

Articulations of a teaching degree in chemistry and school education and their repercussions on pre-service education

ABSTRACT

Nowadays, the teaching degrees in Chemistry are trying to overcome incipient pre-service education models (pedagogical complementation, short-term degree, etc.) that have failed to adequately respond to the educational demands that involve teaching. Based on this reality, the teaching degree in Chemistry at Faculdade de Filosofia Dom Aureliano Matos, offered by the Universidade Estadual do Ceará has graduated teachers since 2007. This article¹ aims to describe a case study focused on the articulations of this teaching degree with the teaching of science/chemistry in basic education, as well as its repercussions on the professional development of its graduates. The official documents that represent and that regulate teacher education in Brazil were submitted to documental research to capture, interpret and characterize the articulations and repercussions through textual discourse analysis. Among many, the following were highlighted: effective promotion of teaching in Science/Chemistry; the offer of extensive pre-service education in this field; preparation and qualification for professional activity, especially in teaching. The official prescription of the course elevates it to the level of pre-service education for teaching. Nonetheless, further analyses are required to verify the convergence between the precepts and the reality experienced in pre-service education, considering the information available in the academic community.

KEYWORDS: Teacher Education. Curriculum. Professional qualification. Teaching Science/Chemistry.²

Francisco Ranulfo Freitas Martins
Júnior
ranulfo.freitas@uece.br
orcid.org/0000-0003-1031-8066
Universidade Estadual do Ceará (UECE),
Fortaleza, Ceará, Brasil

Eloisa Maia Vidal
eloisamvidal@yahoo.com.br
orcid.org/0000-0003-0535-7394
Universidade Estadual do Ceará (UECE),
Fortaleza, Ceará, Brasil

INTRODUCTION

After the enactment of the Law of Guidelines and Bases for the National Education [Lei de Diretrizes e Bases da Educação Nacional, LDBEN nº 9.394/96], teachers pre-service education for the school system was ascribed mostly to higher education institutions, which offer teaching degrees (undergraduate courses). Since the first decade in the 21st century, teachers pre-service education has been oriented by the National Curricular Guidelines [Diretrizes Curriculares Nacionais], heretofore DCN, (BRASIL, 2002a) elaborated by the National Council of Education [Conselho Nacional de Educação, CNE], which also specify norms for the duration and academic load for all teaching degrees (BRASIL, 2002b). The DCN were in effect until 2015, when new guidelines for teachers pre-service education were published.

In these fifteen years (2000-2015), the teaching degrees organized their pedagogical projects to offer teacher education on the grounds of the most recent DCN as well as on specific guidelines, in accordance with demands from their respective fields of knowledge. In the case of Chemistry, a single official document presents the guidelines for both the bachelor and the teaching degrees (BRASIL, 2001). The teaching degree in Chemistry complied, during those fifteen years, with the 19 articles that structured the program for teacher pre-service education (BRASIL, 2002a) and the specific norms for pre-service education for chemistry teachers, for instance, the undergraduate professional description, its competencies and abilities, general structure of the course, and the curricular content outlined for the area specific guidelines (BRASIL, 2001).

The degree has been configured to prepare undergraduate students to teach, trying to systematize teacher education. In this context, despite the efforts to provide an adequate pre-service education, several researches have verified that such education still privileges specific knowledge over the pedagogical knowledge, denying the importance of the Science/Chemistry teacher compared to occupations such as the bachelor in Chemistry and the Industrial Chemists. This jeopardizes the quality of education offered to school students.

Created in 2004, and under impact of the DCN, the teaching degree in Chemistry at Faculdade de Filosofia Dom Aureliano Matos (FAFIDAM), a unit of Universidade Estadual do Ceará (UECE), located in the countryside of Ceará, Brazil, since 2007, has graduated teachers to work at schools, mainly, in the surrounding regions. To investigate this particular reality, considering the context of Brazilian education, the aim of this article is to describe the articulations of that teaching degree and Sciences/Chemistry teaching at schools as well as their repercussions on the professional education of its undergraduate students. This article is an excerpt of the doctoral research developed for the Post-Graduation Program in Education at UECE (2018 – 2022), which exposes significant descriptions of that professional education over a decade (2004 – 2014).

To verify whether the degree abides by the curricular guidelines in terms of prescription to qualify and capacitate pre-service teachers, the two pedagogical projects of the course (PPC – 2001 and 2014) were analyzed through documentary research, since they are official documents that represent the degree in terms of organization, structure, development and educational principles. The

documentary research was supported by discursive textual analysis (DTA), particularly due to its constitutive steps for qualitative investigations in the Natural Sciences (PEDRUZZI et al., 2015; MORAES; GALIAZZI, 2016; GALIAZZI; LIMA; RAMOS, 2020; MESQUITA, 2020). In addition to detailing the method, this article exposes the curricular assumptions on pre-service education for Chemistry teachers, the organization of the pre-service education for the teaching degree in Chemistry as well as reflections on the education offered to undergraduates of that degree.

LEGAL PRESCRIPTIONS FOR PRE-SERVICE EDUCATION OF CHEMISTRY TEACHERS

The Brazilian Federal Constitution of 1988 cites public funding for education workers (art. 60) and ensures the free offer of basic education (art. 208) (BRASIL, 1988), nonetheless, the document makes no mention of pre-service education. This civil legal hallmark influenced the elaboration and institution of the current LDBEN which, in regard to the specific guidelines for this education, proposes: Art. 61) association between theory and practice; Art. 62) educational models, above all teaching degrees; Art. 63) educational programs; Art. 64) education of different workers; Art. 65) teaching practices.

Several regulations of pre-service education for teachers have been produced based on the LDBEN, including the extinction of educational models in effect due to previous legislations (BRASIL, 1999). Therefore, various curricular propositions with educational initiatives in different fields of knowledge emerged in Brazil, answering to organizational and curricular demands of teaching degrees. Regarding the state of Ceará, Martins Júnior and Vidal (2021) point out that in the transition from the short-term teaching degree in Sciences to the full teaching degree in Chemistry, due to that new legal device, the cartography of that pre-service degree at UECE changed either to amplify the offer for that new degree or to enable new offers at different university units located in the countryside of Ceará.

The DCN for teaching degrees propose a general and solid education regarding the knowledge of chemistry and related areas, in personal terms as well as in terms of understanding and teaching Chemistry, of searching for information and communicating, and of expressing the teaching practice, thus allowing for the practical application of knowledge through teaching at basic education schools (BRASIL, 2001). Moreover, on the grounds of the DCN for teacher education (BRASIL, 2002a), the teaching degree must display the identity of a teacher education program through the pedagogical project of the course (PPC) in accordance with the various teacher knowledge.

The struggle to detach pre-service education for Chemistry teachers from a “technical” character has proven to be a great challenge. In addition to motivating enrollment and attempting to ensure the permanence of undergraduate students in the teaching degree in Chemistry (OLIVEIRA; GOIS, 2020), an additional goal was to organize the teaching degrees in Chemistry to promote education based on teachers’ knowledge. Higher education institutions have employed different models to their own pedagogical projects to try and integrate teaching theory and practice. Nóvoa (2009) and Tardif (2002) defend a new ideology for teacher

education based on the demands of teaching as a professional activity, that is, an education capable of producing the teaching activity at the institutions that qualify teachers. While teaching, teachers activate different types of knowledge regarding the work they perform every day (TARDIF, 2002). This generates knowledge, abilities and attitudes, which give them more professional competencies and abilities (NÓVOA, 2009).

In the scope of teacher education, teaching specific activities of a professional character means to support teachers theoretically and methodologically, in order to capacitate them for their professional practice. In Chemistry, in addition to the specificities of teaching, there are particularities intrinsic to the dynamic of the teacher's work (micro and macroscopic perspectives, phenomenology, modeling, representation, etc.) that need to be incorporated to the educational actions aimed to the pedagogical practices at school. The educational demands, the characteristics of teaching and the professional activity are some of the structuring elements of Chemistry teaching, therefore, they must be present in the curriculum of a teaching degree in the field.

Researchers concerned with the situation of the teaching of Chemistry in the basic school system have conducted investigations on the relationship between the teaching degree in Chemistry and curricular assumptions. They exemplify the way how various higher education institutions offer this degree (SANTOS; GAUCHE; SILVA, 1997; ZANON; FRISON; MALDANER, 2010; FONSECA; SANTOS, 2015; OLIVEIRA et al. 2017; MOURÃO; GHEDIN, 2019; SANTOS; LIMA; GIROTTO JÚNIOR, 2020). These works share the need to converge specific and pedagogical knowledge during teacher education.

Pioneers in the curricular investigation of teaching degrees in Chemistry after the enactment of the current LDBEN, Santos, Gauche and Silva (1997) presented academic conceptions and principles of the degree offered at Universidade de Brasília, in order to meet the needs and identities of nightly teaching degrees and the demands of pre-service education for Chemistry teachers. They concluded that, to achieve the proposed goal, different curricular components (educational, psychological, didactical and specific ones) must be integrated.

Another three works reached conclusions similar to the above, limited to the analysis of a single reality, through: the reflection on the identity and trajectory of a degree offered at Universidade Regional do Noroeste in the state of Rio Grande do Sul, emphasizing the education through research in the interaction between university and school (ZANON; FRISON; MALDANER, 2010); the investigation of the epistemological and curricular aspects directed to the teaching practice (FONSECA; SANTOS, 2015); the active participation of teaching degree students in their educational process in a public federal university, primarily focused on teacher education (OLIVEIRA et al., 2017).

The main feature that oriented the categorization of two additional works (MOURÃO; GHEDIN, 2019; SANTOS; LIMA; GIROTTO JÚNIOR, 2020) was the investigation of more than one reality. Mourão and Ghedin (2019) aimed to reflect on the curricular logic of four degrees offered by public federal universities and found that due to the lack of participation in the writing of the PPC and to the failure of understanding of the course identity, undergraduates could face difficulties to foster and to develop their identities as teachers. In turn, to outline

how legal indicatives and researches on teacher education have been incorporated into the course program of two teaching degrees offered by public (federal and state) universities, Santos, Lima and Girotto Júnior (2020) identified difficulties in the proposition of curricular practices that dissociate a teaching degree from a bachelor degree, consequently, limiting the professional learning related to teaching.

In the past two decades, because of the DCN, Chemistry teaching degrees have become the objects of analyses regarding their curricular practices for an effective teacher education. The majority of results from this process were achieved through documentary research on the pedagogical projects of these courses to identify propositions of pre-service education initiatives in the field and, by extension, their influence on the undergraduate teaching practice. The next section presents the methods that allowed the analyses of such a teaching degree.

ASPECTS OF THE RESEARCH

The teaching degree in Chemistry at FAFIDAM/UECE is responsible for graduating most of the Sciences/Chemistry teachers in the jaguaribana region (countryside of Ceará). Hence, the search for answers for the following questions: 1) What are the articulations of the professional education offered by the degree and teaching sciences at school? 2) What are the repercussions of said articulations on the professional development of undergraduates in the teaching degree in Chemistry? Based on the understanding that a social-educational phenomenon rises from these questions, a subjective perspective is employed to investigate it.

Reflecting on the subjectivity of understanding analytical objects, Godoy (1995) claims that the qualitative research involves the collection of data capable of description, in the sense of explaining the interactive processes with which the researcher may get in contact while solving a problem. Here, the case under investigation derives from a specific reality in the pre-service education for Chemistry teachers that justifies a particular investigation.

Consequently, a single and instrumental case study was chosen as a research method, since, according to Yin (2015), this method is supported by procedures and practices from the social sciences to solve problems in a contextualized situation. The documentary research was employed as technical procedure considering that for Silva et al. (2009), the analysis it enables tends to answer pre-elaborated questions based on qualitative data present in documents synthesized by oral and/or written speech, concentrated on the educational investigation.

Using pre-service education to teach at basic education schools as criterion of choice, the corpus was delimited (MORAES; GALIAZZI, 2016) as a set of five texts from which data about the object of investigation was collected between the months of October and November 2019. These texts were: 1) National curricular guidelines (DCN) for the pre-service education of school teachers (BRASIL, 2002a); 2) Duration and academic load of the teaching degree (BRASIL, 2002b); 3) National curricular guidelines (DCN) for the teaching degree in Chemistry (BRASIL, 2001); 4) Pedagogical Project of the Course (PPC) for the teaching degree in Sciences at (FAFIDAM/UECE, 2001); 5) Pedagogical Project of the Course (PPC) for the teaching degree in Chemistry at FAFIDAM (FAFIDAM/UECE, 2014).

Because they were the first official documents proposed by the National Council of Education that outline the characteristics of teachers' pre-service education in Brazil, both DCN mentioned above were consulted, which also justifies the selection of both PPC³ (2001 and 2004) in their entirety (text, syllabus and course program) since they were proposed in accordance with the DCN and represent pre-service education in that field from 2004 to 2014.

Such texts meet the definition of Sá-Silva, Almeida and Guindani (2009) for document, that is, written materials that ensure the objectivity about something that have their validating dimensions such as: 1) Context: appropriation of social and political aspects of the subject for whom the document is destined; 2) Authorship: knowledge of the intentions that result in the document synthesis; 3) Authenticity and Reliability: validation of the collected information; 4) Nature and key-concepts: accuracy of results and research outcomes; 5) Internal logic: understanding the textual content. This validation aimed at the previous analysis of the texts, after their collection on the web (DCN) and from the FAFIDAM coordination (PPC) by formal request through a document stating the goals of the investigation and authorization of depositary⁴.

In order to obtain the articulations and desired repercussions, the corpus was treated through Discursive Textual Analysis (DTA heretofore), which according to Moraes and Galiazzi (2016, p. 67, our translation) refers to a “[...] a self-organized process of constructing new understandings in relation to certain phenomena, based on textual materials referring to these phenomena”. As presented in the following, according to these authors, from March and June 2020, the analysis was conducted in three steps: 1) Unitization: intense disassemble of the *corpus* into smaller understandings of the investigated phenomena, named Sense Units (SU); 2) Categorization: establishment of relationships between SU to synthesize categories (initial, intermediate and final); 3) Metatext: capture and communication of an emergent knowledge.

The DTA was outlined based on investigative actions of research on Sciences/Chemistry teaching, specifically in the area of teacher education. Hence, to execute the steps of the DTA, the following aspects were observed: a) new understanding of the emergent knowledge through the interference of theoretical argumentation with the analysis method (GALIAZZI; LIMA; RAMOS, 2020); b) learning movements in a learning community (PEDRUZZI et al., 2015); c) unveiling of educational perspectives in the PPC of the teaching degree in Chemistry (MESQUITA, 2020).

ARTICULATIONS OF TEACHING PRACTICE AND REPERCUSSIONS ON PRE-SERVICE EDUCATION

The way how the teaching degree in Chemistry at FAFIDAM/UECE articulates with teaching Sciences/Chemistry at schools, promoting pre-service education among the undergraduates, was described resorting to senses about the corpus, which resulted in articulations and repercussions. Nonetheless, before exposing this process, it is necessary to discuss the validation of the five documents selected for the study (SÁ-SILVA; ALMEIDA; GUINDANI, 2009), as well as the preliminary results obtained after the three steps of the DTA (MORAES; GALIAZZI, 2016), also

considering the investigations on the pre-service education for Sciences/Chemistry teachers that employ this method.

The texts consider the teacher's practical rationality, prompting pre-service education models and professional activity based on scientific knowledge, cultural enrichment and collaborative work. The DCN were elaborated by the CNE, and the PPC by the faculty staff of that teaching degree, and both groups of texts are signed, respectively, by entities like the Ministry of Education and Culture and the Superior Councils at UECE, which approve the pedagogical projects and create the degree. These are official documents constituted by topics and subtopics referring, among other aspects, to the structure and the organization of the teaching degree, to the competencies and the professional abilities as well as to the curricular content.

The teaching degree under analysis answers for a significant part of the process of professional development of the undergraduates that chose to teach as their career. Testing that statement, the unitarization of the corpus was first conducted, diving into the research to experiment and to live "the new" and, then, the outcomes that emerge from the investigation (PEDRUZZI et al. 2015). Next, the process tries to capture the senses inherent to the texts, which is related to Hermeneutics and supports the development of qualitative research based on the DTA (GALIAZZI; LIMA; RAMOS, 2020). Moreover, these senses rise before multiple deconstructions of structuring elements of the PPC for the Chemistry teaching degree and, considering the assumptions of Mesquita (2020, p. 787, our translation), the fabrication of a new reality expressed in the "knowledge and reflections about perspectives for Chemistry teacher education".

Therefore, the corpus under analysis was read repeatedly and fragmented into 92 Sense Units (SU), that is, smaller excerpts filled with understanding on the analysis object, coded according to the text from which they derive. For example, the SU from the first text were coded as DCNFP⁵, according to the first letters in Portuguese (Diretrizes Curriculares Nacionais da Formação de Professores/National Curricular Guidelines for Pre-Service Teacher Education), adding sequential numbers (DCNFP1, DCNFP2 etc.). The SU coding for the remaining texts followed a similar process, respecting the title of each text (DCNQ – DCN for Chemistry Degrees; PPLC – Pedagogical Project for Teaching Degrees in Sciences; PPLQ – Pedagogical Project for the Teaching Degree in Chemistry)⁶.

Next, the corpus was categorized associating a SU to one of the two main categories in the research, which were defined *a priori* according to the goals of the investigation, which were: 1) Articulations of the degree and teaching Chemistry at school; 2) Repercussions on the professional education for teaching. This relationship allowed the placement of 56 SU in the first main category and 36 SU in the second. This procedure aimed at establishing relationships and the capture of the new emerging (MOARES; GALIAZZI, 2020), a constant spiral return to the SU, aiming at the category synthesis (GALIAZZI; LIMA; RAMOS, 2020).

After all SU were placed in the main categories, it was possible to agglutinate them according to their validation and homogeneity – pertinence to represent a phenomenon observing a conceptual continuum (MORAES; GALIAZZI, 2016) – thus producing the emergent categories. This process generated 27 initial categories, of which 16 were associated to articulations and 11 to repercussions. Each of these

categories was coded according to the main category in which they were placed. The initial categories placed in the two main categories were coded as AINI⁷ (Articulação Inicial/Initial Articulation) and RINI (Repercussão Inicial/Initial Repercussion) added the number of their sequence (1, 2, 3,...n).

The production of the intermediate and final categories followed the same criteria cited above, the first ones constituted through the agglutination of the initial ones identified as AINT1, AINT2, ...AINTN, RINT1⁸, RINT2, ...RINTN, while the final categories, from the association between intermediate categories were coded as AF1, AF2, AF3, RF1 and RF2, resulting in 10 intermediate and 5 final categories. Chart 1 displays the relationship between the intermediate and the final (emerging) categories and the central (*a priori*) categories.

Chart 1 – Relationship between the categories in the study

Centrais	Intermediárias	Finais
Articulations of the teaching degree with teaching Chemistry at schools	AINT1 and AINT2	AF1: The efficacy of teaching Sciences/Chemistry at schools is the result of a broad education in the teaching degrees in these areas.
	AINT3 and AINT4	AF2: Teaching Sciences/Chemistry requires using multiple educational abilities and competencies.
	AINT5 and AINT6	AF3: The Sciences/Chemistry teacher is responsible for making the scientific knowledge accessible in the educational and social spheres.
Repercussions on pre-service education for teachers	RINT1 and RINT2	RF1: The degree is based on professional education, inducing the appropriation of a set of competencies destined mostly to teaching.
	RINT3 and RINT4	RF2: The professional education in the degree has characteristics and activities to make the relationship between university and school prolific.

Source: Martins Júnior (2022, p. 237).

The categorization expressed the first understandings about the phenomenon cited above, enabling the claim that, considering these articulations, the teaching degree in question abides by the DCN for Chemistry (BRASIL, 2001) and offers pre-service education for school teachers. On the other hand, the teaching degree almost fails to reverberate what is outlined by the DCN for Teacher Education (BRASIL, 2002a) and to prescribe the duration and academic load of the degree (BRASIL, 2002b). All repercussions refer to the pre-service education for school teachers, that is, they concur with both official documents proposed by the CNE that were selected here.

The five metatexts (the final step of the DTA) regarding the two main categories and the five emergent categories explain three articulations of the teaching degree and teaching at basic education schools, as well as two repercussions for the professional development of undergraduates. As seen in the next section, each metatext was described based on new understandings composed of interpretations, arguments and empirical and theoretical interlocutions (MORAES; GALIAZZI, 2016), taking into account new possibilities of analysis through the dialogue with the emerging knowledge (PEDRUZZI *et al.*, 2015) and one's constitution as researcher/author of declarative statements (GALIAZZI; LIMA; RAMOS, 2020; MESQUITA, 2020).

ARTICULATIONS OF THE TEACHING DEGREE AND TEACHING SCIENCES AND CHEMISTRY AT BASIC EDUCATION

This category is exclusively associated with the DCN for the teaching degree in Chemistry (BRASIL, 2001) and allows the conclusion that the degree is intrinsically related to the establishment of a profile adequate to Sciences/Chemistry teaching. According to Chart 1, the themes approached in these three emergent categories were: a) broadness of teacher pre-service education when it leads undergraduates toward promoting efficient teaching; b) mobilization of several educational competencies; c) accessibility of scientific knowledge in different spheres.

The Efficiency Of Teaching Sciences/Chemistry At Schools Is A Result Of A Broad Education At The Teaching Degrees In These Areas

This category emerged from the embedment of 17 SU corresponding to the nature of the teaching degree in Chemistry (BRASIL, 2001) at national level, as well as the orientations of that degree (FAFIDAM/UECE, 2001, 2014) for the teaching of Sciences in the regions of Ceará surrounding FAFIDAM. Two of the SU are important as they represent the dependence between qualified education and the offer of Sciences/Chemistry teaching, which are: DCNQ1 – Science/Chemistry teachers must have broad understanding of Chemistry and in Chemistry Teaching to apply their knowledge to their professional practice in basic education schools; PPLC2 – The teaching degree aims to overcome a model of speedy and improvised education (Short-term Teaching Degree in Sciences), to improve the qualification of teachers in the fields of sciences and mathematics in the region of the Vale do Jaguaribe (Ceará, Brazil).

The SU DCNQ1 reverberate intensely the guidelines for the Teaching Degree in Chemistry (BRASIL, 2001, p. 2) regarding an education that overcomes the “[...] informative content in clear educational loss” [our translation]. In turn, the SU PPLC2 displays the progress of the educational model in the field of Natural Sciences, indicating the need to overcome the insufficiency of teachers for basic education schools in that area of Ceará as well as to improve the qualification of in-service teachers who are still to be properly graduated.

Given the context of analysis, it was noted that teaching Sciences/Chemistry at basic education level is a recurrent issue in the Brazilian educational system, either by the lack of a standard for public schools (RIBEIRO; LAMBACH; HUSSEIN, 2018) or by the deficiencies in the pre-service education of teachers who graduated in a teaching degree for that field. Therefore, based on the second adversity, it is stated the need to improve pre-service education to graduate better qualified teachers. Both PPC discuss the scarcity of these workers in the field of Sciences, which increases the number of laypeople teaching these subjects in the region of FAFIDAM as well.

In the attempt to meet the increasing demand from secondary schools for teachers graduating in the area, in 2004, the educational model for teaching degrees transitioned from Sciences to Chemistry. According to Martins Júnior and Vidal (2021), although the change has failed to supply the definite need for teachers in the region, it has contributed to the internalization of teacher

education in the area. Therefore, the institutionalization of the Chemistry teaching degree helped to improve the quality of education in the surrounding regions in Ceará that sustain the course by providing undergraduates capable of becoming teachers (MARTINS JÚNIOR; VIDAL, 2021).

The transition process for this educational model triggered intense changes in the course curricular program prompted by reflections, discussions and educational researches on Chemistry teaching that expose the urgency of approaching various types of knowledge inherent to the scientific subjects (OLIVEIRA et al., 2017; MOURÃO; GHEDIN, 2019). About this new educational model, the current pedagogic proposition states that:

[...] to elaborate the course program, curricular assumptions were established that had as basic principle the dense and profound education in Chemistry aiming at the technical mastery of the content, allied to competencies inherent to the educational process, characterized by relationships of psychological, sociological, philosophical order, among others (FAFIDAM/UECE, 2014, p. 6; our translation).

The offer of a broad teacher pre-service education in Sciences/Chemistry in the degree is not limited to the appropriation of knowledge specific to scientific knowledge. This conjecture is in agreement with the claims made by Tardif (2002) regarding the university teacher education that the activity should be grounded on practice, as long as guided by theory, to activate theoretical and practical teaching knowledge while teaching. The author also clarifies that these types of knowledge constitute the work of teachers, guiding it according to prescriptions (curriculum) and attitudes inherent to teaching. According to Mourão and Ghedin (2019), undergraduates in Chemistry must have the possibility of seeing themselves working as teachers whose professional development is triggered by the synthesis of pre-service teaching knowledge.

This is directed to the professional education of teachers who have graduated the course, a striking characteristic in the most recent pedagogical proposal, breaking with the essentially instrumental educational model described in the PPC from 2001. Abiding by the guidelines from which it derived (BRASIL, 2001 and 2002a), the program for the 2014 PPC points to a new connotation for the pedagogical field, expanding the practical education by inserting the supervised internship subdivided into four different courses, starting in the second half of the degree. Santos and Silva (1997) as well as Santos, Lima and Giroto Júnior (2020) corroborate this new curricular practice by exposing that the ideology of the supervised internship that crosses all curricular practices of the teaching degree in Chemistry, values and prioritizes teacher education.

It is noteworthy that this movement of curricular change, prompted by national guidelines, has followed the (re)structuring of pre-service education for Chemistry teachers, implemented in Brazil through the expansion of the short-term teaching degree (BRASIL, 1999), separated into Biology, Chemistry and Physics, and allowing the development of specific academic activities (teaching, research and community outreach programs) in each field of knowledge. On that matter, Zanon, Frison and Maldaner (2010) understand that moving away from a simplistic view of Chemistry teaching, it is necessary to make available new possibilities for professional education, such as: university/school interaction,

didactic recontextualization of the chemical knowledge and professional education in the school context.

The last point analyzed in this category is connected to these possibilities, referring to the educational activities conducted in the degree, especially by professors who induce pedagogical practices on the grounds of interdisciplinarity and the contextualization of Sciences/Chemistry teaching. The analysis of the distribution of courses per professional education axis in the programs of both PPC allows the observation of the approximation between chemical content and teaching and the content from related areas (Biology, Physics, Mathematics, Didactics, Pedagogy and Technology). Therefore, while the 2001 PPC outlines the systemic role of science and its integration to different sectors of society, the 2014 PPC endorses the educational knowledge underlying the chemical knowledge. It is noteworthy that using different methodological approaches to teaching is an ongoing process in some Chemistry teaching degrees in Brazil (SANTOS; SILVA, 1997; FONSECA; SANTOS, 2017; OLIVEIRA et al., 2017).

Endorsing the broad university education that aims to overcome educational challenges such as capacitating teachers, articulating different curricular components and stimulating innovative pedagogical practices (interdisciplinarity and contextualization), Tardif (2002) states that educating teachers involves a dense professionalization process in which reflective beings participate in the search for professional development.

Teaching Sciences/Chemistry Requires Using Multiple Educational Abilities And Competencies

In this category, the word **competency** is not limited to the acquisition of techniques by teachers, a process known as technical rationalism. Hence, the word **educational** signals the nature of the competency, understanding, above all, the specificities of teaching scientific disciplines, relating to the following SU: PPLQ4 – the proposition of the degree is to implement a model for teacher education that concentrates on contextualization and interdisciplinarity, mindful of regional specificities; DCNQ6 – the Chemistry teacher must have goals related to the understanding of Chemistry as a science, its principles, laws and applications, the nature of chemical compounds, knowing that such science evolves as humanity develops the knowledge in the field.

The PPLQ4 brings to light the notion that the graduated teachers working in the field must approach different aspects of the scientific knowledge in addition to the conceptual content, in the constitution of teachers who are “[...] integrally competent, autonomous, human, citizen and open to investigating universal themes of contemporaneity as well as contemporary and daily issues” (FAFIDAM/UECE, 2014, p. 13; our translation). The DCNQ6 deduces that the daily teaching activity is a reflex of the teacher’s notion of Science, that must overcome a positivist perspective and induce this educator to “[...] teach students to learn things and solutions” (BRASIL, 2001, p. 2; our translations).

Therefore, it is verified that the outside environment of formal educational institutions becomes increasingly more attractive to students and influences them

to enter the school space with information that has not been necessarily converted into scientific knowledge. In particular, the classroom environment could compromise the students' learning process, since they would lose interest in the teacher's explanations of scientific subjects. Social-cultural demands have been imposed upon educators to make teaching more attractive to students, to reach them, and to contribute to their education.

Inscribed in this reality and sponsored by the DCN for the teaching degree in Chemistry, the pedagogical proposals for the degree would rather provide pre-service education articulated with professional experiences lived in school practices based on different methodologies and didactic resources, such as digital technologies of information and communication (TDIC). During their academic trajectory at FAFIDAM, students can develop their professional identity and, according to the 2014 PPC, promote teaching on the grounds of scientificity, technology and activation of educational knowledge. Hence, Nóvoa (2009) defends that the university becomes, par excellence, a space that fosters professional identities. The author highlights:

[...] the importance of conceiving the pre-service education in a context of professional responsibility, suggesting constant attention to the need for changes in work, personal, collective or organizational routines. Innovation is a central element in the very process of education (NÓVOA, 2009, p. 35; our translation).

It was verified in the pedagogical propositions that undergraduates in the teaching degree must be an active subject in the teacher's learning process, developing autonomy in the search for knowledge inherent to teaching that aggregate value to their identity as a teacher. This proactive attitude on the part of the subject is prior to the rules and tasks proposed by the management and the faculty staff, aiming at pre-service education and corroborates a critical-reflective and investigative instance given the processes of teaching and learning Sciences/Chemistry. This is in accordance with the DCN for the teaching degree in Chemistry regarding the profile of undergraduates (BRASIL, 2001), that is, the promotion of teaching sciences through human effort so that scientific knowledge becomes didactic and accessible. Derived from these guidelines, the 2014 PPC proposes that Chemistry teachers graduated in that degree must "[...] acknowledge Chemistry as a human construct and understand the historical aspects of its production and their relationships with the cultural, socio-economic and political context" (FAFIDAM/UECE, 2014, p. 16; our translation).

Further educational competencies and abilities required from the undergraduates who will work as teachers concern the appropriation of chemical-pedagogic knowledge related to the teaching practice, which results in the specialization of teaching (OLIVEIRA et al. 2017) through the articulation of theory and practice (SANTOS; LIMA; GIOTTO JÚNIOR, 2020). Therefore, competencies and abilities are respectively comprehended in: a) the promotion of interdisciplinary teaching, approximating different school subjects; b) team work, consisting in extracurricular group studies that trigger the feeling of interdependence; c) the production of didactic resources that support the very pedagogical practice of theoretical-experimental nature, revealing the nature of Chemistry as a science; d) adequate treatment of scientific information once the

synthesis of scientific knowledge is a process initiated by the search and selection of reliable sources followed by the reading, the interpretation and the communication in the form of educational research.

The Mission of Making Scientific Knowledge Accessible In The Educational And Social Spheres Belongs To The Science/Chemistry Teachers

The accessibility of scientific knowledge tends to be promoted, largely, by the formal and systematized teaching of Sciences in school, which also displays the social function of Science. Two of the three texts that constitute the part of the *corpus* that refer to that category (BRASIL, 2001; FAFIDAM/UECE, 2014) express the importance of/the need for the Chemistry teacher to approach different aspects that characterize the chemical knowledge, such as the collection, the representation and the communication of data as well as the reflection on the teaching practices aimed to solve problems. Hence, the highlight on two US that subsidize the arguments surrounding the teacher's mission of communicating scientific knowledge: PPLQ200 – The Chemistry teacher needs to develop the ability of applying Chemistry to the social sphere, by interconnecting science, technology, society, environment and work; PPLQ22 – The Chemistry teacher needs to develop the ability of adding to the teaching of Chemistry a set of actions that favor its promotion as well as researches, projects and curricular proposals.

This new order to teach Chemistry derives from the intense scientific and technological development, urging the mobilization of different types of knowledge, abilities and attitudes relating to the varied knowledge that succeed to answer the social-educational demands that increase every day. Scientific knowledge, a key element of this type of mobilization, must be accessible to those who wish to use it to solve problems of social and technological character, among other things. Based on these premises, the PPC, especially the document from 2014, collaborates to a pre-service education on the grounds of specific professional knowledge that use various teaching methods, regardless of the learning environment that teachers will face.

Another aspect that was identified in the analysis concerns the features of the teacher's work in basic schools. It was verified that, while promoting accessible teaching, based in their own professionalism (NÓVOA, 2009), including the natural sciences and their technologies (ZANON; FRISON; MALDANER, 2010), teachers tend to be in constant interaction with students (TARDIF, 2002), colleagues and extra-school community. Therefore, educators in addition to being the main communicator of the teaching practice (BRASIL, 2001), also have a repertoire of knowledge that can help to solve various educational problems (dropouts, indiscipline, difficulties and learning *deficits*, (re)signifying content etc.) as well as demystifying that learning Chemistry is extremely difficult and laborious.

The explanation of the social function of Chemistry can make teaching and, consequently, learning Chemistry feasible, preventing the notion that such processes are only synthesized through memorization of nomenclature, formulas, equations and chemical calculations. Teachers must overcome this type of controversy by teaching based on human actions that approximate science and

learners. On that matter, the most recent PPC, relying on the DCN for Chemistry, explains that teachers qualified to teach Chemistry must:

Read, understand and interpret scientific-technological texts in both national and foreign language (especially English and/or Spanish). Interpret and use different forms of representation, such as tables, graphs, symbols and expressions, among others. Write and critically evaluate the didactic materials, such as books, booklets, “kits”, models, computational programs and alternative materials (FAFIDAM/UECE, 2014, p. 16; our translation).

Producing their own didactic resources for the pedagogical practice is another aspect highlighted in the analysis, which relates to the teacher’s mission of making the scientific knowledge accessible. Given all these reasons, the investigated degree, aiming to prompt the development of professional competencies and abilities (as verified earlier), promoted initiatives aiming the effective use of distinct materials to teach Sciences/Chemistry, for instance, experiments and the TDIC.

Regarding the use of didactic resources to teach Chemistry at basic schools, Zanon, Frison and Maldaner (2010) as well as Fonseca and Santos (2015) attest the importance of educational practices in the context of the teaching degree in Chemistry to familiarize undergraduates with the use of different teaching tools. The former authors were surprised to not find any articulation of the curriculum of a teaching degree in Chemistry at one higher education institution in the state of Rio Grande do Sul and the constitutive aspects of teacher education related to the use of new technologies. On the other hand, the latter authors highlight the use of technologies for teaching, available at a laboratory for investigative practices about teaching Chemistry and educational technologies at a public university in the state of Goiás.

Didactic resources are considered guides for teacher education and practice and can be used to investigate educational phenomena, a principle that is frequently cited in both PPC for the teaching degree. Nonetheless, Sciences/Chemistry teachers must be properly qualified to teach to the extent of systematizing, analyzing and communicating solutions for issues inherent to the teaching and learning processes. Based on this understanding, Fonseca and Santos (2015) explain that pre-service education for Chemistry teachers must promote interaction with formal spaces of education and their variables regarding their specific professional practices, in particular, the basic education schools, a privileged space to develop collaborative research among teachers.

REPERCUSSIONS OF PRE-SERVICE EDUCATION ON TEACHING

This category is related to the DCN for teacher education (BRASIL, 2002a, b), as well as the DCN for teaching degrees in Chemistry (BRASIL, 2001). It displays the intentions of pre-service activities for the teaching degree in Chemistry at FAFIDAM that prepare undergraduates for the teaching practices, as presented in Chart 1. The two emerging categories exposed in the sequence comprehend the following themes: a) organization of the degree by articulating theory and practice effectively; b) development of professional competencies; c) qualifying and capacitating for teaching; d) understanding the particularities of teaching.

The Degree Is Based On Teacher Education, Inducing The Appropriation Of A Set Of Competencies Oriented Mostly To Teaching

Pre-service education in teaching degrees can be conceived as the process of capacitating undergraduates to teach, by conducting educational activities filled with the particularities of the contemporary teaching practice. Analysis of excerpts from the *corpus* regarding this category enabled the verification that this type of teacher education mostly agrees with the professionalism of school teachers, realized in multiple and specific professional (educational) competencies. The guidelines first describe the intention of “[...] orientation inherent to pre-service education for teaching” (BRASIL, 2002, p. 1; our translation); and the official prescription of the degree conceives it as a generalist and solid pre-service education in Chemistry and related areas for teachers (FAFIDAM/UECE, 2014). Therefore, the following SU were projected in agreement with these terms: DCNFP2 – The curricular organization must prioritize the teaching practice, preparing pre-service teachers to appropriate and develop the necessary competencies necessary for the professional practice.

Pre-service teacher education to teach Sciences/Chemistry especially in the PPC from 2004, is in accordance with the propositions made by Tardif (2002) on the pre-service educator for teachers provided by universities. The teacher education activities expressed in the pedagogical propositions analyzed here allow the confirmation of the profusion of teaching knowledge associated with professional competencies. The historic evolution of the degree involves changes implemented in the teaching degrees in the sense of constituting an educational model to qualify pre-service teachers professionally and answering to some of the main legal documents of Brazilian education (BRASIL, 1988, 1996, 2002a). It is noteworthy that the transition from the short-term teaching degree in Sciences to the full teaching degree in Chemistry increased the value of pre-service teacher education, as identified by Martins Júnior and Vidal (2021).

The development of professional competencies relative to Sciences/Chemistry teaching in basic schools constitutes a process of education that overcomes the model of technical rationality, based on the DCN for teacher education (BRASIL, 2002a), which is present in the general aim of both degrees:

Qualify teachers to teach Science at Primary and Secondary Schools; provide teachers with an essential instrumental base for the competent performance teaching Sciences; enable a multidisciplinary and interdisciplinary educational model (FAFIDAM/UECE, 2001, p. 13; our translation).

Allow students to have a solid theoretical-methodological education centered on the axis that constitute the identity of the degree, aiming to educate teachers integrally competent, autonomous, human, citizen and open to investigating universal themes of contemporaneity as well as contemporary and daily issues (FAFIDAM/UECE, 2014, p. 13; our translation).

The degree integrates educational axes in the program to offer professional education for undergraduates, especially in teaching, which mixes specific knowledge and teaching knowledge (TARDIF, 2002): Practice as Curricular Practice, Supervised Internship, and Educational Principles, constituted by courses that tend to relate the science of Chemistry and its teaching. Concerning the specific

qualification to teach Chemistry, a result of the appropriation of countless educational experiences, which became a part of the teaching degrees in the field in Brazil with the current LBDEN, research claim distinct courses need to be integrated rather than separated as often happens (SANTOS; SILVA, 1997; FONSECA; SANTOS, 2015; MOURÃO; GHEDIN, 2019).

In the process of approximating different types of knowledge specific to teaching in the context of pre-service education, Nóvoa (2009) defends that a culture of professionalization can be achieved if more experienced teachers share their experiences with less experienced ones. The author states that it is necessary to “[...] return teacher education to teachers” (p. 36; our translation), warning against the risk of the curriculum of that degree falling into the hands of “specialists and identities of believe” (p. 37; our translation) that do not rely on professional development and on the practical knowledge of teaching.

Despite providing pre-service teacher education for school teachers, the pedagogical propositions under analysis discuss pre-service education in other fields. The PPC from 2001 cites possibilities such as higher education (working as teaching assistant), instructor for instrumental teaching organizations, research either in the academic career (masters and doctorate levels) or applied research. The PPC from 2014 highlights the work in offices at the state level and/or private institutions, educational research institutions, research laboratories for chemical analysis and quality control, and also the academic career in *Stricto Sensu* Post-Graduate Programs.

These additional possibilities could be conditioned, especially, by the influence of professors who, given their academic career (bachelor, engineer, pharmaceutical, etc.) exposed in the PPC develop teaching practices on the grounds of applied research, grounded on specific laboratory practices and not necessarily related to teaching Chemistry at schools. As a matter of fact, if professors teaching in the Chemistry degree lack the pedagogical background, they could hardly influence students to become teachers. Motivation, then, involves engaging in (non-educational) research practices or moving onto advanced studies after graduation (SANTOS; SILVA, 1997; ZANON; FRISON; MALDANER, 2010), although extrinsic motivation is an important factor for students’ academic success in teaching degree in Chemistry (OLIVEIRA; GOIS, 2020). On this topic, Ghedin and Franco (2019) warn against the causes of this issue for pre-service education:

[...] this is so because the curriculum and professors who graduate teachers seem not to value teaching, granting it the status of a minor job by prioritizing specific courses of natural sciences and not relating these courses to teaching practices (p. 2; our translation).

[...] the very history of teacher education for the natural sciences helps us to understand that, since teaching degrees began to be offered by universities, the faculty staff in these courses has come from other areas such as engineering and medicine and, later, from the bachelor degrees (p. 11-12; our translation).

Teacher Education In The Degree Comprehends Features And Activities That Aim To Make Productive The Relationship Between University And School

Based on the DCN for teacher education (BRASIL, 2002a) and the DCN for teaching degree in Chemistry (BRASIL, 2001), the pre-service education provided by the degree can be promoted through the dialogicity between specific and school knowledge regarding Sciences/Chemistry teaching. This process favors the Exchange of teaching knowledge and superior education (TARDIF, 2002), stimulates the construction of teaching in the pre-service education (NÓVOA, 2009) and corroborates with the evolution of the professional identity of pre-service teachers.

Once more, analyses showed that to approximate university and school to qualify teaching, pre-service practices are pivotal to foster the culture of professionalization of teachers in the degree. Regarding the teaching degree in Chemistry at FAFIDAM/UECE, the validity of education provided by its educational initiatives is conferred by both external assessment conducted by MEC, and internal assessment conducted by the university. The performance of the degree in both assessments determines its recognition and legal work, consequently, indicating the regime of collaboration between academia and school environment concerning the professional development of undergraduates in the teaching degree in Chemistry.

The courses of Practice as Curricular Components and Teaching in Chemistry as well as the Curricular Supervised Internship, pertaining to the *corpus*, are major axes in the education for the school context, a fact that is also shown by similar studies (ZANON; FRISON; MALDANER, 2010; FONSECA; SANTOS, 2015). Reinforcing the importance of these curricular components for teacher education Santos, Lima and Giroto Júnior (2020), defend the fact that such pre-service trajectories are articulated and embedded throughout the teaching degree in Chemistry, helping teachers to construct their professional identity.

The most recent pedagogical proposition for the degree under analysis presents the Internship as an indispensable and essential stage for pre-service teacher education, a fact that is displayed in several excerpts distributed throughout the entire text *corpus* that establish a prolific relationship between internship and pre-service teacher education, of which two SU express this sense: PPLQ34 – The degree has a specific program for internships for acquisition and improvement of knowledge and abilities for the professional teaching practice, inducing it to be critical, reflective, therefore, able to solve educational problems with technical, social-political, ethical and human dimensions; PPLQ35 – Beyond the curricular obligation, the internship is an instrument to assess the teacher education of the degree, it works as research activity and the immersion of pre-service teachers in their future work environment, surrounding it with interpersonal relationships. This favors the synthesis of several abilities and competencies, and the supervised internship conducted in the degree is conceived as:

[...] moment of acquisition and improvement of essential knowledge and abilities with the function of integrating theory and practice to consolidate pre-service teacher education on the grounds of competencies for the world of work. Therefore, it is a three-dimensional educational experience:

technical and sociopolitical that provide students to participate in real life and work situations and explores the indispensable basic competencies for pre-service education that is ethical, responsible and committed to human development and the improvement of quality of life (FAFIDAM/UECE, 2014, p. 37; our translation).

In the current configuration of the degree, the internship binds education and work, allowing undergraduates to exercise teaching Sciences/Chemistry at basic education, supported by specific, didactic and pedagogical knowledge learned at university. Indeed, immersing undergraduates in the reality lived by teachers at basic education schools can contribute to pre-service contact with teaching and to the concreteness of the initiative developed in the pre-service education. Several studies attribute effectiveness to internships during pre-service education due to the contact with complex issues of school life (ZANON; FRISON; MALDANER, 2010), the treatment of educational knowledge in Chemistry (OLIVEIRA et al., 2017) and the application of didactic instruments that mobilize teaching knowledge (MOURÃO; GHEDIN, 2019).

FINAL REMARKS

The teaching degree in Chemistry under investigation here articulates with teaching at basic schools, fitting from 2004 to 2014 the scope of curricular guidelines that structure pre-service teacher education and the teaching degrees in the area. The degree observes and seeks to meet the educational demands specific to the Vale do Jaguaribe, in the countryside of Ceará. In addition, the analysis conducted in the text *corpus*, regarding the peculiarities and the vicissitudes of professional education, allow the conclusion that the degree offers them with that a transversal theme in the pedagogical propositions in question.

It is possible to claim that the undergraduates in the degree are oriented toward teaching since they are given broad teacher education in Sciences/Chemistry, percolated with several activities that mobilize professional educational competencies, enabling them to appropriate scientific concepts in different learning spaces. Also in accordance with legal determinations regarding the specific pre-service education for teaching, the degree is organized to associate theory (specific and pedagogical knowledge) and practice (Chemistry teaching) in teaching practices to be performed at schools, as well as the appropriation of numerous abilities pertaining to teaching. Fonseca and Santos (2015) approach this type of need by presenting results from their study on the curricular structure of the course concerning aspects of pre-service teacher education. The authors report incongruities between what is formally prescribed and the discourses of professors and graduates about the pre-service teacher education.

Different stages of the doctoral research conducted at PPGE/UECE from which this article derives signal, in a way, the dichotomy prescribed/real in the curriculum of the teaching degree in Chemistry. Therefore, the research findings indicate that students who graduated in the degree and work as Sciences and/or Chemistry teachers at primary and/or secondary schools feel insecure as to the efficacy of that pre-service education to work at basic education schools given the lack of understanding of the reality faced by teachers at schools, of incentives and

motivation given by professors, or the scarcity of experimental classes in the laboratory.

For the last stage of the doctoral research, a number of students who graduated in the degree were interviewed with the purpose of investigating their discursive representations about learning to teach at pre-service education. Hence, the goal of understanding how that education influenced the students' professional constitution. The results could either confirm or deny the efficacy of the degree to provide pre-service teacher education, in total or partial agreement with the prescription of their Pedagogical Project.

Articulações entre licenciatura em Química e ensino básico e suas repercussões na formação profissional

RESUMO

Atualmente, cursos de licenciatura tentam superar modelos de formação incipientes (complementação pedagógica, licenciatura curta etc.) e que não conseguiram responder adequadamente demandas educacionais que conclamam a prática docente. Situado nessa realidade, o curso de licenciatura em Química da Faculdade de Filosofia Dom Aureliano Matos, ofertado pela Universidade Estadual do Ceará, forma professores desde 2007. Este artigo objetiva descrever as articulações deste curso com o ensino de Ciências/Química na educação básica e suas repercussões na formação profissional para seus egressos, constituindo-se, assim, um estudo de caso. Documentos oficiais que o representam, assim como os que normatizam a formação docente no Brasil foram submetidos à pesquisa documental, para captar, interpretar e caracterizar as articulações e repercussões por meio de análise textual discursiva. Dentre as identificadas, destacam-se, respectivamente: promoção eficaz da docência em Ciências/Química, se concedida ampla formação docente nessa área; preparação e capacitação para atuação profissional, sobretudo, no ensino. A prescrição oficial do curso o eleva ao patamar de formação profissional para a docência. Todavia são necessárias outras análises para verificação da concordância entre preceituação e realidade vivenciada nessa formação inicial, considerando informações disponibilizadas por sua comunidade acadêmica.

PALAVRAS-CHAVE: Formação de professores. Currículo. Capacitação profissional. Docência em Ciências/Química.

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NOTES

1. This article is the expansion of an abstract presented at VI Simpósio Mineiro de Educação Química, that took place on-line from 14 to 18 June 2021.
2. Translated by Larissa de Pinho Cavalcanti. Resume: <http://lattes.cnpq.br/7660087236639667> ; E-mail: laracvanti@gmail.com.
3. It is noteworthy that, parallel to the research, a new PPC was being implemented in the biennium 2018-2019, to meet the guidelines for pre-service teacher education that succeeded the first DCN in effect since 2015.
4. When a legal representative signs the document, the depositary provides the researcher with the right to conduct analysis regarding their own research project in the institution's official documents.
5. An example of Sense Unit (SU): DCNFP1: The teaching degrees aim to qualify teachers to work at the basic school system, to which they must set their institutional and curricular organizations on the grounds of the teaching activity.
6. In Portuguese: DCNQ – Diretrizes Curriculares Nacionais dos Cursos de Graduação em Química; PPLC – Projeto Pedagógico do Curso de Licenciatura em Ciências; PPLQ – Projeto Pedagógico do Curso de Licenciatura em Química.
7. An example of an initial category for the articulations: AINI6: After pre-service education, Sciences/Chemistry teachers will be in better conditions to appropriate the chemical knowledge effectively, conciliating theoretical and practical knowledge in their teaching practice.
8. An example of an intermediate category of repercussions: RINT1: Pre-service education is the main axis of the degree, presented in a course structure that directs the development of professional theoretical-practical competency for teaching and other multiple tasks concerning the teaching practice.

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Correspondence:

Francisco Ranulfo Freitas Martins Júnior

Av. Dr. Silas Munguba, n. 1700, Campus do Itaperi, Fortaleza, Ceará, Brasil.

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