The educational path of teachers of Natural Sciences: a bibliographic review, based on Brazilian theses and dissertations

Geovane Barbosa dos Santos¹
Antônio Azambuja Miragem²
Maria Rosa Chitolina³

Abstract: The training path and professional practice of Natural Science teachers require multiple knowledge and practices. Paradoxically, the training curriculum (initial or continuing) and working conditions do not help to fulfill these demands. In this sense, the objective of this research is to understand the contributions of dissertations and theses produced in the country, present in the Brazilian Digital Library of Theses and Dissertations (BDTD), on training processes and professional practice of undergraduates and teachers in the area of Natural Sciences. Based on specific descriptors, the studies underwent inclusion and exclusion criteria. Nineteen documents resulted in the reading and analysis of the full text. It can be seen that the training course for Natural Science teachers presents barriers and challenges that impact their professional practice. However, there are many strategies to minimize them. Therefore, there is a need to look at the educational documentary parameters and relate them to the training path of teachers of Natural Sciences.

Keywords: Natural Sciences. Science Teaching. Teacher Training. Formative Path.

Trayectoria educativa de profesores de Ciencias Naturales: una revisión bibliográfica, a partir de tesis y disertaciones brasileñas

Resumen: El camino formativo y el ejercicio profesional de los profesores de Ciencias Naturales requieren de múltiples saberes y prácticas. Paradójicamente, el currículo de formación (inicial o continua) y las condiciones de trabajo no ayudan a cumplir con estas demandas. En este sentido, el objetivo es comprender las contribuciones de las disertaciones y tesis producidas en el país, presentes en la Biblioteca Digital Brasileña de Tesis y Disertaciones (BDTD), sobre los procesos de formación y práctica profesional de los estudiantes y profesores en el área de Ciencias Naturales. Los estudios encontrados con base en descriptores específicos fueron sometidos a criterios de inclusión y exclusión. Diecinueve documentos resultaron para la lectura y análisis del texto completo. Se puede apreciar que el curso de formación de profesores de Ciencias Naturales presenta barreras y desafíos que impactan en su ejercicio profesional. Sin embargo, existen muchas estrategias para minimizarlos. Por lo tanto, existe la necesidad de mirar los parámetros documentales educativos y relacionarlos con el camino de formación de los profesores de Ciencias Naturales.

Palabras clave: Ciencias de la Naturaleza. Enseñanza de las Ciencias. Formación de

¹ Master’s student in Science Education: Chemistry of Life and Health at the Federal University of Santa Maria (UFSM). Professor at the Três de Maio Educational Society (SETREM). Rio Grande do Sul, Brazil. bgeovane.2011@gmail.com https://orcid.org/0000-0002-2596-0628.
² Ph.D. in Biological Sciences (Physiology) at the Federal University of Rio Grande do Sul. Professor at the Farroupilha Federal Institute of Education, Science, and Technology (IFFar), Santa Rosa campus. Rio Grande do Sul, Brazil. antonio.miragem@ffarroupilha.edu.br https://orcid.org/0000-0001-6253-8795.
³ Ph.D. in Sciences (Biochemistry) from the Federal University of Paraná. Professor at the Federal University of Santa Maria (UFSM). Rio Grande do Sul, Brazil. mariachitolina@gmail.com https://orcid.org/0000-0002-5240-8935.
Resumo: O percurso formativo e o exercício profissional de professores das Ciências da Natureza exigem múltiplos saberes e fazeres. Paradoxalmente, o currículo da formação (inicial ou continuada) e as condições de trabalho não auxiliam para efetivação destas demandas. Nesse sentido, objetiva-se compreender as contribuições das dissertações e teses produzidas no país, presentes na Biblioteca Digital Brasileira de Teses e Dissertações (BDTD), sobre processos formativos e exercício profissional de licenciandos e professores na área das Ciências da Natureza. Os estudos encontrados, a partir de descritores específicos, passaram por critérios de inclusão e exclusão. Resultaram dezenove documentos para a leitura e análise do texto integral. Percebe-se que, o percurso formativo de professores das Ciências da Natureza apresenta barreiras e desafios que impactam no exercício profissional. Porém, há muitas estratégias para minimizá-los. Logo, há necessidades de olhar para os parâmetros documentais educacionais e relacioná-los com o percurso formativo de professores das Ciências da Natureza


1 Introduction

Science teaching is fundamental in promoting an integral citizen education, while critically developing the knowledge necessary to face contemporary social demands. The area of Natural Sciences, due to historical reformulations, is losing its integrative character in schools, since the curricular components were separated (for example Biology, Physics, and Chemistry), which brought barriers to their integration and contextualization. However, due to new social demands, with Science and Technology immersed in practically all social contexts, the need for interdisciplinary teaching for the area and beyond arises again (RODRIGUES, 2007; GARCIA; MALACARNE; BIZZO, 2009).

It is inevitable to think of interdisciplinary teaching in Natural Sciences without turning to the training path and the practical realities of teachers who work in the area. Teacher training, especially in this segment, has been presenting challenges, mainly due to educational parameters and guidelines. However, there is a paradox in this path; since the curricular guidelines seem sufficient for teacher training, we can see that their texts encourage the search for continuing education, different teaching strategies, and quality in teaching and planning (LOPES et al., 2018).

Immersed in this paradoxical context, teachers of Natural Sciences have been
showing insecurities when teaching the contents of their area, due to the required interdisciplinary character, since the training context presents gaps for the development of contextualized teaching. As a result, there are teachers and students with difficulties in understanding the scientific process, which generates a simplistic and positivist idea of Science, making teaching centered on the simple transmission of knowledge (KRASILCHIK, 1987; CACHAPUZ et al., 2005; POZO; CRESPO, 2009).

Therefore, for the teaching of Science to be able to meet contemporary social demands, it is necessary to turn to research and reflection on the training curriculum of Science teachers. The current demands cannot be faced with the same teaching practices of past decades, since the historical, social, cultural, political, and economic contexts are different (DELIZOICOV, 2011).

The objective of this bibliographic review is to analyze, as well as understand the contributions of dissertations and theses produced in the country, present in the Brazilian Digital Library of Theses and Dissertations (BDTD) of the Brazilian Institute of Information in Science and Technology (IBICT), on training processes and professional practice of undergraduates and teachers in the area of Natural Sciences.

2 Methodological Path

The quest to understand what has been researched on the subject, based on previous studies, characterizes this work as bibliographic research about Science Teaching. With a qualitative approach (MARCONI; LAKATOS, 2022), it was carried out from Brazilian academic works available electronically at the Brazilian Digital Library of Theses and Dissertations (BDTD) of the Brazilian Institute of Information in Science and Technology (IBICT), at the electronic address: http://bdtd.ibict.br/vufind/. There was no temporal delimitation, that is, all research present in the database, based on certain descriptors, was considered.

When searching for dissertations and theses, we used the following descriptors: “Professional Exercise” (3665 results); “Natural Sciences (39754 results); “Science Teaching” (47711 results); “Teacher Training” (25467 results). Therefore, considering the objective of this investigation, the crossing of the four descriptors of the research was carried out simultaneously, resulting in the initial quantity of 152 documents retrieved by the search.
From the dissertations and theses found in the repository, a priori, the titles, keywords, Higher Education Institution (HEI), Graduate Program, and abstracts were analyzed, when necessary. In the list of studies generated, after a thorough analysis, some studies appeared more than once (duplicates), which were excluded (7 studies), leaving a total of 145 studies.

Thus, dissertations or theses should meet the following criteria: (1) The Postgraduate program in which the research was developed should encompass the area of Natural Sciences, focused on Teaching/Education in Sciences and Postgraduate Programs — Graduate in Education. (2) Approach initial training; continuing education and/or the professional practice of Science teachers — for elementary education — and teachers in the area of Natural Sciences (Chemistry, Physics, and Biology) — for secondary education. (3) Research should have a locus of intervention in Basic Education and/or in initial and/or continuing education courses. Therefore, research that covered only bibliographic reviews, Scientometrics, and state-of-the-art studies were excluded. The dissertations and theses found were named by the letter “S” (studies) followed by numbers in ascending order: S1, S2 to S19.

A posteriori, readings of dissertations and theses were carried out (in full), to elaborate syntheses of the works developed, as well as to verify if the ethical questions of research were respected since academic works selected in public domain sites were analyzed.

3 Selection and identification of studies

The search in the IBICT database resulted in an initial total of 152 searches, 100 of which were dissertations and 52 theses (Figure 1). 119 studies were excluded because they did not meet the inclusion criteria. A total of 26 works were then obtained. Of these, after complete reading, seven studies were excluded because they also did not meet the inclusion criteria. Thus, 19 studies (14 dissertations and 5 theses) remained (Figure 1) that were included in this review. Among the studies, the research focuses on initial training; continuing training, and professional practice (teaching strategies in basic and/or professional education) of teachers in the area of Natural Sciences. Table 1 systematizes the dissertations and theses, produced in postgraduate programs in the country, in the order presented on the researched platform.
Figure 1: Flowchart for the selection of participating studies

152 studies were found on the IBICT platform, through the BDTD.

7 studies were excluded due to duplication.

145 studies to be analyzed, through the inclusion criteria.

119 studies were excluded because they did not meet the inclusion criteria.

26 studies were analyzed in full.

7 studies were excluded after full reading, as they did not meet the inclusion criteria.

19 studies were included.

8 studies aimed at Initial Training.

7 studies focused on Continuing Training.

7 studies aimed at professional practice (teaching strategies in basic and/or professional education).

S1, S4, S6, S9, S11, S13, S17 e S18

S1, S2, S4, S7, S10, S13 e S16

S3, S5, S8, S12, S14, S15 e S19

* In some studies, there are two or more research focuses, so the total sum exceeds 19.

Source: Authors, 2022.

Table 1: Theses and dissertations on teacher training in the area of Natural Sciences and Professional Practice (teaching strategies in Basic and/or Vocational Education).

<table>
<thead>
<tr>
<th>Year</th>
<th>Type</th>
<th>Authors</th>
<th>Keywords</th>
<th>HEI</th>
<th>Postgraduate Program</th>
<th>Research Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>2002</td>
<td>T AUTH, Milton Antonio</td>
<td>Teacher training; Interdisciplinarity.</td>
<td>UFSC</td>
<td>Postgraduate Education Program</td>
<td>Initial and Continuing Training</td>
</tr>
<tr>
<td>S2</td>
<td>2018</td>
<td>T DIAS, Lisete Funari</td>
<td>National Pact for the Strengthening of Secondary Education; Science teaching; High school;</td>
<td>UFRGS</td>
<td>Postgraduate Program in Science Education; Chemistry of Life and</td>
<td>Continuing Training</td>
</tr>
<tr>
<td>Year</td>
<td>Type</td>
<td>Name</td>
<td>Education</td>
<td>Program</td>
<td>Professional Practice</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>-------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>D</td>
<td>RODRIGUES, Anna Karolina Fidelis da Silva</td>
<td>Natural sciences; Teacher training.</td>
<td>UEPB</td>
<td>Professional Practice (teaching strategies in basic and/or professional education)</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>D</td>
<td>PERSON, Vanessa Aina</td>
<td>Human Sciences; Education; Activity Theory; Teaching Activity; Science Teaching Teachers.</td>
<td>UNIJUI</td>
<td>Initial and Continuing Training</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>T</td>
<td>BASTOS, Sandra Nazaré Dias</td>
<td>Teachers; Science; Biology; Subjectivity; Speech analysis; Teacher training; Study and teaching; Science education. Teachers - training; Paths and processes; Science teachers - training; Learning trajectory.</td>
<td>UFPA</td>
<td>Initial Training and Professional Practice (teaching strategies in basic and/or professional education)</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>D</td>
<td>OLIVEIRA, Maria Pilar Dias Barreira e</td>
<td>Science; Biology; Subjectivity; Speech analysis; Teacher training; Study and teaching; Science education. Teachers - training; Paths and processes; Science teachers - training; Learning trajectory.</td>
<td>UFSCar</td>
<td>Initial formation</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>D</td>
<td>MARTINS, Eliezer Alves</td>
<td>Curriculum reform; High school; Natural sciences; Educational politics.</td>
<td>UFRGS</td>
<td>Continuing Education</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>D</td>
<td>MELO, Luiz Arlindo Ramos de</td>
<td>Teaching practice; Science teacher training; Natural Sciences; Training of physics teachers.</td>
<td>UFPA</td>
<td>Professional Practice (teaching strategies in basic and/or professional education)</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>D</td>
<td>BARROS, Gabriela Dutra</td>
<td>Science teaching; Teaching of Genetics; Initial Teacher Training; Didactic resources. Secondary school teachers; Chemical Training; Study and teaching; Permanent Education; Methodology.</td>
<td>UNB</td>
<td>Initial formation</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>T</td>
<td>MALDANER, Otavio Aloisio</td>
<td></td>
<td>UNICAMP</td>
<td>Continuing Education</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Year</td>
<td>Type</td>
<td>Name</td>
<td>Qualification/Teaching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S11</td>
<td>2019</td>
<td>T</td>
<td>SOUZA, Rosangela Vieira de</td>
<td>Professional qualification; Didactics.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S12</td>
<td>2010</td>
<td>D</td>
<td>FAÇANHA, Alessandro Augusto de Barros</td>
<td>Institution Program for Teaching Initiation (Brazil); Science teaching; Information and Communication Technologies (ICTs); Teacher training.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S13</td>
<td>2019</td>
<td>D</td>
<td>GERMANO, Francisco Wagner da Costa</td>
<td>Science teaching; Teacher training; Active Teaching.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S14</td>
<td>2019</td>
<td>T</td>
<td>ROSA, Marcelo D'Aquino</td>
<td>Postgraduate Program in Science Education: Chemistry of Life and Health</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S15</td>
<td>2018</td>
<td>D</td>
<td>GONÇALVES, Mayara Cristina Queiroz</td>
<td>UFRGS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S16</td>
<td>2005</td>
<td>D</td>
<td>SUDAN, Daniela Cássia</td>
<td>Initial and Continuing Training</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S17</td>
<td>2015</td>
<td>D</td>
<td>CANABARRO, Paulo Henrique Oliveira</td>
<td>Postgraduate Program in Science Teaching</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Universities and Programs:
- UFRGS
- UFC
- UNICAMP
- UFRN
- UFSCar
- UNB
From the descriptors, dissertations and theses are produced, most of the time, in graduate programs of “Science Teaching”; “Science Education”; “Science Education and Mathematics Teaching” and “Education”. Studies were found between the years 1997 and 2020 (23-year interval), with the year 2018 (S2, S3, S4, S9, and S15) having the highest number of works (five in total).

Of the included studies, five (S1, S2, S4, S7, and S11) come from the South region of the country and, together with the Northeast region (S3, S12, S13, S15, and S19), have the highest incidence of publications (five publications per region). The Southeast region has four studies (S6, S10, S14, and S16), while the Midwest region has three studies (S9, S17, and S18). Finally, the North region, with two publications (S5 and S8), is the region with the lowest incidence of published studies. In addition, in the North region, it was possible to verify that the studies were carried out at the same HEI, at the Federal University of Pará (UEPA), in the postgraduate program of Teaching Science and Mathematics. All studies in the Southeast region were carried out in the state of São Paulo, two at the Federal University of São Carlos (UFSCar) and two at the State University of Campinas (UNICAMP). Meanwhile, in the South region, there was a predominance of studies in the state of Rio Grande do Sul, one at the Regional University of the Northwest of Rio Grande do Sul (UNIJUI) and three of these at the Federal University of Rio Grande do Sul (UFRGS), inclusive, developed in the same graduate program, Science Education: Chemistry of Life and Health. In the Midwest region, the academic debate on teacher training in the area of Natural Sciences and Professional Practice took place at two universities. Lastly, in the Northeast region, the publications covered three states (CE, PB, and RN). It is
important to note that of the 19 studies, only one was not carried out in a public HEI (S4).

It was possible to identify the topics addressed, the objectives, the locus of intervention, the methodology, the analysis, and the results of the studies on the training of teachers in the area of Natural Sciences and professional practice (teaching strategies in basic education and/or professional). In this sense, it can be seen that in studies S6, S9, S11, S17, and S18, the focus of the investigation was the initial training of teachers in the area of Natural Sciences.

In S6, the author seeks to know the educational paths of Science teachers and the way they experienced them. From this objective, it is possible to perceive that many of the difficulties come from training paths (personal and professional) and from the schools in which they work. The devaluation of Education and teaching are also factors that generate difficulties in the professional practice of Science teachers. S9, on the other hand, brought up issues related to genetics, seeking to reflect on pedagogical practices on the subject, but it allows us to extrapolate such reflections to other subjects of Natural Sciences. Through the offer of the curricular component "Special Topics in Biology Teaching", the undergraduates in Natural Sciences were able to perceive that the activities throughout the curricular component caused a greater reflection on the importance of the use of didactic resources in pedagogical practices, allowing to overcome difficulties arising from of professional practice.

S11 discussed the importance of the Institutional Scholarship Program for Teaching Initiation (PIBID) in the initial training of Natural Science teachers, also relating to Information and Communication Technologies (ICT) as facilitators of Science teaching. The research pointed out that the interrelationship between PIBID participants favors the use of ICT in teaching activities which, consequently, favors the improvement and technological knowledge. Furthermore, the program has great relevance in the reflection-action of teachers in training. On the other hand, S17 aimed to investigate the relevance attributed to PIBID by students of the Degree in Biological Sciences, as a facilitator for the development of the teacher-researcher posture. The research demonstrated erroneous/deformed views about being a professor-researcher, as well as about the scientific nature. Therefore, PIBID serves as a possibility of articulation between school and university, facilitating reflections on being
a teacher.

The S18 aimed to deepen the understanding of undergraduates in Chemistry about the specific professional knowledge for teaching in Chemistry, as well as the knowledge inherent to teaching. Among the findings, there were epistemological obstacles: experiential and evaluative. The study showed that such obstacles are closely linked to the training process of Chemistry teachers, with the need for reformulations in such processes, especially in initial training.

The research focused on the continuing/permanent training of teachers in the area of Natural Sciences S2, S7, S10, and S16. In S2, the general objective was to investigate the training of in-service teachers by Pnem/Unipampa, trying to see how it relates to the pedagogical practices of teachers of Natural Sciences. The research shows that teacher training is necessary, but not sufficient for changes to occur in pedagogical practices, as well as in teacher appreciation.

S7, on the other hand, aimed to investigate the movement of production of curricular reforms for High Schools, seeking to understand the contexts of influence, production, and practice. It also investigates the influence of such movements for curricular integration in the field of Natural Sciences. Through analysis of documents and teachers’ writings, it was possible to perceive how the reform of High School education limits interdisciplinary actions. Furthermore, it shows that the lack of dialogue with one of the main agents of the educational process (the teacher) prevents a curricular modification consistent with the educational reality. Therefore, continuing education courses, such as the professional master’s degree, become relevant for teachers to understand the reforms that have been taking place.

S10, through an interview with Chemistry teachers, sought to discuss educational quality in Brazil, focusing on teacher education, specifically continuing education. The need for a dialogic formation is evident, in which teachers can see ways to overcome daily professional obstacles, through studies, debates, and research. In this sense, the author defends the need to facilitate a process of interaction and the intellectual development of teachers, through research. On the other hand, S16 involves an autobiographical study from a perspective of continuous teacher education through reflective practice. In this process, according to the author, it is possible to verify practical interventions during the teaching process, as well as the challenges
and obstacles, such as institutional problems of the Brazilian educational system, relevant to the teaching profession.

Focusing on the professional practice of teachers in the area of Natural Sciences studies S3, S5, S8, S12, S14, S15, and S19 discussed strategies aimed at teaching science or curricular components in the area of Natural Sciences in basic education and/or professional. S3 aimed to know the challenges that teachers in the area of Natural Sciences face in meeting the requirements of the National High School Exam (ENEM). Through the study, obstacles faced in fulfilling the ENEM requirements were identified, among them: the little understanding of interdisciplinary and contextualized practice; temporal issues; shortage of didactic-pedagogical materials, institutional infrastructure, and insufficient professional training. S5, on the other hand, brought reflections and interventions necessary for the teacher training process. As a thesis, the research pointed out how teaching subjectivity is constructed through discursive and non-discursive processes, which define the Biology teacher. Also, in the study, correlations were made with educational parameters, opposing the theory and the practical reality of Biology teachers.

In S8, the focus was to investigate how teachers with a degree in Biology manage to overcome difficulties when teaching physics in the curricular component of Natural Sciences. The research showed that, sometimes, the pedagogical practices developed by teachers are not reflective, using textbooks as support. Consequently, the research highlights the urgency of a curricular restructuring for the training of Science/Biology teachers, but a curriculum is needed that goes beyond only technical issues of the specific area and focuses on the knowledge necessary for teaching.

S12 investigated the pedagogical practice of High School chemistry teachers and their relationship with the training process. The research points out that there are influences of the pedagogical practices developed by the training teachers, throughout the training process. It also indicates that initial training allows gaps throughout the process, mainly for the development of active teaching. Finally, the study brings possibilities, such as Scientific Literacy, so that teaching is based on the active construction of knowledge.

In S14, the problem was in the didactic collections of Sciences approved by the National Textbook Program (PNLD). In this one, the ways in which teachers use these
collections were investigated, and whether they are in line with the program’s guidelines. During the research, it was possible to perceive the great importance that textbooks have for the planning of Science teachers. However, they use other resources and teaching strategies less frequently.

S15 proposed to investigate the social and environmental implications that the shrimp farming practice generates in the reality of a public school in Natal/RN. As much as the shrimp farming practice is more developed in the Northeast region, it was possible to understand how such a strategy helps in the development of interdisciplinary teaching, as well as contributing to the understanding of chemical concepts of students, through the contextualization of the classes. In addition, it was possible to address issues involving the themes of Environmental and Science, Technology and Society (CTS).

S19, on the other hand, presents a strategy for teaching Science, focusing on training students in Basic Education. The proposed teaching strategy was the use of Gamification; its application to pedagogical action favored engagement in knowledge construction. In addition, it has shown enormous potential to increase motivation for pedagogical practice, as well as provide the integral development of students.

Research S1, S4, and S13 had two scopes of intervention and discussion, the initial and continuing education of teachers in the area of Natural Sciences. S1 discussed a proposal for initial and continuing education for Natural Science teachers, based on the historical-epistemological concept, so that participating teachers can recognize the aspects that determine their current practice. Based on these conceptions, the author developed activities in the form of themes and study situations, so that reflections were carried out collaboratively, and practical actions were executed in the professional practice of future graduates.

In S4, the research intended to investigate the needs and reasons that mobilize the process of initial and continuous collaborative and shared training of teachers in the area of Natural Sciences. The research reinforced the importance of dialogue between teachers in training and trained teachers, as well as clarified the idea that the training process only produces meaning if teachers in their practices reflect their experiences (professional and personal). S13, on the other hand, sought to investigate the factors that influence the processes of teacher training as an instrument of didactic
and pedagogical qualification. Through the Laboratory of Didactics and Teacher Improvement (LDAD) of a school, great influences of LDAD were verified in the improvement and professional qualification of Biology teachers, through continuing education. Among the impacts provided by LDAD is the technical qualification for professional practice.

Finally, through the individual analysis of each research, it was possible to perceive that there are interrelationships between the works since they deal with issues that permeate the training process of teachers; challenges and obstacles of the teaching profession; possibilities and teaching strategies during the teacher training process or for application in their work locus.

4 Science Teachers: Interrelationships, Challenges, and Obstacles of the Profession

It is not new that teacher training generates broad debates in the educational field, especially those involving the area of Natural Sciences. Complexity and relevance are aspects developed by a large group of researchers, given their importance in the critical-reflective formation of citizens. When analyzing the training path of teachers, we see how fundamental the initial training is, since it is in this that graduates will have theoretical and practical contributions, as well as begin to develop their professional profile (SEIXAS; CALABRÓ; SOUSA, 2017). In this sense, initial training, according to Imbérnon (2011, p. 68):

must have a solid background in the scientific, cultural, contextual, psychopedagogical, and personal spheres that must enable the future teacher to assume the educational task in all its complexity, acting reflexively with the necessary flexibility and rigor, that is, supporting their actions into a valid foundation to avoid falling into the paradox of teaching not teaching [...] (p. 68).

Through our results, including studies in which the research focus was not primarily on initial teacher education, we realized that this stage has weaknesses. As a result, gaps are created, providing obstacles and challenges in professional practice. In addition, teachers in the areas of Natural Sciences, according to Carvalho and Gil-Pérez (2011), need to develop a set of knowledge and teaching practices, to make their practice contextualized and meaningful. Still, they must get rid of conceptions, perhaps distorted, about what Science means and how to develop it. If this does not
occur, there will be a predominance of a simplistic approach in science teaching (CACHAPUZ et al., 2005).

However, from the studies analyzed, we see that the training curriculum is not able to meet all the professional demands (theoretical and practical) that teachers in the areas of Natural Sciences are expected to have. Great expectations and desires are created for a dynamic, critical-reflexive science teaching, with the development of interdisciplinary activities, but there are training obstacles that mitigate such actions (MELO, 2007; FEISTEL, 2012; CANZIANI, 2015).

Therefore, thinking about an initial training curriculum that can cover the responsibilities and requirements of the profession is a complex discussion, since it should allow the integration of concepts into the curriculum (VIANE, 2014). In this context, Imbérnon (2011, p. 69) states the following about the teacher training curriculum:

> it should promote interdisciplinary experiences that allow the future teacher to integrate the knowledge and procedures of the different disciplines (or disciplines) with a psycho-pedagogical vision (integration and relationship of the didactic knowledge of the content with the psycho-pedagogical knowledge)

In order not to be at the mercy of their initial training curriculum, many teachers seek continuing/permanent training possibilities and strategies to minimize the deficits generated for their full professional exercise, as it was possible to identify in the analyzed works. However, continuing education must extrapolate only conceptual issues and, yes, provide training adapted to the reality of education, encouraging a constant process of reflection-action of social reality and pedagogical experiences, that is, applied to the sociohistorical context (AUTH, 2002; PERRENOUD, 2002; GATTI, 2010; IMBÉRNON, 2011; RODRIGUES, 2018).

However, one of the main obstacles to the search for continuing/permanent training is linked to working conditions and/or teacher (de)valuation. The teachers’ narratives in the analyzed works, for the most part, relapsed into time constraints, incentives – salaries and/or career plans; devaluation of the school community for teachers and others. In fact, for Martins (2005), one of the main challenges of teacher training and specialization is in working conditions and teaching purposes, since today the image of the teacher does not enjoy the same social status, which made the
professional teacher go into crisis. Added to this, low salaries, long hours, and scarcity of didactic-pedagogical materials mean that many teachers end up not being able to continue their training, despite being interested in doing so (MARTINS, 2005). In this sense, as evidenced by Dias (2018, p.116),

continuing teacher training is necessary, but not sufficient, for changing pedagogical practices at school, and for it to imply teacher appreciation, and training, career, and management policies must go hand in hand, aiming at valuing teachers […].

Therefore, it is possible to perceive that the training path and the exercise of teachers in the area of Natural Sciences presents a set of obstacles and challenges, whether of a documentary or practical nature. We understand the complexity of implementing changes along the training course and professional practice of teachers, but an emergency look at such issues is required, so that severe educational losses, in basic and higher education, do not continue to occur.

5 Necessary actions in the training path and professional practice

(Re) adaptations are necessary for the training curriculum of teachers in Natural Sciences, but they are complex. In professional practice, to fill the gaps arising from professional practice, didactic-methodological strategies need to be developed. In addition, programs developed for undergraduates and in-service teachers help overcome certain barriers. (SILVA; FALCOMER; PORTO, 2018; DE OLIVEIRA; PECHLIYE, 2018).

Finally, it can be seen that, even while training and professional diversities, there is a need for a constant search for improvements in the teaching and learning process, as can be analyzed in the vast majority of the works compiled in this text.

6 Final considerations

It is concluded that the body of analyzed works, regardless of the type (theses or dissertations), has a collection of arguments that support the hypotheses of our work. This fragment of the collected literature was able to elucidate the existence of gaps. Based on the works analyzed, both initial and continuing education, as well as the professional practice of Natural Science teachers, present potentialities, obstacles, and challenges at all stages. Teachers have demands related to working conditions
and professional devaluation. In the professional environment, the vast majority of professors and pedagogical spaces of action allow the search or use of different didactic-methodological strategies. This is to alleviate and/or supply the difficulties encountered in the professional practice of Natural Science teachers.

It is believed that there is a need for constant interventions in the training course of Natural Science teachers. Even if these are complex and challenging, it is necessary to look at educational documentary parameters and relate them to professional practice. For this, it is necessary to understand the reality of teachers in their institutions and encourage the necessary curricular adjustments that approach, update and contextualize the initial training of professional practice.

Acknowledgments

To the Coordination for the Improvement of Higher Education Personnel (CAPES) for the scholarship.

References


DE OLIVEIRA, L. G. S.; PECHLIYE, M. M. Programa Institucional de Bolsa de


