

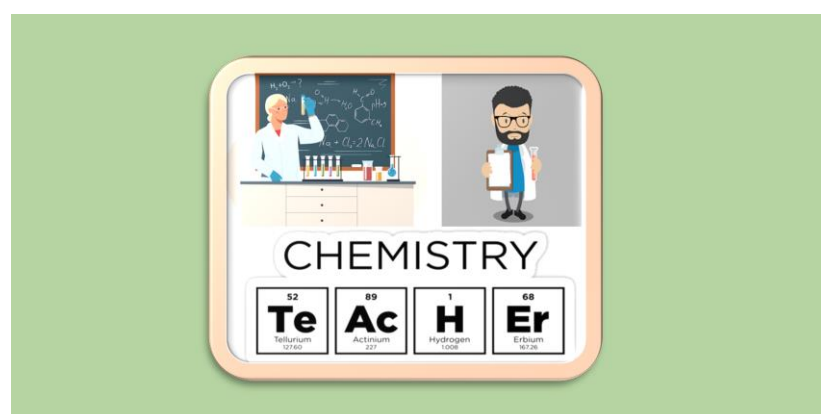
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Teacher Education for High School Chemistry Teachers in Brazil: An Analysis of Manuscripts

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Chemistry is a science that causes human, political and social impacts. Contemporaneous didactic-pedagogical development programs have focused on reflexive teachers who participate in appropriation of knowledge with their students. These programs are based on a close relation between knowledge and learning. The teaching profession is complex and goes beyond knowing and teaching. The search for balance among required competencies in teaching degree programs is fundamental to develop teachers' profiles. To reach balance, teachers' early Education must be guided through the articulation path between specific knowledge and pedagogical knowledge. In Higher Education, teaching degrees in Chemistry should account for several aspects, such as the content to be taught, curriculum, pedagogy related to the course, scientific knowledge and other specificities about teaching and teaching of the chemical science. Keeping in mind the educational process of Chemistry teachers in Brazil, this study aimed at understanding – through scientific studies in the field of chemical Education – the development of Chemistry teachers' practices in their lessons. The investigation aimed at discussing what influences specific and pedagogical development of Chemistry teachers and what challenges their work in Brazil nowadays. Twenty-five papers published in Brazilian journals were selected to determine how pedagogical knowledge is inserted into teacher Education programs that focus on undergraduate students in Chemistry. This paper also describes methodological strategies used by teachers to carry out their tasks. The methodology of the study had a qualitative-exploratory nature. Results reinsure that teachers, mainly Chemistry teachers, need to reflect upon methodologies they use, re-invent their practices, look for theoretical references and update their knowledge of Chemistry teaching.

Graphical abstract



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1. Introduction

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Chemistry taught in High School must be understood as the science that has based its knowledge construction on comprehension and interpretation of phenomena related to properties of the matter and of substances [1]. From this perspective, The National Curriculum Parameters (NCP) in Brazil have recommended that its contents should address the tripod composed of chemical transformations, material and their properties and explanatory models. Thus, teaching should enable students not only to understand chemical processes but also to construct scientific knowledge closely related to technological applications and their environmental, social and economic implications [1].

These close relations are part of pre-service programs that aim at Chemistry teachers and of the development of their theoretical-methodological-practical knowledge [2]. Teachers' identities are developed throughout their professionalization but the process is not merely related to contents addressed by pre-service programs since much knowledge is acquired every day in educational practices (the true meaning of becoming a teacher). Over the years, the main difficulties faced by Brazilian Chemistry teachers at the beginning of their careers seem to be the same [2]. Current literature has highlighted not only certain problems, such as attitudes towards students' lack of discipline, little freedom to write their own lessons, short class periods and the mandatory use of school material (booklets), but also deficits in teaching degree undergraduate programs [2]. On the other hand, some teachers tend to associate their difficulties with the school, students and issues outside of school; in many cases, they do not see themselves as part of the problems [2].

In the category "school", newly graduated Chemistry teachers may have to face the lack of laboratories to teach practical lessons, few lessons per week, excess students per group and excess periods per day (or many groups to teach). In order to appease the lack of Chemistry laboratories, teachers are asked to follow a methodology – a special methodology – that is appropriate to students' difficulties, even to compensate for the lack of experimental lessons [3]. The academic degree, based on the "empirical-positivist conception", highlights that teachers must take on critical-problematizing attitudes and keep away from "conformist" ones. Teachers may count on appropriate pre-service and in-service Education programs to focus their plans on Science, Technology, Society and Environment (STSE) nowadays [4]. However, certain difficulties, such as lack of time and effort to develop pedagogical strategies, shortage of resources and teaching material and inexperience or lack of knowledge to develop such material, are obstacles that have not been totally overcome yet [4].

Scholars in chemical Education have stated that teaching "History and Philosophy of Science" may meet some needs of teaching and learning processes by enabling students to develop critical views and to understand different concepts. However, difficulty in including History of Chemistry in traditional lessons results from the facts that this course is not taught in teaching degree undergraduate programs and that teaching material, such as specific books, is not available [5].

Another issue that hinders Chemistry teaching in Brazil is that, in some schools, mainly in the countryside, some teachers have not graduated in Chemistry, even though they teach the course. Besides, it is worrisome that some Chemistry Teachers, despite their teaching experience, keep using only traditional methodologies, such as chalk-and-board teaching and didactic books, thus, avoiding practical lessons and diversified resources. Therefore, the importance of

supervised apprenticeship to Chemistry teachers-to-be should be reinforced since it enables them to acquire knowledge and experience everyday life in classrooms [6].

The COVID-19 pandemic was a painful moment which also affected teachers' practices all over the world. It was not different in the field of Chemistry since remote teaching was mandatory and there was no choice. Suddenly, teachers had to record audio, make videos and text groups of students, i. e., use strategies which showed their versatility and tenacity [7].

Teachers-to-be must live in an environment which favors acquisition of knowledge about reality comprehension to guide their behavior. Therefore, specific knowledge is constructed throughout undergraduate programs to provide the theoretical basis of professional activities. Since teaching degree programs are specific ones to educate teachers, they are even more complex because they include affective factors, previous experiences and cognitive, political and ethical aspects [8]. Teacher Education has carefully considered students' and the society's needs and has constantly improved.

As opposed to the ideal school reality, since teachers have excess teaching periods per day in Basic Education, for instance, it is almost impracticable to develop educational strategies that account for relevant factors, such as significant time needed for planning, minimum material conditions to develop practical and experimental lessons, funds to buy pedagogical material and structuring of teacher Education programs [9]. These issues, which usually derail the execution of pedagogical actions in schools, get worse when they are intertwined with the following authorities' discourses: "you may even do 'something' else that goes beyond the established plan if you account for what has been determined by the syllabus"; "... if you respect all norms, laws and guidelines of official documents". These issues reflect pedagogical work carried out by teachers who are trapped in the promise that teaching needs to be – and may be – invariably converted into learning ruled by school laws. The contingency that gives feedback to the learning-teaching dualism is perceived, as well as all its gears and devices that establish subjectivation, such as the hegemony of pedagogical strategies disconnected from children's and youngsters' lives [9]. Higher Education does not prepare undergraduate students in Chemistry to face this reality which is 'fossilized' and 'tied' by the educational system.

Considering the previous contexts, this bibliographic study aimed at discussing teacher education programs offered to Chemistry teachers in Brazil with emphasis of their profiles and how literature has shown them. This paper comprises the following sections: Brazilian teaching degree undergraduate programs in Chemistry and teacher education programs (I); and Chemistry teaching in Brazilian High School (II). In addition, a section addresses a current and worrisome issue, i. e., teacher shortage in Basic Education in Brazil, which may reach 235 thousand in 2040 (III).

2. Material and Methods

Methodological Procedures

This review aimed at finding studies which describe teacher Education programs addressed to Chemistry students in Brazilian Higher Education, their preparation to teach in High School and the main difficulties in Chemistry teaching. Papers had to be published in Portuguese but no specific time frame was applied to them to enable gathering an array of studies of the theme. Regarding the methodology, this

qualitative and exploratory study had a bibliographic nature. In this type of study, the object is not what it seems to be at the beginning of the process but it must be perceived, known and unveiled to be, finally, described as precisely as possible. The methodological path of qualitative research enables "interpretation in the context", to determine participants' experiences and perspectives, to identify subjacent trends and patterns and to generate hypotheses for further studies [10].

Every scientific study starts from a bibliographic review which enables researchers to find out what has already been investigated into the topic. However, there are also studies that are solely based on bibliographic reviews in the search for previously published theoretical references to collect information and knowledge about the problem whose response is the target [11].

3. Results and Discussion

Teaching Degree Programs in Chemistry and Teacher Education in Brazil

Teaching degree programs in Chemistry aim at enabling undergraduate students to experience significant learning to master contents in different areas of Chemistry and to appropriately apply pedagogical practices of knowledge and experiments in Chemistry and related areas to their professional careers as Basic Education teachers. Since the beginning, Chemistry teachers-to-be attending courses that belong to the pedagogical area so that they may have an idea of the reality of the course they have chosen.

Chemistry teachers-to-be are expected to master the content they must teach since it shows their competence and skills in the technical-scientific field they chose. What makes a difference in teachers' lives is to know how to teach with the use of effective strategies to connect students to knowledge, an equally important skill that teachers must have [12]. There is a course called *Practices of Chemistry Teaching and Supervised Apprenticeship* (PEES) offered to undergraduates in the three last semesters which aims at preparing Chemistry teachers-to-be to face school reality. Researchers in chemical Education have tirelessly worked on the conceptual and practical improvement of this course [12].

Resolution CNE/CP no. 4, issued on May 29th, 2024, has recently instituted the National Curriculum Guidelines to graduate Elementary School teachers in Higher Education (teaching degrees, pedagogical programs for non-licensed undergraduates and second teaching degrees). It defined fundamentals, principles, a national common basis, teachers' profiles, structure and curriculum which should be respected by policies, management and graduate programs, besides planning, evaluation and regulation of Higher Education institutions (HEI) that teach them [13].

In Brazil, there is a program that funds newly graduate teachers named *Programa Institucional de Bolsa de Iniciação à Docência* (PIBID) (Figure 1), which aims at inserting teachers into Basic Education under the supervision of an area coordinator (a professor) and a public-school Chemistry teacher. Therefore, the so-called "PIBID teachers" learn how to plan lessons, teach fun activities, develop workshops and seminars, use games and investigative experiments and other pedagogical tasks while keeping in touch with students [14].



Fig. 1. Programa Institucional de Bolsa de Iniciação à Docência (PIBID) in some Brazilian Higher Education institutions (slogans).

Thus, the PIBID has become an excellent alternative that encourages teachers-to-be in any field. This pedagogical program was designed by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) which aims at promoting institutional projects of pedagogical resistance implemented by HEI and contribute to improve early Education of Elementary School teachers in teaching degree programs [15]. Therefore, the PIBID has five goals:

1. To strengthen and deepen theoretical-practical development of students who attend teaching degree programs;
2. To contribute to construct teaching degree students' professional identity;
3. To establish co-responsibility among HEI, teaching systems and schools for teachers' early Education;

4. To value Elementary School teachers' experience to prepare teachers-to-be professionally;
5. To encourage collaborative research and academic production based on classroom experiences.

The mission of Brazilian Higher Education is to prepare professionals to work in Basic Education, a crucial role since one of the most efficient ways to improve the school system in Brazil is to start from pre-service teacher Education which must be alert and committed to teachers' future. Chemistry teachers must be able to act critically and participatively, based on ethical principles, in both teaching and management of educational work. They also need to be capable of using diverse methodologies that contribute to students' intellectual development. These so-called active methodologies comprise not only experimental and contextualized lessons, but also inverted classes, didactic games and gamification. The main contributions of active methodologies are to arouse curiosity and to make Chemistry learning more meaningful [16]. Professors that work in teaching degree programs must guide their academic activities to enable students to reflect upon their future role as teachers and to awaken them not only to teaching but also to research in Education [17].

Students who finish their teaching degree programs must have learned several skills throughout their process of becoming a teacher. They must be able to learn and produce knowledge, reflect upon their pedagogical practice and manage efficiently to overcome challenges posed by their profession and the ones related to the context of Brazilian Education. Teaching degree programs should offer not only courses that comprise a curriculum, but also events, pedagogical meetings, teaching and extension programs, conferences, speeches and means that enable students to finish their studies and start teaching in their areas [17].

Graduating students means making them able to carry out practices that belong to a certain situation, defined in a restricted way – function at work – or in a broad way, related to a certain work sector. Graduating is preparing students to conduct guided and contextualized practices in which knowledge only makes sense when it refers to the theme that must be taught. Thus, graduating students to be teachers means to work on knowledge and practices in several levels and focus on spots in which heterogeneous logics may be articulated, a fundamental act, because the intention to integrate knowledge and practice in a totalitarian discourse or practice is the source of dogmatism and totalitarianism. Therefore, the teaching profession is in the interface between systematized knowledge in schools and students, mediating students and knowledge, teaching and learning [18].

Teachers show their competence in their technical-scientific fields when they master the contents they teach. On the other hand, to know how to teach by using effective strategies to bring students and knowledge together is also an important skill that teachers must have. From this perspective, the category "teachers' knowledge" encompasses relations between teachers and knowledge that they master to be able to teach, mediated by practical knowledge which is a relevant element to construct teachers' identity and competence. Both specific knowledge of the field and pedagogical knowledge is fundamental to professional Chemistry teaching. Professional development is believed to be subdivided into specific development (content and concepts of Chemistry) and pedagogical development (methodological strategies and conceptions of teaching and learning) [18].

Several factors may be relevant to students' learning process in Chemistry teaching, specifically. They include the use of adequate methodologies and the proposal of activities that consider students' profiles and their ways of learning [19]. Students see Chemistry as an abstract science because it often promotes the study of structures in the submicroscopic level, a fact that may be an obstacle to their cognitive progress. Curricula that aim at pedagogical development tend to separate the academic world from the practical world and, as a result, keep the monopoly of research [19]. Professors who teach pedagogical courses in teaching degree programs in Chemistry are disconnected from school reality. Consequently, they are neither able to fill the gaps in the pedagogical sphere nor break the tacit formation in Chemistry. Young teachers may get shocked when they start teaching in schools and may even accept ideas proposed by "older and more experienced" teachers and be convinced that it is impossible to reflect on their practice [19]. It cannot be accepted by young Chemistry teachers! Beginning teachers cannot let themselves be "swallowed" by a flawed educational system. Teaching degree programs in Chemistry in Brazil have always aimed at graduating teachers who are ready to face pedagogical challenges and do not give up when obstacles emerge.

Difficulties may be related to lack of resources and appropriate infra-structure in schools, little support given by the school management and poor professional acknowledgement [20]. Besides, teachers are affected by other obstacles that they must face in their careers. Brazilian Elementary School teachers have reported that their teaching hours are long and tiring since they need to teach in two or more schools to increase their salary. We believe that this scenario could change if teachers were valued and got fair wages. As a result, the profession would be acknowledged and young Brazilian students would wish to become teachers [20].

Teachers are expected to be professionals who reflect on their knowledge, specific and pedagogical knowledge and factors that interfere with their pedagogical practices. Thus, it is important to know how Chemistry teachers' educational processes start, their professional experiences and their life experiences since they are the basis of their pedagogical practices. In teaching degree curricula, teachers-to-be must take part in "apprenticeship of observation" and "class training", which are not mandatory in bachelor's degrees. On the other hand, educational processes of Chemistry teachers are complex and courses that aim at teaching how to teach are called *pedagogical* ones, a term that is outdated and must be reconsidered [21].

Courses that traditionally aim at guiding and supervising the apprenticeship are called "Supervised Apprenticeship" which, as a common course, is an official moment that students have to show the "accountability report" of activities carried out during the apprenticeship – both the observation and class training – by means of a report [22]. Observation, as a creative process, may serve as a relevant instrument to provide data that may be used for further analyses. The use of observation and the examination of the real situation of teaching and learning in everyday lessons in educational institutions have advantages. When teachers-to-be conduct observations, they may face conflicts, but they may also propose new strategies and generate reflection which aims at contributing to their development as a reflective professional, i. e., teachers who are willing to participate in discussions about the curriculum and educational changes and show coherence in school situations which are chaotic sometimes

[22]. The supervised apprenticeship is a privileged space of interface between theoretical knowledge and professional experience. Such theoretical-practical interface comprises constant interaction of knowing and doing, of academic knowledge and confrontation of problems experienced in typical school situations [22].

Educational processes that enable teachers to work in what the 1996 LDB calls Basic Education has been the object of heated discussions among scholars and of important changes in professional profiles and competences in the period under analysis. Teachers' educational programs to teach in Elementary School and in High School have gone through changes since the 1961 LDB, from graduation in a short teaching degree program (lasting five semesters) and pedagogical complementation for those who have not got any degree (lasting three semesters) to implementation of long-term teaching degree programs, which last up to eight semesters, as determined by the current LDB [23].

Despite efforts to increase the number of professionals to teach in schools, some measures resulting from rapidity, low cost and volatility of initiatives of the public management have contributed to precariousness of Basic Education and has not solved the problem of teacher shortage. In the current scenario, there is clear transitoriness of teaching policies on teacher Education which leads to the belief that there is no continuity of these actions. It keeps de-characterizing teachers' educational processes, mainly the early ones [23].

It should be highlighted that neither policies on teaching nor other educational policies should be instituted as government policies, but as State policies. Continuity of initiatives enables constant evaluation and adjustment whenever necessary. Finally, it should be pointed out that there is little academic production of the history of Chemistry teachers' development in Brazil. New production in this field enables to create new educational proposals that articulate good practices experienced by HEI together with Basic Education schools and to abandon old unfortunate methodologies [23].

Chemistry Teaching in High School in Brazil

Chemistry teaching in Brazil is the main concern of several researchers and scholars in Education because, despite its importance, most students have considered it complicated, hard, boring, meaningless and uninteresting. Many teachers do not know how to act pedagogically to make teaching of this group of courses more attractive. Could it a failure of teachers' Education throughout their teaching degree programs? Many teachers who are stuck with outdated teaching methods look for solutions in simple didactic procedures, believe that they have the right answer and forget that practice requires continuing reflection to construct knowledge needed for teaching [21].

Chemistry teaching, as seen in the Brazilian system, is basically an experimental science, rich in concepts and theorization in its scientific constitution. It is relevant to the development of scientific knowledge due to concepts and laws that were universalized, thus, instituted as Science. By means of some regulations, it occupied its space and was inserted into the Brazilian Educational System by the Guidelines and Bases of National Education (LDBEN) no. 5,692 (1971) and mandatorily by the LDBEN no. 9,394 (December 20th, 1996) which stated that High School was mandatory to all Brazilian citizens. Chemistry contents are extensive and systematic. In three years in High School, teachers have to teach several topics, such as basic

Chemistry concepts, methods of mixture separation, atomic structure, periodic classification of elements, chemical bonds, inorganic compounds, chemical reactions, chemical calculations, dispersions and solutions, Thermochemistry, chemical kinetics, Electrochemistry, radioactivity, Organic Chemistry, and organic compounds [9].

The NCP state that Chemistry learning in High School should enable students to understand chemical processes and the construction of scientific knowledge closely related to technological applications and its environmental, social and economic implications [24]. When Chemistry contents are taught together with other courses, such as Physics, Biology and Mathematics, and others from Human Sciences, such as Geography, Sociology and History, they not only promote correlations among everyday issues in the search for scientific literacy but also offer benefits in social, economic and environmental scopes, mainly when the approach Science, Technology, Society and Environment is addressed by teachers who have these objectives in their professional lives. Scientific literacy results from learning of terms, knowledge and expressions which are unknown to students and leads them to reflection and ordering of knowledge which is related to events experienced in their lives; thus, potential significance and re-significance of contents emerge in formal and informal teaching in the environment in which the society is inserted [25].

Some studies have shown that teaching methods propose that teachers should add all knowledge learned in their lives to their pedagogical practices. These experiences may be important to add and lay the foundations for the categories that affect the educational process, mainly, the exchange among actors, their work and their roles in this context [26]. Regarding Chemistry, issues related to teaching and learning have caused controversy between researchers and scholars whose studies focus on difficulties attributed to Chemistry teaching. It does not happen because the course is irrelevant, but due to the way in which it is shown by educators, whose pedagogical action is directed towards activities that introduce concepts, elements, numbers and formulas, distancing from students' reality and merely reaching results in large-scale evaluations. However, it should be pointed out that teaching concepts and basic categories is fundamental, but it must be connected to what is concrete and real [26].

Chemistry taught in High School must be understood as a Science whose construction of knowledge has been based on the comprehension and interpretation of phenomena related to properties of matter and compounds. From this perspective, the NCP recommend that its contents should address the tripod *chemical transformations, material and its properties and explanatory models*. There is no doubt about the fact that Chemistry is hard to learn since it requires students to make great intellectual effort [27]. Difficulties in learning may result from teachers' lack of teaching skills, from students' difficulties in interpreting facts and phenomena and from differences in knowledge (every individual has his/her own way of learning). Finally, significant learning means that new knowledge is connected to what was already learned. Chemistry learning is even more complicated because it requires that work should happen in both macroscopic (physical world) and microscopic (atoms and molecules) levels. Besides, a system of symbolic representations (formulas, equations, etc) and a new language are needed [27]. In short, teaching and learning Chemistry must be committed to making Science broadly and universally.

How could Chemistry teaching tied to old-fashioned methodologies – described at the beginning of Section 4 –

free itself? It should be highlighted that we are not looking for anyone to blame for inefficient Chemistry teaching, which is so far from the dream shown in teaching degree Chemistry programs in Brazil. However, researchers in chemical Education and High School teachers must gather elements to promote the development of effective teaching-learning processes in High School. Therefore, studies carried out in the field of chemical Education keep searching for and proposing solutions to find a method of liberation from the problem embedded in traditional and mechanical teaching. One of the papers selected by this study suggests that new Chemistry teachers should focus on proposals of active research from different perspectives, such as themes related to science, technology and society (STS) in the attempt to develop High School students' scientific skills and in-service programs for teachers to reach significant and updated learning [28].

Teacher Shortage in Basic Education in Brazil

Brazilian Education has gone through deep uncertainty, mainly after the COVID-19 pandemic. There has been impact on the whole educational system, from management of institutions to students' learning. In addition, it has been said that Brazil may have to face "teacher blackout" in the near future, i. e., the risk of having no teachers in all stages of Basic Education.

A study that was carried out in October 2022 showed that teacher shortage in all stages of Basic Education in Brazil may reach 235 thousand in 2040 [29]. Considering the current ratio of 20.3 people aged between 3 and 17 years old to every teacher in Basic Education, 1.97 million teachers will be needed in 2040. Based on the 2021 growth rate, the number of teachers will have decreased 20.7% by 2040, dropping to 1.74 million. Thus, the shortage will be 235 thousand teachers. The study also showed the process of teachers' aging in the last years, mainly the increase in the number of teachers who are about to retire. The number of young teachers who were beginning their careers (up to 24 years old) dropped 42.4% from 2009 to 2021, which means 116 thousand and 67 thousand, respectively [29]. The number of teachers who were 50 or over increased 109% in that period. The study revealed that teachers also stopped teaching due to lack of appropriate infrastructure in schools. In 2021, 3.8% of public schools had no restrooms, 5.8% had no potable water, 2.5% had no electric energy and 5.5% had no sewage system in Brazil. Another relevant issue of the study is teachers' health, since they suffer from physical and mental exhaustion, the main cause of absenteeism at the workplace. In 2021, about 47% of teachers classified their mental health into good or excellent, 34% of them complained about prolonged stress and 72% of them said that they have access neither to psychologists nor psychiatrists and that they are not encouraged to care for their mental health [29].

In short, the Special Commission that studied measures to overcome teacher shortage in High School (CNE/CEB) wrote a report whose title was "Teacher Shortage in High School: Structural and Emergency Proposals" [30]. The number of young adults interested in beginning the teaching career is gradually decreasing due to low wages, inappropriate teaching conditions, violence in schools and lack of in-service Teacher Education programs associated with an attractive career ladder. The emergence of the Fund of Maintenance and Development of Basic Education and Professional Appreciation of Educators (FUNDEB) will promote high demand for High School, which may increase, depending on its weight on the model of fund sharing [30]. Besides, the

number of retired teachers tends to outweigh the number of young graduates in the next years. In fact, since there has already been shortage of teachers in Exact Sciences courses, the conclusion is that the current situation of High School is serious and may get worse in the future. There is even the threat of a "High School teacher shortage" if emergency and structural measures are not taken. Therefore, the Basic Education Chamber of the National Council of Education has taken on the responsibility of diagnosing and making short- and medium-term recommendations to help mitigate the risk of the feared shortage. The CEB/CNE, together with the Ministry of Education and Culture (MEC), has aimed at controlling this educational problematic and at reaching approval of public policies that focus on this demand [30].

4. Conclusions

Results showed that most publications address issues related to teachers' identity and professionalization. These themes have been widely discussed. There have been discussions about different focuses, such as (1) educational research as a curriculum activity, (2) contribution of PIBID to development, identification and construction of knowledge needed for teachers' argumentation and (3) discourse appropriation in class. There are few studies of Chemistry teachers' educational development even though they are fundamental to better investigate issues related to the area and its pedagogical aspects. Current teachers and teachers-to-be must keep improving their investigation skills and self-criticism to improve their practices in class.

Important discrepancies between Chemistry teachers and the job market were also found. Teachers' lack of motivation and uneasiness, mainly regarding the job market in Higher Education (difficulties in becoming a federal or state professor) influence Basic Education seniors who choose not to attend teaching degree programs.

The teaching profession needs to be understood as complex learning which requires not only teaching contents but also several skills. Class experiences represent a factor that aggregated to pedagogical practices even though academic development also contributes to aggregate knowledge to teaching practices.

Finally, contemporaneous Chemistry teachers' work encompasses great challenges. Some steps and mismatches – a paradox – may be measured; in general, they are latent in both choices for attending teaching degree programs (or not) and adherence to the profession (or not). A lot of difficulties faced by teachers to keep working in Brazil were found. Some elements that surround this professional in the Education field are violence in school, shortage of didactic and pedagogical material, lack of acknowledgement in the civil society, shortage or inexistence of glassware and reagents in laboratories and low wages and/or salary paid in installments.

Author Contributions

M.L.D.M. outlined the whole research project, conducted the systematic literature review, wrote the manuscript and was in charge of the final review and submission to *Orbital: The Electronic Journal of Chemistry*.

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