The initial education of Biology teachers in the state of Santa Catarina: controversies for implementing the Base Nacional Comum

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Abstract: The objective of this article is to investigate the curriculum changes imposed by the promulgation of the Base Nacional Comum Curricular — BNCC [National Common Core Curriculum] in the final years of Science Elementary Education in the state education schools and to investigate the suitability of curriculum matrices in some formation courses for Science teachers to work in Science Elementary Education offered in the state of Santa Catarina. With the qualitative and interpretative study of the documents, we found that the reform imposed by the BNCC considerably diversified the curricular matrix of Science teaching in Elementary Education. This diversification comes with the inclusion of contents of Astronomy, Physics, Chemistry, and Geosciences. However, the curricula of the seven teacher education courses analyzed devote much time to Biology content. We consider that this disparity of approaches represents a significant gap in the formation of the prospective teacher of the final years of Science Basic Education.

Keywords: Biology Teacher Education. Science Elementary Education. Base Nacional Comum Curricular.

La formación inicial de profesores de Biología en el estado de Santa Catarina: contradicciones para la implementación de la Base Nacional Común Curricular en la Educación Básica de Ciencias

Resumen: Este artículo tiene como objetivo investigar los cambios curriculares impuestos por la Base Nacional Común Curricular (BNCC) en la enseñanza de Ciencias en los últimos años de la Educación Básica de escuelas públicas estatales. También pretende averiguar las matrices curriculares de algunos cursos de formación de profesores de Ciencias ofrecidos en el estado de Santa Catarina. Con el estudio cualitativo e interpretativo de los documentos, se constató que la reforma impuesta por la BNCC diversifica considerablemente la matriz curricular de la enseñanza de las ciencias en la Enseñanza Fundamental. Esta diversificación surge con la inserción de contenidos de Astronomía, Física, Química y Geociencias. Mientras tanto, los siete cursos de formación del profesorado analizados, ya que tienen una gran carga horaria dedicada a los contenidos de Biología. Se considera que esta disparidad en los enfoques de los cursos analizados representa un vacío considerable para la formación del futuro docente de los últimos años de Educación Básica en Ciencias.

Palabras clave: Formación de Profesores de Biología. Educación Básica de Ciencias.

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A formação inicial dos professores de Biologia no estado de Santa Catarina: controvérsias para a implementação da Base Nacional Comum Curricular no Ensino Fundamental de ciências

Resumo: O objetivo deste artigo é investigar as mudanças curriculares impostas pela promulgação da Base Nacional Comum Curricular (BNCC) nos anos finais do Ensino Fundamental de Ciências das escolas da rede estadual de ensino, assim como averiguar a adequação das matrizes curriculares de alguns cursos de formação de professores de Ciências para atuar no Ensino Fundamental de Ciências oferecidos no estado de Santa Catarina. Com o estudo qualitativo e interpretativo dos documentos, verificou-se que a reforma imposta pela BNCC diversificou consideravelmente a matriz curricular do ensino de Ciências do Ensino Fundamental. Essa diversificação surge com a inserção dos conteúdos de Astronomia, Física, Química e Geociências. Entretanto, os currículos dos sete cursos de formação de professores analisados têm grande carga horária destinada aos conteúdos de Biologia. Considera-se que esta disparidade de enfoques represente uma lacuna considerável para a formação do futuro professor dos anos finais do Ensino Fundamental de Ciências.


1 Introduction

Despite advances in public educational policies in recent decades (BRASIL, 1996, 2002a, 2006, 2014), Brazilian Basic Education still needs to present satisfactory results in national and international external assessments (INEP, 2021; OECD, 2020). In this context, economic, political, and market movements were mobilized to pressure government officials to implement educational reforms. Those mobilizations culminated in changes to the Lei de Diretrizes e Bases da Educação Nacional — LDB [Brazilian National Education Guidelines and Framework Law] N. 9394/1996 (BRASIL, 1996) and the approval of the Base Nacional Comum Curricular — BNCC [Brazilian National Common Core Curriculum] (BRASIL, 2018). The BNCC, in turn, demanded an adaptation of school curricula at the national level. However, during the last educational reform mentioned above, factors such as the infrastructure of schools, teacher education, career, teachers’ working conditions, and students’ socioeconomic conditions, among others, were not considered. Besides, the Basic Education teachers’ participation was disregarded during the curriculum proposal process.

The implementation of learning and development rights and objectives that shaped the BNCC is a strategy contemplated in the current Plano Nacional de Educação and Plano Estadual de Educação de Santa Catarina [National Education Plan and the State Education Plan of Santa Catarina] for the universalization and
promotion of the quality of basic education. However, when the educational legislation determined the updating of the school curriculum, it did not provide for a transition period for those students who were already attending Elementary School or High School, much less an adjustment in the education of in-service teachers.

Currently, the state of Santa Catarina is reorganizing the Basic Education curriculum by the BNCC, through the enactment, in 2019, of the Currículo Base da Educação Infantil e do Ensino Fundamental do Território Catarinense — CBTC [Basic Curriculum for Early Childhood and Elementary Education in the Territory of Santa Catarina]. This curriculum was adopted by the state schools and most of the state’s municipal schools. The Currículo Base do Ensino Médio do Território Catarinense [Basic Curriculum for High School in the Territory of Santa Catarina] was approved by the Conselho Estadual de Educação [State Council of Education] through Resolution CEE/SC n. 004 of March 9, 2021.

In the state schools of Santa Catarina, Science is imparted in the final years of Elementary School by teachers with a degree in Biological Sciences. Seixas, Calabró, and Sousa (2017) and Silva and Jófili (2018), among others, before the curricular reform imposed by the enactment of the BNCC, point out that Science teachers faced great difficulties in teaching their students concepts of Chemistry and Physics, traditionally concentrated in the 9th grade of Elementary School, due to their education with emphasis in Biology.

In this scenario, the objective of this article is to investigate the curriculum changes imposed by the enactment of the BNCC in the final years of Elementary School at state schools, specifically in Sciences, and verify the adequacy of the curriculum matrices of some formation courses for Science teachers to work in Elementary Education offered in the state of Santa Catarina. Thus, we seek to answer the following research questions: What changes were generated by the implementation of the BNCC in Science Elementary Education offered in the state of Santa Catarina? How are the curriculum matrices of some degree courses in Biological Sciences in Santa Catarina?

It is relevant to point out that we analyzed the curriculum matrices of seven courses that had the pedagogical project and the course curriculum with the workload of the subjects uploaded on their internet pages or had them sent via contact with the coordinators, as will be detailed along the methodological path.
2. Theoretical Foundation

Although the education of Science teachers for the final years of Elementary Education occurs predominantly in Biological Sciences courses, during the 1990s and 2000s, new degrees in Natural Sciences were created in all regions of the country, predominantly in the North and Northeast. In some institutions where these courses are offered, the undergraduate can also qualify in Chemistry, Physics, and Biology for teaching High School and Mathematics for teaching Elementary School (REIS and MORTIMER, 2020). However, the policies have not yet established the curriculum guidelines for the Full Degree in Natural Sciences.

The Diretrizes Curriculares Nacionais (DCN) para a Formação dos Profissionais do Magistério [National Curriculum Guidelines for the Education of Teaching Professionals], approved in 2015, applied to the initial and continuing teacher education for Early Childhood Education, Elementary School, and High School and in their respective education modalities (Youth and Adult Education, Special Education, Professional and Technological Education, Field/Rural Education, Indigenous School Education, Distance Education, and Quilombola School Education) (BRASIL, 2015).

In addition, the 2015 DCNs extended to 2,200 hours the workload dedicated to the qualification activities structured by the centers of general education studies in specific and interdisciplinary areas and the nucleus of deepening and diversification of studies in the areas of professional activity (BRASIL, 2015). The 2015 DCN emphasizes practical activities, as they allocate 1,000 hours for the development of practical activities in the initial teacher education, distributed as follows: 400 hours of practice as a curriculum component, distributed throughout the initial education; 400 hours of supervised pre-service education and 200 hours of in-depth theoretical-practical activities in the undergraduates’ specific areas of interest (MATOS and REIS, 2019).

With the approval of the 2015 DCN, the high education institutions, which aim at the qualification of education professionals, would have two years to adjust their Projetos Pedagógicos de Curso - PPC [Pedagogical Course Projects], which also led to revisions in the Projeto Pedagógico Institucional — PPI [Institutional Pedagogical Project] and the Plano de Desenvolvimento Institucional — PDI [Institutional Development Plan] (MATOS and REIS, 2019). However, with Resolution CNE/CP n. 1, of August 9, 2017 (BRASIL, 2017), the deadline for the adjustments was extended
to three years, i.e., July 2018.

According to Matos and Reis (2019), many Higher Education Institutions (HEI) postponed the restructuring of undergraduate courses, waiting for the publication of the BNCC, approved in December 2017 for Early Childhood and Elementary Education and, in 2018, for High School, which would imply new demands for the qualification of Basic Education professionals.

On December 20, 2019, the approval of Resolution CNE/CP n. 2 defined the new DCN for the initial teacher education for Basic Education and established the Base Nacional Comum para a Formação Inicial de Professores da Educação Básica — BNC-Formação [Common National Base for the Initial Education of Basic Education Teachers] (BRASIL, 2019). That resolution also imposed up to two years after its publication for the implementation of the new DCN for the initial teacher education and the BNC-Formação. For institutions that had already implemented the curriculum adjustments provided for in Resolution CNE/CP N. 2/2015, the deadline for curriculum adjustments, according to Resolution CNE/CP N. 2/2019, was three years. Due to the short time that has elapsed since the publication of the DCN and the BNC-Formação and the deadline set for their implementation, they have not yet been incorporated into the curricula of the pedagogy and degree courses of the HEIs.

The latest reforms in the curricula of teacher education courses have not been implemented yet; however, when this study was carried out, the school curricula of Early Childhood Education and Elementary School had already executed the changes instituted by the approval of the BNCC. The implementation of learning and development rights and objectives that configured the Base Nacional Comum Curricular is a strategy contemplated in the Plano Nacional de Educação - PNE (National Education Plan) to universalize Basic Education and promote its quality (BRASIL, 2014). The approval of a national common core curriculum starts to dictate the contents that will be assessed in the external assessments, such as the Exame Nacional do Ensino Médio - ENEM [National High School Exam], the Sistema de Avaliação da Educação Básica - SAEB [Basic Education Assessment System] and Prova Brasil, i.e., it is now the curriculum that guides the assessment.

Until the approval of the current document, three versions of the BNCC had been presented. The first version was made available for public consultation between September 2015 and March 2016. After the public consultation, the MEC sent a second
version of the document to the Conselho Nacional de Educação [National Education Council]. The second version of the BNCC was made available on the MEC website in May 2016. The short time between the end of the public consultation of the first version and the availability of the second version of the BNCC can be considered an indication that a new version of the document was already being drafted independently of the public consultation. The final version of the BNCC for Early Childhood Education and Elementary School was approved in 2017, complemented with the base curriculum for High School in 2018. The approved version presents deep differences from the previous versions, which caused many discussions in the National Education Council and the academic sphere.

The BNCC is not a curriculum, but it is a mandatory reference for the elaboration and revision of the curriculum in the educational systems and pedagogical proposals of the school units, contributing to the alignment of public policies related to education at the federal, state, and municipal levels (BRASIL, 2018). The essential learning defined in the BNCC must collaborate to ensure the development of ten general basic education competencies that summarize the rights of learning and development (BRASIL, 2018).

Developing competence involves students developing skills to use the conceptual, procedural, and attitudinal knowledge acquired at school in everyday situations, respecting principles such as ethics, human rights, social justice, and environmental sustainability (BRASIL, 2018). However, for Cury, Reis, and Zanardi (2018), the function of the ten competencies established in the BNCC is to guide a curricula that would no longer be objective-oriented.

In the BNCC, the elementary school stage is organized into five areas of knowledge composed of curriculum components that have, in this way, favored their communication by the horizontal approach. One of these areas is Natural Sciences, which corresponds to the Science curriculum component.

Bearing in mind the BNCC proposal for the Final Years of Elementary School, we must, however, highlight some points: “thematic units define an arrangement of objects of knowledge throughout Elementary School” (BRASIL, 2018, p. 29), according to the specifics of each curricular component. The thematic units contemplate objects of knowledge, which, in turn, are related to skills.

As for the quality assurance aimed at with the implementation of the BNCC, the
external assessment processes become the focus, as a way of measuring the results and searching for better standards.

The BNCC delivered by the Ministry of Education (MEC) has been criticized by many representative entities, scholars, and education professionals either for the undemocratic way in which its final version was built, its technicist approach or for being considered a prescribed and unifying curriculum that may imprison education into handouts (CURY; REIS and ZANARDI, 2018).

For Silva (2018), the BNCC is regulatory and restrictive, reinforcing the idea of “education under control,” contrary to the texts of the 2016 DCN. The standardization the BNCC brings is against autonomy and the exercise of freedom of schools, teachers, and students in the definition of the school's curriculum proposal. For the author, the BNCC is a strategy of control through assessments, which can reinforce educational inequalities. This way, it would determine the content of exams such as ENEM, Prova Brasil, and the like.

Given the legal requirements, Basic Education teaching networks are reviewing their curricula to adapt them to the precepts of the BNCC (SANTA CATARINA, 2019). Likewise, institutions responsible for initial teacher education must review their curricula to adapt them to a common national framework. For this, they will need investments to expand the specialized teaching staff, as well as infrastructure to meet the specificities of teaching dynamics in the fields of Astronomy, Physics, Chemistry, and Geosciences. However, with the amendment to the Constitution that froze public investments, it is difficult to imagine who will invest to guarantee the effectiveness of the BNCC and the goals of the PNE.

In Santa Catarina, the adequacy of the Early Childhood Education and Elementary School curricula to the BNCC was carried out through the approval of the Currículo Base para a Educação Infantil e Ensino Fundamental do Território Catarinense (CBTC) [Base Curriculum for Early Childhood and Elementary Education of Santa Catarina] (SANTA CATARINA, 2019).

In 2011, the Santa Catarina State Department of Education made available to the state network a document designed to “objectify one of the curricular aspects: essential concepts and contents to guide the teaching action in what is most fundamental” (SANTA CATARINA, 2011). The document above, entitled “Orientação Curricular com Foco no que Ensinar: conceitos e conteúdos para a Educação Básica
(documento preliminar)” (OCFE) [Curricular Guidance with a Focus on What to Teach: Concepts and Contents for Basic Education (Preliminary Document)], brought the concepts and contents to be worked on during Elementary and High School, divided by years/grades. This document was used as a reference for teachers working in the state education network to carry out teaching planning until 2019, when the schools’ curriculum was updated to meet the BNCC with the approval of the CBTC.

3 Methodological Path

The research described in this study has a qualitative and interpretive nature (BOGDAN and BIKLEN, 2014). The investigation was carried out based on Documentary Analysis, a technique that considers “document” any written material that can be used as a source of information about human behavior (LÜDKE and ANDRÉ, 2013).

During the analysis, we surveyed the contents/knowledge objects proposed in the CBTC (SANTA CATARINA, 2019) and those indicated and used until the 2019 school year in the OCFE document (SANTA CATARINA, 2011), a regulation of the State Secretary for Education on the contents to be worked on in the state schools of Santa Catarina at each stage of Basic Education, for the curriculum component Sciences in the final years of Elementary School.

Finally, we analyzed the curricula of some degree courses offered in the state of Santa Catarina that qualified undergraduates to teach Science in the final years of Elementary School. This analysis aimed to assess the compatibility between teacher education and the contents/objects of knowledge to be worked on by teachers at this level of education.

To select the courses that had their curricula and syllabuses analyzed, we consulted with the database of the Ministry of Education (e-MEC) to identify the institutions that offer degrees in Biological Sciences, Sciences of Nature, and Natural Sciences in Santa Catarina.

The search in the database of the Ministry of Education for the degree course in “Ciências Biológicas” [Biological Sciences] returned 48 records. Given the many courses offered in the state, we selected, among the courses that had already started and which were not in the process of voluntary deactivation/extinction, those offered by public institutions, and the courses of private institutions that were authorized to
offer a higher number or equal to one thousand four hundred vacancies per year.

According to the data provided by the e-MEC platform, we selected courses from ten private and two public institutions. Then, we visited the websites of those institutions to locate the pedagogical projects of the Teaching Degrees in Biological Sciences offered in Santa Catarina. Due to the difficulty in finding the pedagogical projects of the courses, the curricula of the selected courses and the pedagogical projects, when available, were analyzed.

Among the ten private institutions selected, one does not offer the course in the state, and six institutions did not provide the pedagogical project or the curriculum of the course with the workload of the disciplines on their internet pages. We contacted the institutions that did not provide the pedagogical project nor the curricula of the courses on their internet pages and requested the curricula of the courses with the workload of each subject. Given the unavailability of information, we evaluated the curricula of the courses offered by three private institutions and four courses offered by two public institutions (two offered in the face-to-face and two in the distance modality). We chose to identify the analyzed courses by numbers (1 to 7) without identifying the HEI that offers them.

For the analysis of the curricula, we used the assumptions of Bogdan and Biklen (1994) to catalog the data. To this end, the categories proposed by Reis and Mortimer (2020) were initially used, adapted for the context of this research. We read the curriculum matrices to identify whether the teacher education suited the Science curriculum of the final years of Elementary School determined by the CBTC. To this end, the curriculum components were divided into fifteen categories of analysis (Chart 1):

<table>
<thead>
<tr>
<th>Category of analysis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology (BIO)</td>
<td>Where the curricular components that address biological knowledge were grouped, such as cellular and molecular biology and evolution; biological diversity and ecology.</td>
</tr>
<tr>
<td>Physics (PHYS)</td>
<td>It brings together curricular components that deal with physical knowledge, such as Physics I, Physics II, Mechanics, Electromagnetism, etc.</td>
</tr>
<tr>
<td>Chemistry (CHEM)</td>
<td>In this axis, the components that address chemical knowledge were grouped, such as General Chemistry, Organic Chemistry, Inorganic Chemistry, etc.</td>
</tr>
<tr>
<td>Mathematics (MATH)</td>
<td>It groups the components that address mathematical knowledge, such as Calculus I and II, etc.</td>
</tr>
<tr>
<td>Category</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------------</td>
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</tr>
<tr>
<td>Geosciences (GEO)</td>
<td>It brings together the curricular components that study the structure and origin of the Earth, such as Geology, Mineralogy, etc.</td>
</tr>
<tr>
<td>Portuguese (POR)</td>
<td>It comprises the components of introduction to the Portuguese Language, or Basic Portuguese, such as Reading and Textual Production, etc.</td>
</tr>
<tr>
<td>Computing (COMP)</td>
<td>In this axis, the components of introduction to computational resources were gathered, such as Introduction to Informatics, Microinformatics, Basic Informatics, etc.</td>
</tr>
<tr>
<td>Statistics (STAT)</td>
<td>It groups the components that approach statistical knowledge applied to Natural Sciences, such as Biostatistics.</td>
</tr>
<tr>
<td>Content Pedagogical (PEC)</td>
<td>It comprises the components that integrate the knowledge of the subject content to be taught and pedagogical knowledge, such as Didactics of Science, Teaching in Science Education, School Culture, and Scientific Culture, Science Education in Formal and Informal Spaces, etc.</td>
</tr>
<tr>
<td>Metascientific (MET)</td>
<td>It groups together the components that promote a critical reflection of science, such as the History of Science, Philosophy of Science, Scientific Dissemination, etc.</td>
</tr>
<tr>
<td>Pedagogical (PED)</td>
<td>It brings together the components that deal with the fundamental pedagogical knowledge for teaching, such as Philosophy of Education, Psychology of Education, Assessment and Curriculum, Public Policies, etc.</td>
</tr>
<tr>
<td>Mandatory Supervised Teaching Practice (STP)</td>
<td>It groups supervised teaching-practice components.</td>
</tr>
<tr>
<td>Libras (LIB)</td>
<td>It comprises the components that study Brazilian Sign Language</td>
</tr>
<tr>
<td>Optative/Elective Subjects (OPT)</td>
<td>It refers to the workload of mandatory elective components that academics must attend to complete the course curriculum.</td>
</tr>
<tr>
<td>TCC/monograph/final project (TCC)</td>
<td>It groups the curricular components that comprise guidelines on the course conclusion work as a project to be applied or monograph.</td>
</tr>
</tbody>
</table>

Source: Reis and Mortimer (2020, p. 4-5)

Once the categories of analysis were defined, we counted the workload allocated to each subject that comprised them and established the proportion in hours for each category. When the name of the curriculum component left doubts about which category it fell into, we consulted the syllabus of the component to classify it. In this analysis, the hours of complementary activities were not considered.

Subsequently, these categories were grouped into two formative axes: (i) specific subjects, in which the categories BIO, CHEM, PHYS, MATH, and GEO described above were grouped and (ii) pedagogical content, which concerns the teachers’ specific education, grouped into subjects belonging to the PEC, PED and STP categories. This organization makes it possible to analyze the curricular matrices of the courses to verify if they are still organized according to the 3 + 1 model. Therefore, the subjects allocated in the POR, COM, STA, LIB, OPT and TCC categories will not be considered in this discussion, according to the methodology proposed by Reis and Mortimer (2020). The analyses were done to compare the
curricula.

To adapt teacher education to professional practice, Resolutions CNE N. 2/2002 (BRASIL, 2002b) and CNE N. 2/2015 (BRASIL, 2015) introduced the activity called Prática Pedagógica como Componente Curricular [Pedagogical Practice as a Curriculum Component] (PPCC), to differentiate teacher education from the $3 + 1$ model linked to the research-oriented courses, as had been happening. According to current legal regulations, the PPCC must have a minimum workload of 400 hours and be developed from the beginning of the degree course. In this context, the workloads related to PPCC present in the pedagogical projects of the analyzed courses will be commented on later.

4 Results and Discussion

Comparing the contents proposed by the CBTC (SANTA CATARINA, 2019) and in the OCFE (SANTA CATARINA, 2011) for the final years of Elementary School in Science, we observed that, in the OCFE, each of the concepts listed to be worked on unfolds in contents related to each grade of Elementary School. In the CBTC, the thematic units are broken down into “objects of knowledge,” skills, and, finally, into content to be worked on in each grade of Elementary School. In the BNCC, objects of knowledge are defined as “content, concepts, and processes” (BRASIL, 2018, p. 28).

Analyzing the curriculum proposed by the OCFE, we note that it follows the traditional curriculum, i.e., Science teaching comprises: Geosciences and Biology – Ecology- subjects for the 6th grade, Biology subjects Zoology and Botany for the 7th, Biology subjects Human Anatomy and Physiology for the 8th grade, and Physics and Chemistry subjects for the 9th grade. The curriculum proposed in the CBTC, however, does not follow this traditional division, making a composition of Science contents: Biology, Physics, Chemistry, Geosciences, and Astronomy in all the final years of Elementary School.

There is a significant difference between the documents regarding the number of contents that must be worked on, with a higher number in the CBTC. The CBTC brings to Elementary School the Biology contents that were originally treated in High School, such as genetics and evolution, with which the Biological Sciences teachers are familiar but which they find complex, and other concepts in the area of Physics, Chemistry, Astronomy, and Geosciences. Table 2 presents a list of the contents
prescribed for the final years of Elementary School that are not directly addressed by the Biological Sciences.

Table 2: Physics, Chemistry, Astronomy, and Geosciences-related contents in the CBTC for the final years of Elementary School

<table>
<thead>
<tr>
<th>Year</th>
<th>Science</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>6th grade</td>
<td>Chemistry</td>
<td>Homogeneous, heterogeneous mixtures, phases, and components. Separation of miscible and immiscible mixtures. Separation of oil and its by-products. Use of Chemistry in the food and pharmaceutical industry. Utensils, reagents, equipment, and tools for laboratory (Physics, Chemistry, or Biology).</td>
</tr>
<tr>
<td></td>
<td>Physics</td>
<td>Vision problems (myopia, hyperopia, astigmatism, presbyopia, color blindness, glaucoma, etc.). Corrective lenses. Air properties (mass, weight, volume, atmospheric pressure, etc.). Concept of Light Year as a unit to express distance.</td>
</tr>
<tr>
<td>7th grade</td>
<td>Astronomy</td>
<td>Earth and other planets. The Moon, the Earth’s natural satellite. The phases of the Moon. Eclipses (of the Moon and the Sun).</td>
</tr>
<tr>
<td></td>
<td>Geosciences</td>
<td>Origin and formation of the layers of the atmosphere. Difference between climate and weather</td>
</tr>
</tbody>
</table>
Factors that influence the weather.
Air masses and their contribution to the composition of hot and cold fronts.
Natural elements and phenomena (volcanoes, earthquakes, and tsunamis).
Air temperature.
Air humidity and rainfall.
Types of rain.
Atmospheric pressure.
Plate tectonics and continental drift.

| 8th grade | Physics | Electric energy, resistance, electrical, potential Electric.
|           |         | Electric Current (direct and alternating), simple electric circuits.
|           |         | Electricity consumption and rational and conscious consumption
|           |         | Energy sources, types of power plants and their impacts.

| Geosciences | Seasons of the year.
|            | Earth’s rotation and the dynamics of the atmosphere and marine currents.
|            | Average temperature and thermal amplitude.
|            | Weather forecasting and its importance at local, regional, and global levels.

| Astronomy | Phases of the Moon.
|           | Lunar eclipses.

| Chemistry | Atomic models (the atom).
|           | Subatomic particles (proton, neutron, and electron).
|           | Chemical elements, molecules, and substances.
|           | Introduction of the periodic table by similarity between the chemical elements.
|           | Chemical bonds.
|           | Chemical reactions (reagents and products).

| Physics | Light spectrum.
|         | Decomposition of light.
|         | Sound, infrasound, and ultrasound.
|         | Laser.

| Astronomy | Universe: dimensions and theories of formation.
|           | Solar system (origin of the Sun, Earth, and Moon).
|           | Natural and artificial satellites.
|           | Asteroids, comets, and meteoroids (*sic*).
|           | The Milky Way.
|           | Stars and their life cycles.
|           | Exploration of cosmic space by man.
|           | Life off Earth.
|           | Black holes, quasars, and dwarf stars.

Source: Authors

The CBTC, which came following the implementation of the BNCC, is criticized
by researchers in Science Teaching. In Franco and Munford’s (2018) study on the three versions of the BNCC’s approach to Natural Sciences, the authors identified that the current document (the third version) organizational structure is strongly based on conceptual aspects. In this sense, it does not favor the principles of social and historical contextualization, investigative practices, and contemporary epistemological perspectives. The authors also emphasize the little participation of students, teachers, and school communities in the construction of the third version of the BNCC, which conceals many of the obscure interests and power struggles involved in the construction of the document (FRANCO and MUNFORD, 2018). Convergingly, Compiani (2018) highlights that the current edition of the BNCC represents a setback in contemplating competencies and skills as guides for education processes in the area of Natural Sciences. The author reports that he participated in the formulation of the previous version of the BNCC, which underwent broad and democratic consultation, as a member of the team of experts. In this context, Compiani (2018) reports that the preliminary base proposal advanced to contemplate the four educational axes defended by researchers in Science Teaching, in a comprehensive and complex perspective, namely: “Conceptual knowledge; Social, cultural and historical contextualization of the knowledge of Natural Sciences; Research processes and practices in Natural Sciences and Languages used in Natural Sciences” (COMPIANI, 2018, p. 94).

Given the above, we understand that the current BNCC contradicts its main purpose, which is to ground the construction of a curriculum that respects the regional particularities and not to define goals, such as the development of competencies, with an end in themselves. Thus, it standardizes documents that do not contemplate the educational axes defended by researchers in the area, as in the case of the CBTC analyzed in this work.

Given the significant change suffered by the Science curriculum for the final years of Elementary School, we selected the curricula of some teacher education courses to assess whether they were complying with the new curriculum of the subject the prospective teachers will be qualified to teach. So, we labeled the curricula of the analyzed courses with numbers from 1 to 7.

Most of the seven selected courses are carried out in the distance or blended mode, with only two in-person courses offered (one during the day and the other an
evening course), both at a public institution. Table 1 presents a summary of information from the curricula of the analyzed Biological Sciences Teaching Degree courses.

Table 1: Summary of information from the analyzed Biological Sciences Teaching Degree courses

<table>
<thead>
<tr>
<th>Courses</th>
<th>Funding</th>
<th>Modality</th>
<th>Operating shift</th>
<th>Academic semesters for curricular completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Public</td>
<td>In-person</td>
<td>Daytime course</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Public</td>
<td>In-person</td>
<td>Evening course</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Public</td>
<td>Remote</td>
<td>Does not apply</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Public</td>
<td>Remote</td>
<td>Does not apply</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Private</td>
<td>Blended</td>
<td>Evening course</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Private</td>
<td>Blended</td>
<td>Evening course</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Private</td>
<td>Remote</td>
<td>Does not apply</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Research data

The courses classified as blended distance learning offer weekly face-to-face moments such as teleclasses and mandatory-attendance classes-activities, carried out in a face-to-face support center, in addition to other asynchronous activities carried out using information and communication technologies.

Table 1 shows that most courses offered by public universities require a longer time to be completed than those offered by private universities. Nevertheless, all comply with the higher workload defined in the DCNs. Based on Resolution CNE/CP 01/2002 and Opinion CNE/CP N. 28/2001, Resolution CNE/CP 02/2002 established the duration and workload of higher education degree, full degree, and teacher education courses for Basic Education, establishing a minimum workload of 2,800 hours, including 400 hours of practice as a curriculum component, 400 hours of supervised teaching practice, 1,800 hours of curriculum content and 200 hours for academic-scientific-cultural activities (BRASIL, 2002b).

Table 2 shows the distribution of the course load according to the 15 categories of analysis defined by Reis and Mortimer (2020). It is important to point out that we did not consider the complementary activities workload for the distribution of workloads in the categories of analysis. Those activities are guided by the Diretrizes Curriculares Nacionais para a Formação Inicial Docente [National Curriculum Guidelines for Initial Teacher Education] with a minimum of 200 hours (BRASIL, 2002b; BRASIL, 2015; BRASIL, 2019) and refer to participation in research, teaching, and extension projects.

Table 2: Distribution of course hours by the analyzed categories

<table>
<thead>
<tr>
<th>Categories of analysis</th>
</tr>
</thead>
</table>
### Table 2: Curricular Workload Details

<table>
<thead>
<tr>
<th>Courses</th>
<th>BIO</th>
<th>PHY</th>
<th>CHE</th>
<th>MAT</th>
<th>GEO</th>
<th>POR</th>
<th>COM</th>
<th>STA</th>
<th>PEC</th>
<th>MET</th>
<th>PED</th>
<th>STP</th>
<th>LIB</th>
<th>OPT</th>
<th>End-of-Course Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.538</td>
<td>0</td>
<td>72</td>
<td>72</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>54</td>
<td>252</td>
<td>216</td>
<td>360</td>
<td>504</td>
<td>72</td>
<td>72</td>
<td>252</td>
</tr>
<tr>
<td>2</td>
<td>1.944</td>
<td>0</td>
<td>72</td>
<td>0</td>
<td>36</td>
<td>0</td>
<td>0</td>
<td>36</td>
<td>342</td>
<td>180</td>
<td>234</td>
<td>504</td>
<td>72</td>
<td>144</td>
<td>234</td>
</tr>
<tr>
<td>3</td>
<td>1.895</td>
<td>0</td>
<td>60</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>225</td>
<td>400</td>
<td>72</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>1.638</td>
<td>72</td>
<td>72</td>
<td>72</td>
<td>0</td>
<td>72</td>
<td>0</td>
<td>72</td>
<td>468</td>
<td>72</td>
<td>396</td>
<td>486</td>
<td>54</td>
<td>0</td>
<td>72</td>
</tr>
<tr>
<td>5</td>
<td>1.100</td>
<td>80</td>
<td>60</td>
<td>0</td>
<td>70</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>160</td>
<td>180</td>
<td>1,000</td>
<td>400</td>
<td>60</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>1.380</td>
<td>60</td>
<td>60</td>
<td>0</td>
<td>60</td>
<td>60</td>
<td>30</td>
<td>30</td>
<td>150</td>
<td>120</td>
<td>440</td>
<td>400</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>1.200</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>520</td>
<td>180</td>
<td>685</td>
<td>400</td>
<td>60</td>
<td>0</td>
<td>120</td>
</tr>
</tbody>
</table>

Source: Research data

The analyzed courses have very different curricular matrices. The analysis of the data in Table 2 reveals that the workload of the curriculum units that address biological knowledge (BIO) is much higher than the workload of the categories dedicated to Chemistry (CHE) and Physics (PHY), which was expected in the case of the Teaching Degrees in Biological Sciences.

Regarding the Mathematics (MAT) workload, we observe that in the courses in which this category of analysis is contemplated, it has the same workload as CHE and PHY categories. Regarding the Geosciences (GEO) category, we note that in the courses where this category is offered, its workload is very close to the workload of CHE and PHY, except for course 2, in which the GEO category has half the workload of the CHE category. In the analyzed curricula, the CHE, PHY, MAT, and GEO categories are covered by a subject in each category.

Another important point is that, in most of the analyzed curricula, the workload of the CHE category is dedicated only to the approach of chemical concepts and contents that allow the understanding of biological processes. The same happens with the PHYS category, i.e., the subjects are not aimed at equipping the undergraduate to teach in the final years of Elementary School. Course 1 does not have a workload dedicated to the PHY category, although it has a small workload focused on the Physics teaching methodology. The workload of this subject was classified in the
pedagogical content category (PEC).

In this context, we understand that they are indicative that the teaching of Chemistry and Physics, Geosciences, and Astronomy contents can become arduous for Biology teachers in Elementary School. Therefore, we believe that the degrees should prepare them better so they can act more adequately and effectively in the classroom in the fields of knowledge of Natural Sciences mentioned above.

The subjects of the Metascientific (MET) category have a significantly higher workload than the CHE, PHY, MAT, and GEO categories, except for courses 3 (in which they are not covered) and 4, in which they have the same workload as the other categories cited.

Considering the knowledge necessary for the teaching exercise, we observe that the Pedagogical Content category (PEC) has a lower workload than the Pedagogical (PED) category, except for courses 2 and 4. There is also a big difference in relation to the optional workload of each course. More than half of the curricula analyzed do not offer this category. The End-of-Course Paper category is addressed in all courses, but with a great difference in the hours offered, ranging from 20 to 252 hours in the analyzed curricula.

The Compulsory Supervised Teaching Practice (STP) category is offered in all analyzed courses with a minimum workload of 400 h, which meets the assumptions of the curriculum guidelines for teaching degree courses. We believe that the courses offered by public institutions usually offer a higher workload of supervised teaching practice than those offered by private institutions.

Concerning preparation for teaching, in five of the seven courses analyzed, the Pedagogical Content category (PEC) corresponds to less than 10% of the total workload. In all analyzed courses, this category has a workload of less than 15% of the total workload of the course. Regarding the Pedagogical category (PED), in only three analyzed courses, the workload of the category is greater than 15%, less than 11% in the other analyzed courses. Courses that offer a workload of less than 11% of the total workload in the PED category are offered by public institutions.

As in the Teaching Degree in Natural Sciences analyzed by Reis and Mortimer (2020), the workload allocated to the MET category stands out, being equal to or greater than the workload allocated to the CHE, PHY, MAT, and GEO categories
individually, in all the courses in which it is offered. The knowledge included in the MET category can support the prospective teacher in teaching the contents so as not to treat them as ready, unquestionable, neutral, and decontextualized (REIS and MORTIMER, 2020). In addition, the results obtained in this research also converge with Reis and Mortimer’s (2020) regarding the PEC category, hovering around 10% of the total workload in most of the analyzed courses.

Aiming to analyze the curricula of the courses to verify whether they are still organized according to the 3 + 1 model, we divided them into two axes: (i) subject content, which relates the curriculum units with content to be taught, such as Chemistry, Physics, Geosciences, and Biology (grouping the categories BIO, PHY, CHE, MAT, and GEO) and (ii) pedagogical content, subjects related to preparation for teaching (grouping the subjects belonging to the PEC, PED, and STP categories). The results of this analysis are shown in Table 3:

Table 3: Sum of the percentage of the categories in relation to the total course workload

<table>
<thead>
<tr>
<th>Courses</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis i</td>
<td>60.07%</td>
<td>54.03%</td>
<td>68.60%</td>
<td>53.23%</td>
<td>41.46%</td>
<td>54.75%</td>
<td>40.15%</td>
</tr>
<tr>
<td>Axis ii</td>
<td>25.00%</td>
<td>28.43%</td>
<td>26.40%</td>
<td>37.31%</td>
<td>49.37%</td>
<td>34.73%</td>
<td>44.77%</td>
</tr>
</tbody>
</table>

Source: Research data

In most of the analyzed courses, between 53% and 69% of the total workload is allocated to the Biology, Physics, Chemistry, and Geosciences categories, content subjects, in which most of the workload is occupied by subjects in the biological area, as seen above.

Although in some courses the workload allocated to axis i is almost twice the workload allocated to axis ii, the analyzed courses are not configured as a “3 + 1” educational model. Furthermore, the insertion of a workload addressed to pedagogical practice as a curriculum component (PPCC) distributed throughout the course in courses where it was possible to identify it configures greater attention to teacher education from the beginning of their undergraduate course.

In course 1, the PPC indicates a total of 456 h as PPCC, distributed among different subjects throughout the course. According to the PPC of that course, the PPCC aims to articulate the biological knowledge taught at the university with the particularities and objectives of this knowledge in basic education and in other educational spaces. The PPC contains an appendix in which some PPCC possibilities in Biology content subjects are described. Among the activities described are the
analysis of textbooks, the production of teaching materials, and thematic projects. There is also a description of activities that cannot be considered PPCC.

In course 2, the PPC considers it more effective to offer integrative subjects for carrying out the PPCC (Projeto PPCC Integrado I and II [Integrated PPCC Project I and II], in a total of 90 mandatory hours and the elective (optative) Projeto de PPCC Integrado III [Integrated PPCC Project III], with a workload of 72 hours ), in addition to including a workload of 307 hours for the PPCC in the compulsory subjects of the course and also in some of the elective subjects.

In course 3, the workload allocated to pedagogical practice as a curriculum component (PPCC) is 419 h, distributed among different subjects during the course. According to the PPC, it is a strategy for discussing and creating ways to teach and learn subject knowledge in High School and other levels of schooling. The activities developed within the scope of the PPCC are related to the teaching exercise of the prospective teacher in the basic school and are foreseen during all phases of the course. However, the workload of the PPCC was accounted for in this work as part of the workload of the subjects to which they are linked, as well as accounted for in the PPC of the course. With the PPCC, there is an increase in the workload for reflecting on the exercise of the profession by the prospective teacher and the development of teaching strategies that can be used during professional practice.

In course 4, the PPCC is divided between two of the three cores that make up the course, being distributed in 180 h in the common core of the teaching degrees and 306 h in the core of general training studies, totaling 486 h distributed among different disciplines. The subjects entitled Tópicos Especiais em Ciências Biológicas I, II, III and IV [Special Topics in Biological Sciences] accounted for in the PED category aim to complement the topics of interest in Biological Sciences and/or Education during their execution and have open syllabuses in the PPC of the course. According to the PPC, the syllabuses of those subjects will be defined by the course collegiate at the time they are offered and can be a valuable space to collaborate with the future professional exercise of the prospective basic education teacher. In the other analyzed courses, the available documents did not allow the identification of the workload addressed to the PPCC.

The results were similar to those found in the analysis of Teaching Degree courses in Natural Sciences by Reis and Mortimer (2020) with regard to the
educational model adopted in the analyzed courses, none of the analyzed courses was classified as structured in the “model 3 + 1”. However, the curricula examined by Reis and Mortimer (2020) demonstrate a greater balance between the workloads of axes i and ii compared to the Teaching Degree courses in Biological Sciences, the object of analysis of this research.

In this way, we accept that the elementary school science teacher should have a specific qualification, which was in line with the pedagogical demands of this level of education and that would meet the materialization, in the school environment, of a science curriculum of Natural Sciences associated with the dialogue between the disciplinary knowledge that forms the areas of Chemistry, Physics, Biology, Geosciences, and Astronomy.

However, the action of the State, through the Diretrizes Curriculares Nacionais [National Curriculum Guidelines] for teacher education, corroborates the advantage of learning to learn, thus providing an opportunity to reduce the theoretical foundation, which leads to an emptying of human education of teachers and students of Basic Education. This emptying of the theoretical foundation in teacher education suggests, through consecutive connections, the disappearance of the true meaning of practice as an integral category of the human education of Basic Education students, given the appropriation of the human dimension in teacher education.

We notice that the teacher education policy has, for a long time, been implemented to ensure the maintenance and increase of a social, political, and economic model in which education and, consequently, the teachers’ tasks are seen as essential to keep those values. However, incoherently, it threatens the objectives and conservation of hegemonic groups, which explains the policy-makers concern with the standardization of the structure and the control of the teachers’ work, subtracting the primordial function of education, which is the individuals’ humanization.

In this context of teacher education, Rodrigues, Pereira, and Mohn claim that there are influences from external experiences regarding the prescribed resizing. However, it is noteworthy that the general competencies prescribed in BNCC of Basic Education are in equal number and nature as those present in the BNC-Formação (BRASIL, 2019) and BNC-Formação Continuada (BRAZIL, 2020). Therefore, we can say that, beyond suggesting teacher education, for the first time, from the idea of competencies, with a focus on the development of practical, efficient, and productive
skills, we seek to eliminate formative projects that had been developed until them, thus promoting the de-characterization of teaching through control and standardization of educational processes.

Given the above, we infer that the reforms currently imposed interrogates the literature in the area. Promising results were identified in research in Science Teaching in Basic Education (LAUXEN et al., 2020; LIVRAMENTO et al., 2020) and in the teachers’ education in this area (DOMINICIANO and LORENZETI, 2019), as they implemented collaborative educational proposals and favored the understanding of the processes involved in the construction of scientific knowledge and their interrelationships with economic, political, cultural, and social issues.

5 Final Considerations

Studies prior to the enactment of the BNCC already revealed the difficulties encountered by teachers who graduated in Biological Sciences to teach Chemistry and Physics-related concepts in the Science subject in the final years of Elementary School, which were formerly concentrated only in the 9th grade.

The new curriculum prescribed by the CBTC for the Science subject for the final years of Elementary School considerably increased the number of contents related to the areas of Physics, Geosciences, Chemistry, and Astronomy compared to the curriculum previously adopted by the state schools. The extensive list of contents prescribed by the new curriculum will make it difficult for the curricular complements to be carried out by the school units in their pedagogical projects, since the Science workload has not changed.

Moreover, concepts related to Physics, which were previously concentrated in 9th grade, were distributed over the final four years of Elementary School; the contents of Geosciences and Astronomy, previously concentrated in the 6th grade, were distributed throughout practically all the final four years of Elementary School and the Chemistry contents, previously concentrated in the last year of Elementary School, must now be addressed in the 6th and 9th grades.

The teacher education courses analyzed in this work have a high workload dedicated to biological content, to the detriment of the workload destined to the subjects related to Physics, Chemistry, Geosciences, and Astronomy, as they are teaching degree courses in Biological Sciences. However, the low workload destined
to the subjects of the areas of Astronomy, Chemistry, Physics, and Geosciences does not equip the prospective teacher adequately to teach in the final years of Elementary School, especially after the last curricular reform that enacted the Base Nacional Comum Curricular (BNCC) and the Currículo Base da Educação Infantil e do Ensino Fundamental do Território Catarinense (CBTC) [Base National Common Curriculum and Basic Curriculum for Early Childhood Education and Elementary Education in the Territory of Santa Catarina]. This gap in teacher education, which had already been perceived in the new curriculum, can lead to a bookish and wearisome Science teaching and may alienate students from Sciences in Elementary School.

Another point to be considered is the absence of a transition period between the two curricula. This can harm students already attending the final years of Elementary School during the implementation of the CBTC, given the significant change suffered in the component’s curriculum and the High School reform established by Law N. 13415/2017. We emphasize our criticism of the reform format imposed by the BNCC, constructed without dialogue with the entities that historically fight for the right to public education for all based on public and democratic management. We also criticize the processes of privatization and commodification of education. We believe that although there must be guiding documents and markers of knowledge to be addressed in national basic education, they must respect the diversity and plurality of the population and Brazilian regions.

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