Scientific Production on Early Chemistry Teacher Training Disclosed Through five Brazilian Journals (2012-2016)

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ABSTRACT

This study analyzed the scientific production on early chemistry teacher training as disclosed by Brazilian specialized science teaching journals during the period from 2012 to 2016. It is a descriptive, exploratory ascertainment from a mixed approach. From 927 articles consulted, 40 were selected. Besides the quantitative outlook of the published articles, the analysis considered the following aspects: author characterization (gender, geographic distribution, and institutional affiliation), subject/thematic, objective, methodology, individuals involved, and theoretical reference. The results revealed that most articles are signed by 2 or 3 authors. The number of authors totaled 100, the majority are female, concentrated more around the Southeastern and Southern regions of the country, and the main institutional affiliation is from the University of São Paulo (USP). It was also found that the recurring subjects were teacher discourse, problem-solving methodology, guided reflection, and reading competences. The predominant approach for researching was qualitative and the most widely used data collection instrument was the questionnaire. As to the theoretical references, authors Roseli Schnetzler, Otávio Maldaner and Maurice Tardif stand out. The ascertainment allowed learning about research that have already been carried out on the subject and thus project future research with the intent of broadening knowledge of the area.

Keywords: Science teaching, Chemistry teacher training, Brazilian Journals, Scientific production.

Produção Científica sobre Formação Inicial de Professores de Química Divulgada em Periódicos Brasileiros Especializados em Ensino de Ciências (2012-2016)

RESUMO

Este estudo analisou a produção científica sobre formação inicial de professores de Química divulgada em cinco periódicos brasileiros especializados em ensino de ciências durante o período de 2012 a 2016. Trata-se de um levantamento descritivo e exploratório cuja abordagem é mista.

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Dos 927 artigos consultados, 40 deles foram selecionados. Além do panorama quantitativo dos artigos publicados, a análise considerou os seguintes aspectos: caracterização dos autores (gênero, distribuição geográfica, filiação institucional), assunto/temática, objetivo, metodologia, sujeitos envolvidos e referencial teórico. Os resultados revelam que a maioria dos artigos é assinada por 2 ou 3 autores. Totalizaram 110 autores, sendo a maioria mulheres, concentrados mais nas regiões sudeste e sul do país. A maior filiação institucional é da Universidade de São Paulo (USP). Verificou-se ainda que os assuntos recorrentes foram: discurso docente, metodologia de resolução de problemas, reflexão orientada e competências leitoras. A abordagem predominante nas pesquisas foi a qualitativa, e o instrumento para coletar dados mais utilizado foi o questionário. Quanto aos referenciais teóricos utilizados, merecem destaque os autores Roseli Schnetzler, Otávio Maldaner e Maurice Tardif. O levantamento permitiu conhecer algumas pesquisas já realizadas sobre o assunto e assim projetar pesquisas futuras no intuito de ampliar o conhecimento da área.

Palavras-chave: Ensino de Ciências. Formação de Professores de Química. Periódicos Brasileiros. Produção Científica.

INTRODUCTION

One of the core subject areas in the discussions about the educational process is teacher training. This is because the work of those professionals, through motivation and mediation during the learning construction, is a determining factor to make the education act significant for students. Thus, investigating teacher training, especially the early stage (licentiate degree), is one way to comprehend how the construction of the professional profile of those who are mediators of the teaching and learning acts is established.

Teacher training is becoming a highly relevant research area, insofar as it is the teacher who will implement in the classroom the advances that are consolidated in research teaching and learning. Studies by Harres et al. (2012) reveal research advances in the sciences teaching area. The authors' attention was focused on early teacher training.

In the above-mentioned authors justification, one of the reasons to broaden studies in this area is that it is researcher teachers who train the professors at the Higher Education Institutions (HEI). This fact makes it indispensable to analyze the results of that training process through research.

On the other hand, this field of investigation contributes not only towards obtaining research advancements in the area, but also as a possibility of contributing towards the construction of teacher knowledge of future professionals during training. In this sense, investigating the early chemistry teacher training process becomes relevant, since it involves the qualification of the professionals required to meet society's demands.

Before that, however, it is necessary to learn about the scientific production on the theme with the intent of identifying characteristics of the studies carried out within a certain time frame on this subject that would allow to reveal thematic and methodological trends obtained from research, as well as the gaps on yet unexplored areas. According to Lüdke & André (2013), any research made requires the confrontation between the collected data and the accumulated theoretical knowledge about this subject. That is, before anything

else, it is necessary to investigate what is already known about the research object, which can be considered the starting point of a scientific study.

There have been previous studies similar to those proposed herein. The investigation by Papi & Martins (2010) discusses all the research carried out in the country about beginner teachers, more specifically, about the trends in the studies during that stage of the teachers' professional development stage. To do so, the papers presented at the 2005, 2006 and 2007 gatherings of the da National Post-Graduation and Research in Education Association (Associação Nacional de Pós-Graduação e Pesquisa em Educação – ANPEd), and others referent to 2000 to 2007, available from the theses and dissertations bank of the Coordination for Higher Education Personnel Enhancement (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES). The majority of the 14 identified works analyzed teacher identity construction. One of the most concerning finding in this study was the low number of Brazilian research dedicated to this subject.

In turn, Silva & Queiroz (2016) also carried out an ascertainment of research in the field of chemistry teacher training in Brazil. That research analyzed master's dissertations and doctorate theses presented between 2001 and 2010 held in the CAPES bank. This study investigated the following aspects: geographical region, post-graduation institution and program, schooling level, thematic focus, and type of academic paper.

The studies by Harres et al. (2012), in turn, focused on 5 (five) international journals to map out the scientific productions that describe the implementation of innovative curricular strategies to promote training students' (future teachers) knowledge evolution. The 18 articles published within the established time frame, i.e, from 1995 to 2005, analyzed the following characteristics: approach, data collection technique, individuals involved, duration, research context, and implemented training curricular approaches.

Considering the relevance of this teacher training stage and the need to investigate the chemistry licentiate graduates' professional constitution, some questions arose that served to direct this study: What is being produced about early chemistry teacher training in the country? Which are the most recurrent themes in those researches? Which investigation methodologies are most widely used? Which references were most widely used in the research published in Brazilian journals between 2012 and 2016?

The choice to investigate in journals was made due to the CAPES repository not having a defined time period for input, that is, it is at the discretion of the post-graduate programs to insert the productions developed in HEI, which would not produce recent data following the example of what occurred with Papi & Martins (2010), whose publication considering data from 4 previous years, and with Silva & Queiroz (2016), whose time frame was of 7 previous years.

On the other hand, such input is regular in journals, which provides more precise and updated data. Five journals were selected for this study, all of which specialize in sciences teaching and graded Qualis A1 or A2 in Teaching by CAPES. This option is justified since currency, pertinence, and relevance of the investigated works are basic requirements for a revision study.

This text is organized into four sections to facilitate reading. In the first section, some reflections were made upon the importance of investigating the early chemistry teacher training process. The second presents the methodological path employed to make this ascertainment of scientific production. In the third section, the data obtained are presented and discussed; and the fourth covers the final considerations and describes the lessons learned from this study.

METHODOLOGICAL PROCEDURES

This descriptive, exploratory ascertainment is of a mixed approach and utilizes document analysis to identify elements in the set of scientific articles encountered about early chemistry teacher training (Creswell, 2010). The chosen time frame was of the last five years, not including this current year, due to there not being all the published figures.

According to Teixeira & Megid Neto (2012), this type of study is recommended to ascertain the scientific production characteristics within a defined time frame, which allows to analyze the historical evolution of studies on a certain field of research, in addition to revealing thematic and methodological trends, main results obtained from the researches, gaps and unexplored areas on the theme sought to be investigated.

Journal selection adopted the following criteria: be a Brazilian medium that specializes in sciences education or teaching; be a free access electronic medium; be linked to some Sensu Stricto Post-Graduation Program or researcher society that is renown by the scientific community; be rated Qualis A in Teaching by CAPES; be a consolidated scientific medium with a minimum of 10 published volumes; and feature international indexers (Chart 1). It needs pointing out here that those criteria were adopted exclusively for journal selection and not as exclusion requirement, that is, it is possible that more journals exist that fit into those same characteristics, however, for the purpose of this investigation, it was decided to limit their number to five.

Chart 1: *Characteristics of the selected journals*

Name of Journal	Link	Number of Volumes	Qualis Teaching	International Indexers
Acta Scientiae (ULBRA) (ISSN: 1517-4492)	ULBRA PGP	19	A2	Google Scholar Journals for free Latindex and REDIB
Areté (ISSN: 1984-7505)	UEA PGP	10	A2	ERIH PLUS and Latindex
Ensaio: Pesquisa em Educação em Ciências (ISSN: 1983-2117)	UFMG PGP	19	A1	DOAJ, OEI, ROAD, Redalyc, SciELO,

Name of Journal	Link	Number of Volumes	Qualis Teaching	International Indexers
Investigações em Ensino de Ciências – IENCI (ISSN: 1518-8795)	UFRGS PGP	22	A2	DOAJ, EBSCO, IRESIE and Latindex
Revista Brasileira de Pesquisa em Educação em Ciências – RBPEC (ISSN: 1984-2686)	ABRAPEC	17	A2	OpenAIRE

Most chosen journals are of published every four months, i.e., each volume has three numbers published per year. The Acta Scientiae, Ensaio Magazines: Pesquisa em Educação em Ciências (Sciences Education Research), Investigações em Ensino de Ciências (Investigations in Sciences Teaching) and Revista Brasileira de Pesquisa em Educação em Ciências (Brazilian Magazine of Sciences Education Research) are published every four months. The only journal that is published every semester is Areté, however, since 2014 the journal has also been publishing a special number every year. One other journal that released special editions during that period was Acta Scientiae, which as from this year (2017) will be published every two months.

This investigation was carried out in two stages. There was an initial search, identification, gathering and grouping of the articles on the subject. Data collection started by consulting and selecting the articles from the Web sites of the selected journals, which are of free access.

The search was firstly made of the titles contained in the summary of each edition. The presence of a direct relation with the thematic of interest was verified (early chemistry teacher training). As a resource of this selection process, mainly in reference to studies with broad titles, e.g. "Teacher training in times of uncertainty", the abstracts and key words of the studies were also analyzed. The explored texts that did not relate to the thematic were discarded, and the scientific productions related to the area in question were selected by year of publication.

The second stage was the analysis of the texts. For such, the articles were read in their entirety. Some of the characteristics ascertained in this production: quantity of articles published yearly and by journal; number of authors per article; author gender; geographical distribution; institutional affiliation; subject areas covered; research approach type; data collection instruments; individuals involved; objective of research; most widely used references the article foundations.

Categorization took place by means of the earlier establishment of the characteristics of interest for the analysis, which have been mentioned above. The analysis methodology adopted for this stage was similar to that adopted by Silva & Queiroz (2016), which considered the interaction between the researcher and the investigated object as the starting point, since text analysis was made according to the researcher's understanding of the object examined.

The way the results were analyzed was by theme and frequency, since according to Bardin (2012), categories might be preset or emergent, according to researcher choice. Thus, the categories were the preset characteristics themselves and the sub-categories emerged from the data according to their frequency and their proximity to the object being studied.

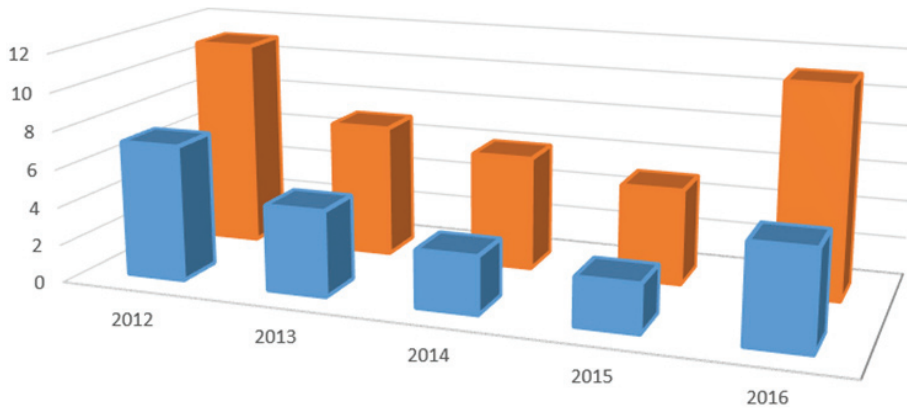
RESULTS AND DISCUSSIONS

In the first stage of the investigation a total of 927 (nine hundred and twenty-seven) articles published by the 5 (five) journals between 2012 and 2016 were consulted, with 40 (forty) articles being selected for approaching the study thematic. The quantitative distribution of articles can be seen in Table 1.

Table 1: *Quantity of articles consulted and selected*

	Number of articles published					Number of articles selected				
Period	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
Acta	28	35	46	54	56	3	4	0	0	2
Areté	16	20	42	49	66	2	1	2	0	1
Ensaio	44	36	33	35	26	1	1	1	0	4
IENCI	36	36	36	32	30	3	1	2	3	1
RBPEC	30	29	44	30	38	2	0	1	2	3
Total	**154**	**156**	**201**	**200**	**216**	**11**	**7**	**6**	**5**	**11**

It can be observed that the journal with most articles published on this thematic was IENCI with 10 (ten) texts, followed by Acta Scientiae (9), RBPEC (8), Ensaio (7), and Areté (6). The text distribution by year of publication can be seen in Graph 1.



Graph 1. List of articles selected by year of publication.

It was found that the years with the highest number of publications on the subject were 2012 and 2016, with 11 (eleven) articles each. However, when compared to the total number of articles consulted from that period, 2012 featured 7.14 % of its articles that discussed early chemistry teacher training and in 2016 that percentage was of 5.09 % of the total, it being the year with the highest quantity of published articles. In turn, 2015 was the year with the lowest number of publications about the investigated thematic.

From the analyzes sample, only 1 (one) of them was by an individual author; 18 (eighteen) articles are signed by 2 (two) authors; 15 (fifteen) of them were by 3 (three) authors; 4 (four) articles feature 4 (four) authors; and 2 (two), 6 (six) authors, with one of these articles with a high number of authors published in Areté and the other in IENCI.

There is a total of 110 (one hundred and ten) authors in these 40 (forty) articles, of which 73 (seventy-three) are female and 37 (thirty-seven), male. A predominance of women is observed, which represents 66.4% of the total number of authors. Another characteristic observed is that only 9 (nine) authors in this universe do not hold and have not entered Sensu Stricto training, at least up to the time the article was divulged, which shows that because the journals are qualified, they select a distinct group of authors who usually have theoretical enhancement in the area of the journal.

As to their geographic distribution, 45 (forty-five) authors are from the South-Eastern region of Brazil, 33 (thirty-three) from the South region, 12 (twelve) from the North, 8 (eight) from the North East, and 3 (three) are from the Mid-West region of the Country. It should be mentioned that the remaining 9 (nine) authors reside in other countries in Europe and South America. From this data, it is possible to associate the low number of authors from the Mid-West and North regions of Brazil to the fact that those are the ones that actually offer the lowest number of Post-Graduation Programs (Matos & Gonçalves, 2014), and with less doctors qualified to train, a lower number of post-graduates attended, and consequently less research is developed and lower will scientific productions published.

Studies by Silva & Queiroz (2016) also revealed that the South-East region is the most productive on teacher training in the country and corroborate this finding of a low amount of research in the Mid-West and North regions. However, according to the authors, the North East region stands second in the development of research on the thematic followed by the South region.

Regarding the authors' affiliated institutions, USP is the institution that features 16 (sixteen) authors. There are 7 (seven) authors linked to the Amazonas State University (UEA), 6 (six) to the Londrina State University (UEL), with the same number being linked to the Minas Gerais (UFMG) and Santa Catarina State Universities (UFSC), 5 (five) authors linked to the Juiz de Fora (UFJF) and Lavras State Universities (UFL) and 4 (four) linked to the Federal University of Rio Grande do Sul (UFRGS), Júlio de Mesquita Filho São Paulo State University (UNESP) and Maringá State University (UEM). It can be perceived that, although the North region features few authors, most of them are linked to the UEA, which is actually the institution in charge of Areté. USP

was also the HEI with the highest number of Brazilian researchers in the investigation by Silva & Queiroz (2016).

It was also found that 9 (nine) authors are from other nationalities, of which 3 (three) are linked to the Universidad de Granada, 1 (one) is linked to the Universidad Autónoma de Madrid,and the same number to the Universidad de Burgos, Universidad de Huelva and Universidade Pontifícia de Salamanca (both Spanish institutions), Universidad de Antioquia, from Colombia and the Universidad Pedagógica Experimental Libertador from Caracas, Venezuela. It is likely that the presence of international members takes place preferably through a research partnership and broadening the reach of those media, and that the thematic is also important within international education and research contexts.

The most recurring focuses in those articles' discussions were: Teacher Argumentation/Discourse (4 times), Problem Solving Methodology (3), Reflection/ Guided Activity (3), Reading Competences (3), Science, Technology and Society – STS (2), Writing Skills (2), Student Perception About Teaching (2) Student Conception of Chemical Concepts (2). Subject areas such as curriculum, theoretical review on DE, teacher knowledge, and teacher training research mapping were the focus of only one research on each subject.

Some gaps that were observed regarding the discussed subject areas is that none of the studies covered the curricular framework of chemistry licentiate degree courses, nor the potentials and limitations of studying in the DE modality, not to mention the offering of courses through this modality.

The descriptors used for the articles selected totaled 133 (one hundred and thirty three) key words: The most frequent ones were: teacher training (16 times), chemistry (7), chemistry learning (5), chemistry teaching (5), faculty training (4), professors (4), sciences teaching (3), early training (3), writing (3), and supervised internship (3).

Less frequently used, but also worth highlighting, is the use of the following key words: licentiate degree in chemistry (2 times), chemistry curriculum (2), pedagogical practice (2), interdisciplinarity (2), student profile (2), communication (2), discursive interaction (2), discourse (2), reading (2), scientific language (2), and teacher knowledge (2). The other descriptors were used once.

It can be perceived that the key word trend revealed follows along the line of the studies' subject areas. It was expected that the terms teacher training, faculty, early and chemistry would be widely used, however, the descriptors worth highlighting are chemistry learning, supervised internship, writing, reading and discourse, as they reveal the most recurring subjects in these researches.

The approach employed in the researches, the data collection techniques, and the public involved (research individuals), the results are shown in Chart 2.

Chart 2: *Research methodological characteristics*

Study	Approach	Collection technique	Individuals involved
Maziero & Carvalho (2012)	Qualitative	Structured interview	5 supervised internship supervisors
Del Pino (2012)	Qualitative	Semi-structured interview and document analysis	4 trainer teachers
García et al. (2012)	Quantitative	Questionnaire with Conditional Probability Ratio	196 licentiate undergraduates
Barros et al. (2012)	Qualitative	Questionnaire	17 students enrolled in Analytical Chemistry
Barbosa, Peixoto & Maia (2012)	Qualitative	Bibliographical research, participant observation and life stories	64 professors from the Pedagogy, Biology, Physics, Masubject areas and Chemistry courses
Mesquita & Soares (2012)	Qualitative	Discursive Textual Analysis of 8 Chemistry Licentiate Degrees CPPs in Goiás	Not applicable
Zanon, Rames & Sangiogo (2012)	Qualitative	Audio records followed by the individuals' speech transcription.	3 groups on research individuals in licentiate degree classes (number not informed)
Gonçalves & Marques (2012)	Qualitative	Semi-structured interviews	10 professors
Pereira & Benite (2012)	Qualitative	Discursive interactions form the participant individuals recorded on the Web	5 trainer teachers, 4 post-graduation students, 4 graduation and 12 Basic Education teachers
Ferreira & Queiroz (2012)	Qualitative	Questionnaires: on early impressions of reading and on the activity carried out	2 classes: one with 24 students and the other with 21 students.
Espimpolo, Iamamoto & Abreu (2012)	Qualitative	Videos of the 2nd module development covering the realization of experiments	18 students enrolled in the 3rd semester of the Chemistry Licentiate Degree course
Broietti et al. (2013)	Mixed	Questionnaire	15 students from the chemistry licentiate degree course
Christino & Ferreira (2013)	Qualitative	Semi-structured interviews	Interns and new teachers (number not informed)
Kuhn & Bayer (2013)	Qualitative	Bibliographical Research	Not applicable
Nacarato, Grando & Mascia (2013)	Qualitative	Reflexive records, interviews, statements and meeting transcriptions	Not declared
Anastacio & Barros (2013)	Qualitative	Bibliographical Research	Not applicable
Marques et al. (2013)	Qualitative	Bibliographical research, participant observation and pedagogical intervention	18 students from the 9th Year of Elementary Education

Study	Approach	Collection technique	Individuals involved
Neto, Campos & Marcelino Júnior (2013)	Mixed	Questionnaire, field observation and semi-structured interview	100 students from the Chemistry Licentiate Degree Course
Figueiredo & Rodrigues (2014)	Qualitative	Open question questionnaire	11 licentiate undergraduates from the course 4th period
Klepka, Leite & Franco (2014)	Qualitative	Structured questionnaire	10 licentiate undergraduates, 6 Chemistry and 4 Biology from 2 universities in North Paraná.
Lopes & Silva Junior (2014)	Qualitative	Questionnaire and individual semi-structured interview	12 licentiate undergraduates from the 2nd semester
Goi & Santos (2014)	Qualitative	Review of literature	Not applicable
Castaño, Andrés & Villagrá (2014)	Qualitative	Bibliographic research and Structured interviews	4 future teachers
Massi & Villani (2014)	Quantitative	Socioeconomic questionnaire of VUNESP students	355 students enrolled in the Chemistry bachelors and licentiate degree course (indirectly)
Suart, et al. (2015)	Qualitative	Analysis of two didactic sequences	Not applicable
Miranda, Rezende & Lisbôa (2015)	Qualitative	Open question questionnaire	44 new and 27 graduating students from a Chemistry Licentiate Degree course
Massi & Villani (2015)	Qualitative	Document analysis and individual interviews	8 first generation teachers, 6 second generation and 1 employee in charge of academic administration
Lima, Pagan & Sussuchi (2015)	Qualitative	Document analysis and semi-structured interview	5 chemistry teachers
Quadros, et al. (2015)	Qualitative	Videos with interns' discourse appropriation	3 teacher/interns (indirectly)
Souza, Broietti & Passos (2016)	Qualitative	Open question questionnaire	27 Chemistry Graduation and 8 Specialization students
Cantionílio, Marcelino & Rodrigues Junior (2016)	Qualitative	Forum and questionnaire	12 participants (3 in early chemistry training and 9 teachers working in Intermediate Education)
Lorencini Júnior, et al. (2016)	Qualitative	Questionnaire	14 students from a chemistry licentiate degree course
Martins, Ibraim & Mendonça (2016)	Qualitative	Semi-structured interviews about two problems	5 teachers in training

Study	Approach	Collection technique	Individuals involved
Wenzel, Maldaner (2016)	Qualitative	Text production, registering in notebook and observations	59 Sciences licentiate degree students
Fernandes, Marques & Delizoicov (2016)	Qualitative	Bibliographical Research	Not applicable
Cabral & Flôr (2016)	Qualitative	Statements produced by students and school and discussions during gatherings observations	5 students enrolled in the Supervised Internship discipline
Silva & Queiroz (2016)	Qualitative	Bibliographical Research	Not applicable
Massena & Siqueira (2016)	Qualitative	Questionnaire with three open questions	17 PIBID scholarship holders at UESC (9 in Physics and 8 in Chemistry)
Oliveira & Queiroz (2016)	Qualitative	Participant observation followed by a projective interview	One collaborator – future Chemistry teacher
Lourenço, Abib & Murillo (2016)	Qualitative	Questionnaire, conceptual map, blog posting, report, interview	6 students from the Chemistry Licentiate Degree Course

It can be observed that the prevailing research approach is qualitative with 36 (thirty-six) studies, corresponding to 90% of the investigated production. The quantitative approach was employed in just 2 (two) researches, that is, 5% of the total. One of them actually defined that the study used the conditional probability ratio magnitude. The mixed approach was chosen by another 2 (two) studies, that is, 5% of the investigated production.

According to Lüdke & André (2013), this type of approach is indicated for those who intend to carry out research in the human sciences area, such as investigating the early chemistry teacher training. According to the authors, qualitative research has been gaining ground and recognition amongst scientists, especially in the last decades.

This result seems to be related to the fact of the subjectivity, singularity and specificity that are involved in the training process of the chemistry licentiate degree courses. However, it is interesting to consider that a mixed approach allows for the use of numbers to sustain subjective interpretations of the text data and vice-versa, providing the research with further support and trust, especially when discussing educational aspects. Silva & Queiroz (2016) reached the same finding and advocate the combination of quantitative data with those originated from qualitative methodologies to favor the comprehension of the object selected for studying.

As to the data collection techniques, it can be observed that questionnaires prevail, being the instrument used in 19 (nineteen) studies, corresponding to almost half (47.5%) of the analysis body. 13 (thirteen) researches used interviews as the instrument (32.5%),

with 7 (seven) being semi-structured, 2 (two) structured and the remaining 4 (four) did not declare the type of interview.

Bibliographical research was the technique employed by 7 (seven) studies, corresponding to 17.5% of the total. The observation technique was employed in 6 (six) researches, with 3 (three) declaring as participants It can be observed that forms were not used as data collection instruments by any of the investigated reports.

As to the individuals involved category, it can be perceived that 21 (twenty-one) researches involved students in training (licentiate undergraduates) as research individuals, corresponding to 5.2%. Another 7 (seven) studies featured as research individuals the professors (17.5%), with 4 (four) of them involving trainer teachers. The results show that over half of the investigations employed students in training as sources of information.

Another characteristic that can be observed is that few researches evaluate as individuals the trainer teachers, not did any study involve the graduates from the related licentiate degree courses. Henceforth, the more sources of information involved in the process are consulted, the more effective will the research be, that is, the more complete will be the study in which trainer teacher and course graduate perceptions on the early chemistry teacher training process are considered

By comparing studies by Harres et al. (2012), is can be observed that the most widely used approach in researches involving early teacher training is the qualitative. From the 18 (eighteen) articles investigated by the authors, 14 (fourteen) employed this type of approach. But the most widely used data collection method in these international articles they investigated was the interview. As to the individuals involved in the research, it is not possible to compare, since the authors chose as a selection requirement that the researches involve students in training.

The data referent to the object of study and the theoretical references about teacher training that were most used in these analyzed researches are shown in Chart 3.

Chart 3. *Theoretical references and general objectives of the studies*

Study	Objective	Main references
Maziero & Carvalho (2012)	Identify the contributions offered by the internship supervisor towards the future teachers' training process.	Carvalho (1985); Pimenta & Lima (2004).
Del Pino (2012)	Bring to evidence teacher perceptions on the selection and integration of knowledge in general chemistry from their pedagogical process in their teaching reality,	Cachapuz (2001); Nóvoa (1992); Schnetzler (2002); Schön (2000); Shulman (1986);
García et al. (2012)	Evaluate among the future teachers the possible presence of any preconceptions in competence for problem solving, known and the time axis fallacy.	Díaz (2007); Contreras (2011) Azcárate (1996)

Study	Objective	Main references
Barros et al. (2012)	Problematize by means of scientific texts the characteristics of the scientific language aimed at enhancing the reading capacity of that type of texts by chemistry graduation students.	Oliveira & Queiróz (2007); Silva (2009); Teixeira Júnior & Silva (2007)
Barbosa, Peixoto & Maia (2012)	Discuss intrapersonal, interpersonal communication in educational practices of university professors that contribute towards making student learning difficult.	Bastos & Nardi (2008); Contreras (1997); Pimenta & Ghedin (2008). Tardif (2000)
Mesquita & Soares (2012)	Identify how interdisciplinarity is characterized in the CPPs and whether those documents present the enabling of interdisciplinary character training for future teachers.	Fazenda (2001); Mello (2001) Silva & Schnetzler (2008); Veiga (2004)
Zanon, Rames & Sangiogo (2012)	Analyze the interaction of undergraduates, intermediate education teachers and the university in a training space for Sciences teaching focused on problematizing interdisciplinary approaches.	Gauthier et al. (1998); Maldaner & Zanon (2004); Santos & Schnetzler (1997); Schön (1987)
Gonçalves & Marques (2012)	Analyze the discourse appropriation process surrounding “experimentation in teaching” Chemistry teacher trainers working in curricular components of a specific content.	Gonçalves, Marques & Delizoicov (2007); Pimenta & Lima (2004); Silva & Schnetzler (2005)
Pereira & Benite (2012)	Analyze the discursive interactions produced within a social network about Special/Inclusive Education.	Benite et al. (2008); Galiazzi et al. (2007); Gatti (2005); Zanon & Schnetzler (2001)
Ferreira & Queiroz (2012)	Verify whether the questions made by the undergraduates, as produced discourses, provide signs of dislocations of an authoritarian pedagogical discourse towards a polemic discourse.	Santos & Queiroz (2007); Silva & Almeida (2005); Schwartz (2002)
Espimpolo, Iamamoto & Abreu (2012)	Discuss the signs surrounding the knowledge apprehension process within the context of the Qualitative Analytical Chemistry discipline.	Alvim & Andrade (2006); Duarte (2004); Gadotti (2006); Moura (2010)
Broietti et al. (2013)	Comprehend the meanings of the expression “dislocate the balance”, related to systems in chemical equilibrium, for undergraduates of the Chemistry Licentiate Degree course.	Gomes et al. (2010); López & Escalona, (2009); Quílez-Pardo (2006); Teixeira Junior & Silva, (2009);
Christino & Ferreira (2013)	Analyze how interns and new Chemistry teachers at a public school in Pelotas are constituted as basic education teachers.	Foucault (2012); Lopes (2005); Tardif (2000)
Kuhn & Bayer (2013)	Link up the teacher training themes with principles of sustainability, responsibility, hope, and moral, ethical training.	Biduco (2003); Perrenoud (2002); Zabala (1998)
Nacarato, Grando & Mascia (2013)	Analyze the training processes that occurred in the partnership between the University and the public school in Itatiba/SP, about its potentials and limitations.	Camargo (2007); Farias (2008); Kleiman (1995)

Study	Objective	Main references
Anastacio & Barros (2013)	Discuss about the possibilities offered by the distance Pedagogy Course, covering the theme of the real and the virtual within this context.	Biduco (2010); Brasil (1996); Granger (1995);
Marques et al. (2013)	Understand how interdisciplinary practices Portuguese, Masubject areas and Sciences may contribute towards the development of reading and writing competences of Elementary Education students.	Anastasiou (2012); Fazenda (2008); Passos (2008); Silva & Rêgo (2006), Skovsmose (2008)
Simões Neto, Campos & Marcelino Júnior (2013)	Investigate isomerism comprehension of future chemistry teachers at the start of their training and the construction of the knowledge of isomerism following an approach centered around problem situations	Kurbanoglu (2006); Schimdt (1992); Silva & Núñez (2002)
Figueiredo & Rodrigues (2014)	Inbestigate whether the Chemistry Licentiate Degree course at a Public State University in Paraná provides the theoretical foundation instructed by the STSE perspective.	Galiazzi (2003); Santos & Schnetzler (2010); Santos & Mortimer (2001);
Klepka, Leite & Franco (2014)	Investigate the understanding of undergraduates of the representations involving time and what are the relations established in sciences teaching	Bergson (2006); Moscovici (2003)
Lopes & Silva Junior (2014)	Verify whether new Chemistry Licentiate Degree course students feature the conceptions that are characteristic of spontaneous faculty thinking	Carvalho & Gil-Pérez (2011); Maldaner (2006); Santos Junior & Marcondes (2010); Tardif (2012)
Goi & Santos (2014)	Identify how the research carried out approach the epistemological, cognitive and pedagogical aspects of problem solving in training teachers for Basic Education.	Carvalho & Gil-Pérez (2009); Goi & Santos (2009); Schnetzler (2002); Tardif (2002)
Castaño, Andrés & Villagrá (2014)	Value the theoretical relevance of Conceptual Fields in sciences teacher training.	Pérez (1998); Vergnaud (1996); Vergnaud (2008)
Massi & Villani (2014)	Analyze statistically student profiles of the Chemistry bachelor and licentiate degree courses at UNESP/Araraquara.	Bourdieu (2009); Nogueira & Nogueira (2009); Schneider, et al. (2008)
Suart, et al. (2015)	Analyze the evolution and relation of investigative levels in four teaching proposals elaborated by two licentiate undergraduates from a guided reflection process.	Lorenzetti & Delizoicov (2001); Maldaner (2006); Sasseron & Carvalho (2008);
Miranda, Rezende & Lisbôa (2015)	Investigate the representations of new and graduating students in Chemistry Licentiate Degree about being a chemistry teacher.	Carvalho & Gil-Pérez (2009); Maldaner (2006); Neto, Queiroz & Zanon (2009); Tardif & Gauthier (2001)
Massi & Villani (2015)	Analyze the relations between the official curriculum and the effective training of licentiate undergraduates of the Chemistry Licentiate Degree Course at UNESP in Arararaquara.	Camargo (2007); Goodson (1995); Massi & Villani (2014);

Study	Objective	Main references
Lima, Pagan & Sussuchi (2015)	Investigate some limits and possibilities to train reflexive/researcher teachers at a Chemistry licentiate degree course in the northeast region of Brazil.	Maldaner (2006); Nóvoa (1997); Santos & Schnetzler (2005); Tardif (2010)
Quadros, et al. (2015)	Analyze the role of discourse in classroom and its contribution towards the construction of meaning.	Mortimer & Scott (2003); Santos & Schnetzler (2003); Scott, Mortimer & Aguiar (2006)
Souza, Broietti & Passos (2016)	Identify and discuss the perceptions of licentiate undergraduates and students from a Chemistry specialization course about Teaching and Learning	Carvalho & Gil-Pérez (2006); Garrido & Carvalho (1999); Maldaner & Zanon (2004); Zanon (2010);
Cantionílio, Marcelino & Rodrigues Junior (2016)	Investigate the conceptions of teachers in early and continuous training about the relevance and feasibility of the case study method.	Carvalho (2010); Delizoicov, Angotti & Pernambuco (2007); Sá (2007); Sá & Queiroz (2010)
Lorencini Júnior, et al. (2016)	Discuss the implications of a didactic unit under the STSE (Science, Technology, Society and Environment) perspective developed by students from a Chemistry licentiate degree course.	Maldaner (2006); Santos & Schnetzler (1997); Santos & Mortimer (1999); Schnetzler (2002)
Martins, Ibraim & Mendonça (2016)	Utilize Walton's 60 Argumentative Schemes to analyze the arguments of chemistry teachers in early training who were interviewed about problems of a scientific nature and discuss those analyses in the light of the contemporary literature.	Sasseron & Carvalho (2011); Walton (2001, 2002, 2006, 2009, 2014)
Wenzel, Maldaner (2016)	Provide students with from Sciences licentiate degree course with the use and meaning of the chemical language through writing and rewriting in a qualified instruction process.	Bakhtin (2001); Fontana (2005); Wenzel & Maldaner (2014)
Fernandes, Marques & Delizoicov (2016)	Favor reflections of a theoretical-methodological order about contextualized practices in early teacher training and in science teaching from Paulo Freire's educational perspective based on his work Extension or Communication?	Delizoicov (1983, 2008); Freire (1977; 2005; 2006); Santos (2007, 2008); Santos & Schnetzler (1997)
Cabral & Flôr (2016)	(Re)think technical report writing practices that commonly take place in the Internship discipline and present the writing activity and the elaboration of a report logbook by Chemistry Licentiate Degree students from UFJF.	Gonçalves (2008); Gonçalves & Fernandes (2010); Pimenta (2012); Pimenta & Lima (2012); Silva & Schnetzler (2008)
Silva & Queiroz (2016)	Analyze dissertations and theses presented in the country about Chemistry teacher training together with the PGP linked to CAPES areas 46, 38 e 4 between 2001 and 2010.	Almeida (2006); Gonçalves (2009); Lima (2003) and several others
Massena & Siqueira (2016)	Evaluate the contributions the PIBID has brought about towards early Sciences teacher training who will work in Basic Education	Delizoicov, Angotti & Pernambuco (2002); Maldaner (1999, 2007); Maldaner & Zanon (2001)

Study	Objective	Main references
Oliveira & Queiroz (2016)	Investigate the threads that comprise training of a teacher as an intellectual transformer.	Gauthier (1998); Nóvoa (1992); Pimenta (2012); Schön (1987); Shulman (1986, 1987); Tardif (2007)
Lourenço, Abib & Murillo (2016)	Identify knowledge of teacher argumentation that have been mobilized of developed during the reflexive instances related to the supervised internship of a discipline from a Chemistry Licentiate Degree course at a Brazilian public university.	Maldaner (2000); Sá & Queiroz (2009); Schön (2000); Tardif (2010)

According to the data shown in Chart 3, it is possible to ascertain that the prevailing objective in 11 (eleven) of the selected researches, about 27.5%, was to analyze the interactions between the licentiate degree course individuals or the relations of those players with the early training process received.

In 6 (six), or 15% of the researches, the main objective related to the construction of knowledge, skills and competences that are desirable for chemistry teachers. The intent to identify characteristics of some elements, such as communication, pieces of knowledge, discourses, interdisciplinarity, that are present in teacher formation was identified as the objective in 5 (five) researches (12.5% of the total).

The concerns in those researches are very similar to the studies investigated by Papi & Martins (2010) and developed by Brazilian researchers about the training process of new teachers. According to the authors, the researches aimed towards the constituting processes of early practice in teaching, teacher knowledge, the construction of their identities and the difficulties and dilemmas found along that path.

It is worth pointing out the evidence of Brazilian authors as references, studies of researcher Roseli Pacheco Schnetzler were mentioned in 14 (fourteen) different studies, usually signed in co-authorship, highlighting the article mentioned in 4 (four) researches titled "Conceptions and actions of Chemistry teacher trainers about the supervised internship: Brazilian and Portuguese proposals", signed with researcher Rejane Maria Gomes da Silva.

Researcher Otávio Aloísio Maldaner was used as reference in 12 (twelve) articles analyzed, with the most widely used work (6 times) being the book "Early and continuous Chemistry teacher training". Productions by Anna Maria Pessoa de Carvalho are cited in 9 (nine) articles, 4 (four) of which make reference to the book "Science teacher training", signed in conjunction with researcher Daniel Gil-Pérez.

6 (six) articles cited studies by Selma Garrido Pimenta, with the book "Internship and Faculty", of shared authorship with researcher Maria Socorro Lucena Lima, being the most widely used in 3 (three) publications analyzed. Studies by Demétrio Delizoicov were cited in 6 (six) articles, all of them with different titles.

These data reveal that Brazilian researchers' works are the most consulted and used as reference in this study. This could be harnessed also to the fact that the reading of renowned authors, most being from other nationalities, features a large portion of writings published only in their native language.

However, highlighting Harres et al.'s (2012) statement about the need to understand other languages, especially in regards to researchers under Sensu Stricto training, as it is essential to have knowledge of both Brazilian and international works.

Some international authors were also taken as references for the development of the analyzed researches. The work "Faculty knowledge and professional training" by Maurice Tardif served as reference for 8 (eight) os those studies. Donald Schön's writings were used in 4 (four) articles, 2 (two) of which mention the book "Educating reflexive professionals: a new design for teaching and learning" and 2 (two) others the chapter "Training teachers as reflexive professionals".

The book "Teachers and their training", by the Portuguese author António Nóvoa was cited in 3 (three) studies, as was Clermont Gauthier and his work "For a Theory of Pedagogy: contemporary research about faculty knowledge". 2 (two) articles employed as reference studies by Lee Shulman, "Those who understand: knowledge growth in teaching".

The review of the literature presented in this study allowed ascertaining characteristics of the existing scientific production about this certain field of research as well as its main references. These most widely used authors in the investigated productions may serve as research sources and theoretical support in future studies about the subject.

Furthermore, the study allowed ascertaining important aspects about this scientific production as advocated by Teixeira & Megid Neto (2012). The context within which the research was developed has been characterized, the frequency with which those studies occur – albeit within the time frame that was established – the thematic and methodological trends employed, as well as the gaps in this field of research, that is, it was possible to find which aspects still need exploring about early chemistry teacher training.

FINAL CONSIDERATIONS

This study is of a bibliographical character and of the state-of-the-art type that proposes to map and discuss the scientific production about early chemistry teacher training that was published in the last five years in Brazilian journals that specialize in sciences teaching. Among the 927 (nine hundred and twenty seven) articles published in the selected journals within that period, the study analyzed 40 (forty), which were those that covered the established subject.

Regarding the frequency in which those productions occurred, it was possible to ascertain that 2012 and 2016 were the most productive years on the subject, totaling 11 (eleven) articles in each year. The journal with the most publications on this thematic was

IENCI with 10 (ten) published texts, but there is a considerable quantity of productions about the subject in the other journals, with all of them publishing 6 (six) texts or more within that period, which shows that the amount of research on this subject is on the rise.

The analysis of this scientific production revealed that the articles are signed by 2 (two) or 3 (three) authors, most of whom have links to post-graduation programs, which provides a certain support to those publications. In total, there were 110 authors signing the articles, 9 (nine) of which are foreign nationals and among the remaining, their highest concentration is in the South East and South regions of Brazil.

As to the thematic trends in those productions, the highlights were argumentation and faculty discourse, problem-solving methodology, guided reflection and reading competences, as they were the most widely debated subject areas in the studies about early chemistry teacher training. Some subject areas were not approached, such as the curricular framework of chemistry licentiate degree courses, the potentials and limitations of studying through the DE modality, or even about the offering of courses in this area in the country. These gaps indicate likely subject areas for future research.

As to the methodological trends ascertained in the investigated articles, a prevalence of the qualitative approach is perceived, with the questionnaire being the most widely used instrument to collect data and students in training being the most widely consulted sources. One of the objectives that was most aimed at in these studies was to analyze the interactions between the individuals in the licentiate degree courses or of those players with the early training received.

However, it is recommended that future research in this area consider the many possibilities, e.g., the mixed approach that provides the opportunity to comprehend the object according to more than one aspect that is not restricted to either numerical or subjective data, as well as the need to consider all the players in this training process, such as trainer teachers, for example.

Regarding the theoretical trends contained in the investigated articles, the most widely used authors for references were Brazilian authors Roseli Pacheco Schnetzler and Otávio Aloísio Maldaner, and Canadian researcher Maurice Tardif. Due to the frequency they were used, those authors are recommended sources of consultation for future papers, that is, those renowned authors may serve as a basis for other studies.

In conclusion, the analyze this article provided about scientific production on early chemistry teacher training served to reveal thematic, methodological and theoretical trends on the subject, as well as allowing to identify possible gaps that are yet to be explored about this area of investigation.

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