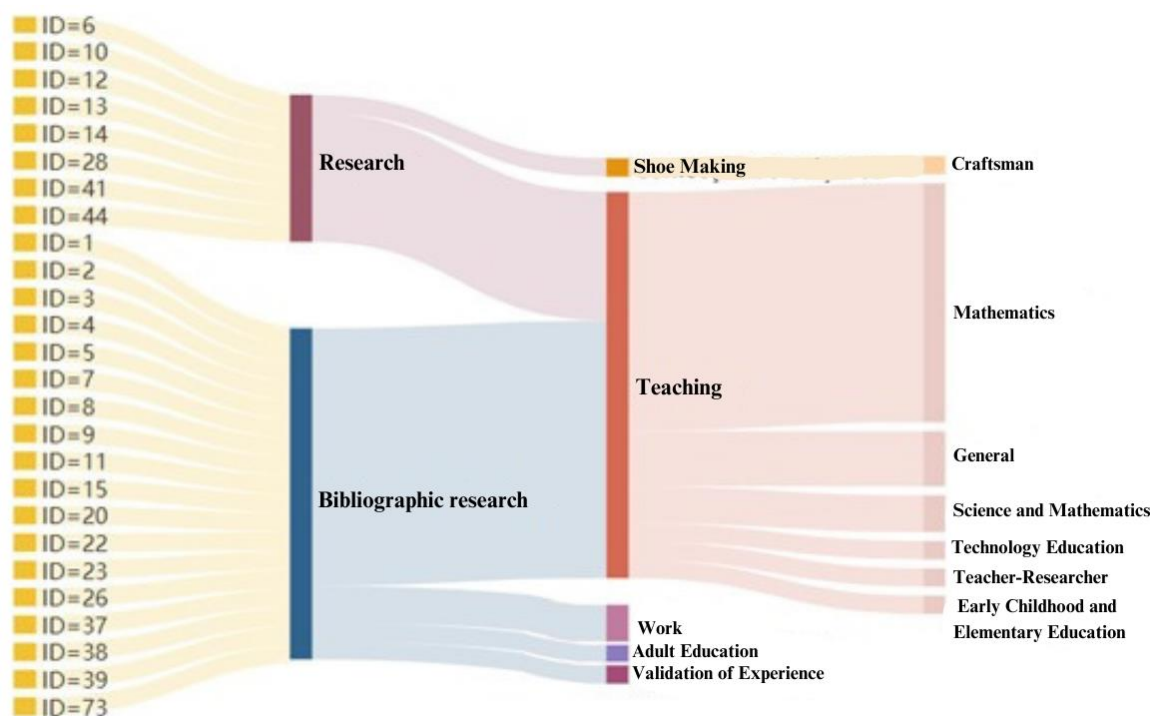
Results

This section presents the main areas investigated, the concept of professional competence, and lists the software used in the studies. Finally, it provides summaries of the analyzed articles.

Overview of research

Regarding the main thematic areas and professional domains investigated (**RQ1**), the results show a predominance of research related to Education (84.61%), as shown in Figure 3. Specific contributions to Basic, Technical, and Technological Education (BTTE), Early Childhood and Elementary Education, and Adult Education focus on STEM subjects, especially Mathematics. The analyzed phenomena address aspects of teachers' daily lives, such as routines, regulations, improvisations, and classroom situations. National articles focused on teaching, while international ones predominantly analyzed work.

Figure 3 – Categorization of thematic areas investigated in the articles

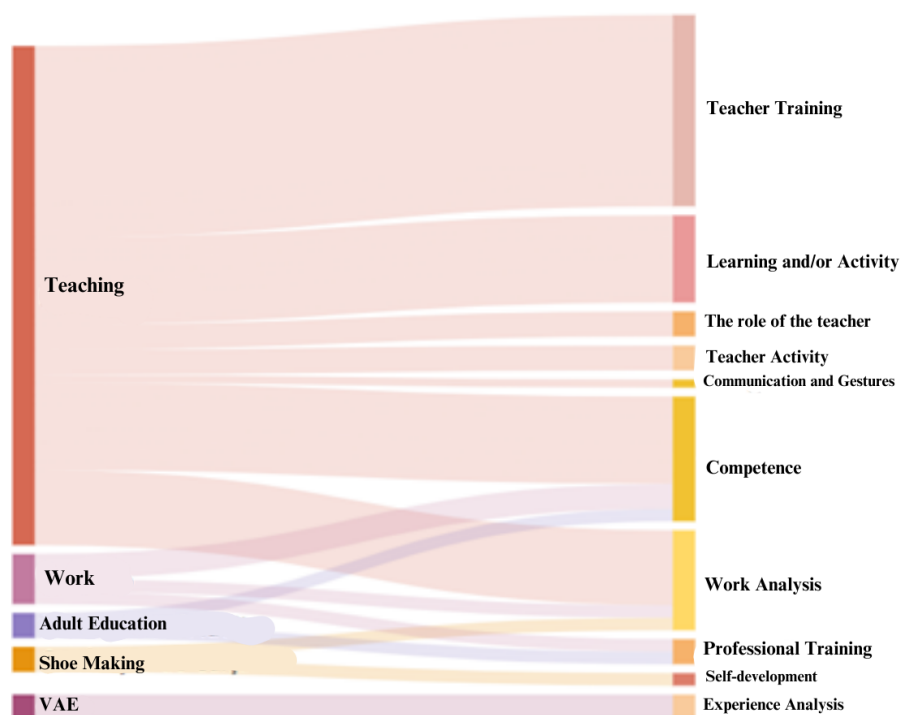


Source: Elaborated by the authors

Reports on work analysis occurred mainly in three contexts, encompassing the daily activities of a footwear manufacturing company, situations related to the teacher's work in teaching, and theoretical foundations in a more generic sense, without specifying a particular location or profession.

The areas of the 26 articles are categorized into 10 different phenomena, as shown in Figure 4 (each article may be classified into more than one): (i) teacher training, specifying aspects to be considered in teacher education, whether in undergraduate programs or professional development; (ii) learning in and through activity, involving the understanding of the practice of the activity and learning processes; (iii) the role of the teacher, addressing situations that go beyond their specific subject areas; (iv) teacher activities, providing insights for teachers based on PD principles; (v) communication and gestures, highlighting colloquial forms of gestures and language in interactions between teachers and students; (vi) competence, discussing the concept of competence and professional skills; (vii) work analysis, examining professional activity situations; (viii) professional development, emphasizing professional elements inherent in PD; (ix) self-development in collaboration, analyzing situations and collaboration at work promoting well-being; and finally, (x) experience analysis, exploring the conceptualization of the teacher-researcher's work.

Figure 4 – Specialties and phenomena addressed in the studies



Source: Elaborated by the authors

Several related concepts were identified in PD, such as: (i) Training Engineering, Cognitive Ergonomics, Action Conceptualization Theory, and Conceptual Fields Theory; (ii) Mathematics Didactics, Science Didactics, Didactics of Mathematics and Science (DCeM), Didactic Transposition, and Didactic Development Engineering; (iii) Didactic Situation, Professional Situation, and Professional Didactic Situation; (iv) Epistemological and Professional Obstacles; (v) Pragmatic Concepts; (vi) Conceptual Structure of the Situation; (vii) Scheme (Psychology) and *Habitus* (Sociology).

Regarding the main professional competencies investigated (RQ2), it is noted that the term is often erroneously associated with worker performance, i.e., their efficiency. Thinking in this way reduces the concept to a performance comparison, merely linked to the result of the activity performed, without considering the form, context, and conditions related to the situation (hence the importance of understanding the dynamic functional totality and the invariant organization of the activity - "schema") (PASTRÉ; MAYEN; VERGNAUD, 2006). Therefore, competency is not directly observable; "*we can at most infer conduct from observation*" (p. 113, our translation), as what is observed are the performances linked to situations. However,

multiplying such observations and the achieved interpretations makes it possible to infer which competencies correspond to them (PASTRÉ, 1999).

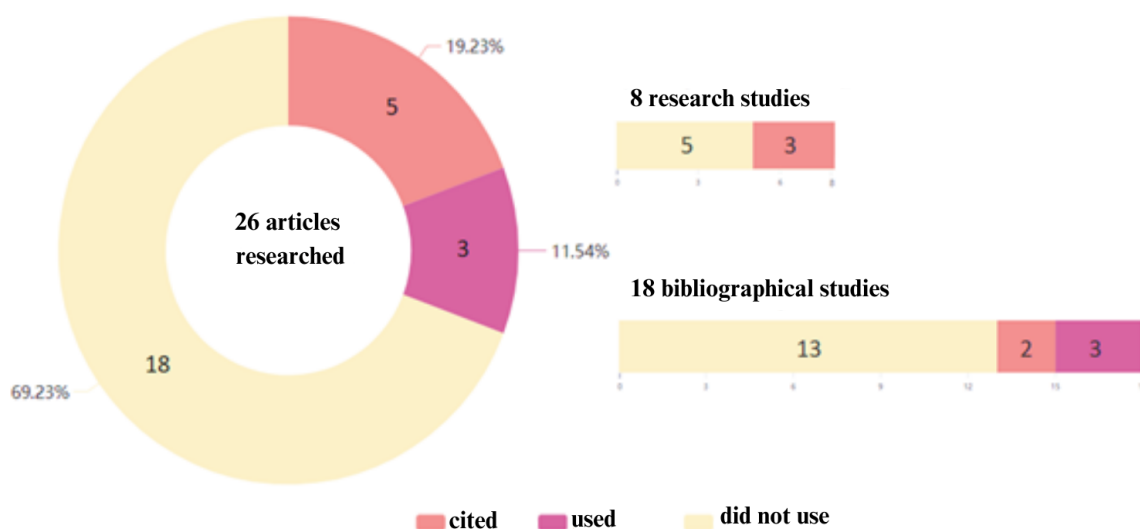
Considering Leplat (1995), it is understood that the notion of competence is broad and challenging to define in words. For example, it can be mentioned that the worker who knows how to perform activities that are not officially prescribed, meaning they have not received instructions to do them, and often they cannot explain them adequately. However, it can be defined as a pragmatic and non-scientific concept (VERGNAUD, 2007), not solely tied to epistemic knowledge but at the core of pragmatism (ALVES; CIDRÃO, 2021).

Various authors have argued that competence reveals itself when the worker encounters unplanned critical situations, requiring them to confront, diagnose, and propose alternative solutions. Especially those who analyzed the teaching practice of the teacher, such as: "*an increasingly tacit and substantial capacity to act and react to unforeseen incidents and new school situations*" (ALVES, 2021b, p. 5, our translation), "*the ability to manage and coordinate student learning within an evolving educational system that gradually responds to the set of actions and activities developed*" (ALVES, 2021a, p. 16, our translation), "*it demands from the teacher the capacity to handle certain unusual situations that arise in the classroom context*" (SOUSA *et al.*, 2021, p. 1, our translation) and "*knowing how to act and react in a specific work situation where the individual can implement professional practices to solve problems arising from new work situations*" (ALVES; CIDRÃO, 2021, p. 10, our translation). From this perspective, Alves (2020a) states that when faced with unexpected didactic situations, the teacher must contribute to the regulation and improvement of their activities while developing strategies to overcome identified problems, requiring an adaptive potential in the face of unpredictable situations (ALVES; 2020b) or erratic school incidents (ALVES; JUCÁ, 2019).

Therefore, the analyses conducted highlight that competence is a pragmatic concept that cannot be reduced to "performance" and is linked to the ability to solve problems that emerge from atypical situations; it is inherent to a dynamic professional who knows what they are doing (SONNTAG, 2019). The articles have no specific investigation of professional competencies or desirable ones for professional practice.

Regarding the contexts and tools related to professional learning (**RQ3**), 5 (19.23%) studies used software, and 3 (11.54%) mentioned platforms from other research (Figure 5), representing only 30.77%.

Figure 5 – Relationship of software in the analyzed approaches



Source: Elaborated by the authors

The software mentioned in the bibliographic approaches (ID=2, ID=4 and ID=20) were: Geogebra (3 times), CAS Maple, Maxima and Google Colaab. While those used in the research (ID=3, ID=10, ID=12, ID=13 and ID=73) were: Geogebra (3 times), Moodle and Google Classroom.

Despite these occurrences, the approaches provided exemplifications of Professional Didactics or virtual classroom/training mediations, with no explicit forms of learning regulation aimed at monitoring, analysis, and retrospective of actions, either for individual self-regulation or co-regulation in the social context (among peers) in professional practice.

Analysis of the studies

Alves (2021a) describes, through a literature review, the assumptions, foundations, and organizing principles of Professional Didactics (PD). By qualitatively investigating teachers' professional competencies, he considers that for a practical learning experience, it is necessary to integrate organizational and professional realities and individual experiential strategies.

Alves and Acioly-Régnier (2021) discuss the strategic relevance of communication in teaching and learning, focusing on the activities of mathematics teachers, based on a literature review. It is noted that the teacher's repertoire of skills "*regulates and conditions the quality of transmission, judgment, language, and communication*" (p. 11, our translation).

Alves and Jucá (2019) propose a discussion, based on a literature review, about the different dimensions of competence in mathematics teachers from the perspective of Professional Didactics. The work points out that the profession is a significant element of a culture and that qualitative indicators are necessary to understand the teacher's learning in and from their work.

Alves (2020a) envisions implications for analyzing the teacher's activity in teaching specific subjects, such as Mathematics and Science Didactics. The literature review highlights important aspects of Professional Didactics, extracts timely implications, and presents unique contexts that go beyond the classroom but contribute to the structuring of professional practice and the formation of a teaching "identity."

Based on a literature review, Alves (2020b) proposes an analysis of teachers' professional activity and learning in specific subjects (Mathematics, Physics, Chemistry, and Biology) from the perspective of Professional Didactics. According to the author, to contribute to their professional development, teachers need to be engaged in a dialectical process of updating the result of their judgment about interactions among students, the institution, and other teachers.

Cidrão and Alves (2019) conduct a qualitative investigation through semi-structured interviews with teachers to analyze their professional activity and identify the pragmatic concepts involved in this activity. Thanks to Professional Didactics (PD), the analysis of work contributes to enriching teacher learning, with a focus on the competences exercised and developed.

Alves (2021b) presents Professional Didactics as an extension of Piagetian thought, emphasizing adult learning and overcoming obstacles that arise from work. Through the review, the author presents some of its assumptions and key concepts and, in the end, seeks to indicate implications for analyzing the mathematics teacher's activity and teaching in Brazil.

Alves and Cidrão (2021) synthesize research on Didactic Development Engineering, Mathematics Didactics, and Professional Didactics regarding professional learning and teacher training. They define the concepts of activities and competences and provide a theoretical overview to understand the modus operandi of the teacher's didactic situations.

Silva *et al.* (2019) discuss Professional Didactics and its principles through bibliographic research to demonstrate its contribution to the training of teachers in Technological Education in Brazil. They emphasize the need for the creation of specific training

as an opportunity for collaboration among Federal Institutes towards a more comprehensive and humane education of individuals.

Mororo *et al.* (2021) present a study on using digital technologies in teacher education based on the theoretical foundations of Professional Didactics (PD), using qualitative data collected from electronic questionnaires. The authors highlight that the appropriate use of tools can promote stimuli and contribute to the development of teachers' learning.

Pastré (2017) introduces and characterizes Professional Didactics, defining its key concepts and principles. Three conclusions are reached through various analyses of professional activity: the convergence between the evolution of ergonomic psychology and the evolution of the conceptualization-in-action current, the dual function of concepts, and the similarity of professional didactics with the spirit of the "ladder."

Fontenele and Alves (2021) analyze student teachers' perceptions, listing the guiding concepts of Professional Didactics and identifying different operative invariants in work situations. The need to work on teacher training based on various identified problems, such as the school environment and concepts of teacher authority and autonomy, is highlighted.

Camilo, Alves and Fontenele (2020) discuss teacher education based on Professional Didactics and the Theory of Didactic Situations. To do so, they provide a bibliographic foundation that contributes to the analysis of teaching practice and describes the development of didactic situations using the software Geogebra, emphasizing the benefits of the software for solving and understanding the proposed problem situation.

Acioly-Régner and Monin (2009) reflect on the role of sociology and psychology in training teachers for early childhood and elementary education. Through videography of school situations, followed by interviews using the self-confrontation method, this instrumental device is proposed to contribute to understanding pedagogical practices and teacher training based on Professional Didactics (PD).

Sousa, Alves and Fontenele (2020) relate the perspectives of PD and Mathematics Didactics in teacher training. The literature review highlights theoretical and methodological elements, as well as the results of activity analyses, proposing reflective and investigative research of the teacher's activity and demonstrating the potential contribution of PD to teacher education.

Alves (2022) presents data from a study on teacher education considering historical elements of nature and mathematics with concepts from Didactic Engineering and PD. By analyzing two sets of research, a historical overview of sequences of numbers by different

mathematicians is traced, providing a scenario for teacher learning with implications for the present day.

Sousa *et al.* (2021) conducted a literature analysis to define the professional competence of mathematics teachers in light of PD. The authors conclude that professional competence is comprehensive and holistic, requiring the teacher's ability to deal with atypical situations that arise within the classroom context.

Alves (2021c) seeks to understand, through a literature review, how mathematics teachers act and learn to be educators through the resolution of professional tasks. There is a need to comprehend the essential cognitive elements, structuring, and organizing factors of the teacher's learning in the workplace and during the performance of specific professional tasks.

Sonntag (2019), through a literature review, addresses professional development, competence acquisition, and Validation of Acquired Experience (VAE), which are elements involved in adult education and continuous training. Drawing on andragogy, PD, and competence logic, the author concludes that adult education cannot be reduced to mere professional training.

Daguzon and Marlot (2019) analyze the effects of co-teaching on teachers' practices when working in pairs. The research aims to understand how implementing a cooperative engineering approach can aid this process. Collaborative engineering is an attempt to concretize what is theoretically considered abstract.

Munoz, Sylvestre and Soulard (2013) conducted a study on the Validation of Acquired Experience (VAE) in the university context, parallel to Vergnaud's (1994) notion of homomorphism. The study validates the teacher-researcher's acquired experience through an analysis derived from the vocational education paradigm.

Mayen and Pin (2013) investigated the commitment dynamics and activities of individuals subjected to the Accreditation of Prior Learning (APL) social situation. To do so, they listed the factors of commitment and engagement with VAE. The results showed that people are familiar with the acronym VAE through vague information obtained online or through documents, surprising the researchers.

Lacomblez (2001) undertakes a historical approach that establishes connections between work analysis and the conception of professional training, where the crisis of the Fordist mode may have contributed to the growth of developed research. It is evident from the work that the types of formalized social contracts directly interfere with the purpose of projects and their outcomes.

Munoz, Minassian and Vinatier (2012) conducted a case study of a science lesson to analyze the co-piloting of the teaching and learning process. After a detailed analysis, the authors conclude that in face-to-face scientific debate situations, teaching and learning become co-piloted (performed jointly) by a group of actors, but this occurs less when the teacher is unfamiliar with their students.

Pacquola and Magnoler (2019) present the results of a research project using Activity Analysis, PD, and Neo-functional Methodologies. The focus was on SMEs (Small and Medium-sized Enterprises), concluding that the role of the trainer becomes that of mobilizing knowledge within the company, encouraging new representations and work organizations, promoting well-being, and positively impacting production.

Alves and Catarino (2018) analyze the teacher's role in the French context from the perspective of Mathematics Education and Professional Didactics. They propose a theoretical discussion to understand the mathematics teachers' learning in the workplace, with a model for regulating their actions and improving their skills.

Discussions

The results indicate a significant growth in research on the topic in recent years. When analyzing **RQ1**, it is evident that most articles come from the teaching field, a somewhat expected result, as the term "learning" is often related to the teaching-learning process in educational institutions. However, it is essential to consider that learning is diverse and plural, experienced from the perspective of Professional Didactics (PD) through doing, i.e., in the practice of various professional activities (PASTRÉ, MAYEN, VERGNAUD, 2006). It is understood that when acting, the individual modifies the "object" and modifies "oneself," incorporating the experience of the situation lived (learning). Professional practice is, therefore, a continuous experience of acquired experiences, practices, and knowledge. The most investigated areas were in Education/Teaching, especially in bibliographic studies in Mathematics.

Despite there being few reports of "new" investigated situations, several articles provided a definition of the concept of teacher professional competence (**RQ2**), referring to a set of skills that enable the teacher to proactively, tacitly, and "naturally" perform actions in response to unplanned and non-trivial situations. These definitions often involve occurrences not foreseen in the activities prescribed in the teacher's regulations, directly associated with the

differentiation between tasks and activities provided by Cognitive Ergonomics. In other words, teaching requires adapting and improvising in various situations. Additionally, it is evident that teachers engage in dual regulation in their professional practice: (i) self-regulation - their processes/routines, training, conflicts, and situations related to teaching practice, and (ii) student regulation - subjects, learning, and practices in the classroom. These are two regulations of different "moments" of the teacher (also called binomials), situations when they are not in the classroom (teacher and teacher-institution) and situations in the classroom (teacher and teacher-student). It is also noteworthy that there is a significant occurrence of "cyclical" citations in studies on teaching, meaning references between works by the same authors. The authors discussed the concept and identified inherent elements of competence in 34.61% of the studies. Specific skills necessary/desirable in the investigated labor practices were not reported.

Three articles stand out for their more advanced level of research: ID=12 - "*The teaching activity in the perspective of the graduate student in Mathematics: contributions from Professional Didactics to teacher education*" (FONTENELE, ALVES, 2021), ID=14 - "*From the theory of conceptual fields to professional didactics for the training of teachers: Contribution of psychology and sociology to the analysis of pedagogical practices*" (ACIOLY-RÉGNIER, MONIN, 2009) e ID=44 - "*Activity Analysis as a Method for Accompanying Industrial Craft Companies to Internal Changes and Market Challenges*" (PACQUOLA; MAGNOLER, 2019). In the first, the authors conducted research based on reports of teaching internships to identify theorems-in-action and concepts-in-action involved in situations. On the other hand, the second ran a refined study through videography and cross-analysis of teaching based on the concepts of scheme and *habitus*. There was an in-depth examination of various aspects of the profession, such as pedagogical freedom in contrast to school programs, the prospect of losing professional autonomy, and the versatility of professional practice. Finally, the authors analyzed and contributed to self-development in collaboration among footwear artisans in the third study. The results led to changes in action schemes, improving well-being and collective performance.

The critical concepts of Professional Didactics identified include:

- The concept of competence, by distancing the term from efficiency/performance and qualifying different dimensions in the professional exercise of teaching practice;
- The differentiation between operative and cognitive images by presenting the comparative scenario between activities carried out by a novice teacher and an experienced

teacher; regulation and competence can be limited to mastery of knowledge and teaching, or it can be broader, encompassing the environment, instrument management, using experiences from lived situations, among other factors;

- The dimension of carrying out an activity, by contrasting the actions performed with what the regulations formalized; officially, documents "regulate" what teachers should do, but in practice, teachers use different skills to achieve expected results (there is a "theoretical regulation" of tasks and a practical regulation exercised in daily life);

- Practical knowledge exceeds epistemic knowledge by describing teacher learning through labor practice and the need for teachers to be in constant training and qualification; regulation is in the behavior exhibited in the face of adversities to achieve the expected outcome;

- Conducting *debriefing* sequences and reflection episodes contributes to teacher learning through retrospective analysis of their actions;

- Learning occurs through the experience of different situations, as over the course of their school life, teachers manage complex and non-trivial cases, gaining an increasingly tacit ability to react to incidents over time;

- The use of language and communication by describing teaching practices through gestures and jargon in the transmission of knowledge, where such informal jargon persists in dialogues/practices among colleagues; regulation lies in the competence to mediate/manage/articulate the teacher's different repertoires in teaching;

- Schema and competence development in education, by positioning schema as a theoretical tool and a cognitive unit that enables the professional to adapt to a defined class of situations;

- Learning situation in the ability to diagnose a condition, referencing the elements of the conceptual structure of a problem: organizing/pragmatic concepts, indicators, classes of situations, and expected strategies;

- The operational invariants (concepts-in-action and theorems-in-action) relating possibilities/conditionals in the teacher-student relationship, such as motivation and the need to study, contrast with the effectiveness of teaching/learning.

Explicit forms of regulation/monitoring of learning (**RQ3**) were not found, indicating a lack of practical approaches, investigations, and experiential reports addressing learning in professional practice in light of DP concepts. There is a gap between the analysis of work aimed

at competence development and systematized instruments for learning/activity regulation, such as the photographic catalog where construction defects in walls are observed by masons through a pedagogical exercise in software (RABIET, 2006; GRUBER; ALLAIN; WOLLINGER, 2019), and in the monitoring of learning regulation by students through instrumentalized management tools engaged by the teacher (ANGELUCI; OKAYAMA, 2019). This deficiency highlights the need for research that appropriately investigates learning regulation occurring "in action" to promote professional training, especially in environments focused on Vocational Education. Through these approaches, it will be possible to analyze/catalog/assess/compare the competencies required for the practice of the studied profession more appropriately, aligning teaching actions with the role played by the student in a more specific form of training.

It is important to note that this research did not aim to analyze the efficiency of different approaches but to guide how these themes are addressed. It is also essential to emphasize that the intention is not to delimit the competencies analyzed, nor to provide support for generalizations or labels, but to offer a general overview of the investigations.

Final considerations

Through a systematic review, this research investigated works that relate to the regulation of learning in Professional Didactics. A total of 83 articles were found in six different repositories, of which 26 were analyzed (18 bibliographical and 8 research articles). The final considerations regarding the employed method and the discussions are presented.

Regarding the method, it is inferred that using the term "regulation" in the search strings may have contributed to filtering out research that analyzes learning implicitly, meaning they investigate the process without explicitly using the word "regulation." Using more inclusive terms could have identified more research, but it would have been less precise since it would bring in unrelated works. Additionally, despite using different digital repositories, many duplicate jobs were found, suggesting that CAPES and Scopus index most productions, including primary studies from regional conferences.

Through the alluvial chart, the main areas and themes of the articles were categorized, listing the concepts investigated and which ones used/referenced software in regulating activities, providing a general overview of the research through the visual perception of data categorization. Most studies address teaching practice, especially in the field of Exact Sciences. The core focus of the works was on training, learning, the exercise of activities, and

competencies, encompassing pragmatic concepts, epistemological and professional obstacles, and didactic situations/transposition, among others. Syntheses of the analyzed articles were conducted, encompassing DP concepts mainly related to professional competence.

In the discussions, it is highlighted that there needs to be more literature addressing practical learning experiences in professional practice within the framework of Professional Didactics concepts. This scarcity suggests that explicit analyses for this purpose are novel, underscoring the importance of further research in this context.

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