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BNCC and climate change: analysis of a collection of textbooks from the new high school curriculum

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ABSTRACT

Discussions on climate change are extremely relevant in the current context, given its alarming and potentially irreversible nature. In light of this reality, education emerges as a key tool for fostering students' understanding and awareness of the climate crisis, enabling active and informed engagement. This study aimed to analyze how the topic of climate change is addressed in a collection of Natural Sciences textbooks following the implementation of the BNCC reform, within the context of the new brazilian high school curriculum. We adopted a content analysis methodology, which began with a preliminary review of the textual material. The content was then coded and organized into subcategories based on recording and context units. In the final stage, the results were interpreted through inferences and comparisons with similar studies. The analysis revealed several gaps and a simplistic approach to climate change in the new high school curriculum. Key findings include the concentration of content in a single volume, the absence of interdisciplinary perspectives, a focus on physical phenomena without socio-environmental context, limited discussion of consequences, lack of proposals for mitigation actions, and the inclusion of numerous topics unrelated to the core theme. The limitations identified in both the student textbook and the teacher's guide highlight a discrepancy between the objectives and guidelines set by the BNCC. This inconsistency may hinder students' critical thinking development and compromise a comprehensive understanding of the issue in the analyzed materials.

KEYWORDS: Ecology; Textbook; Curriculum Guidelines; Science Education; Environmental Education.

BNCC e mudanças climáticas: análise de uma coleção de livros didáticos do novo ensino médio

RESUMO

As discussões sobre mudanças climáticas são extremamente relevantes no cenário atual, dada a sua natureza alarmante e potencialmente irreversível. Diante dessa realidade, a educação surge como um instrumento de compreensão e sensibilização dos estudantes sobre a crise climática, possibilitando uma atuação ativa e consciente. Este estudo teve como objetivo analisar como o tema das mudanças climáticas é abordado em uma coleção de livros didáticos de Ciências da Natureza, após a reforma da BNCC, no contexto do novo ensino médio. Utilizamos a metodologia de análise de conteúdo, que se iniciou com uma pré-análise do conteúdo textual. Em seguida, o material foi codificado e classificado em subcategorias por meio de unidades de registro e de contexto. Na etapa final, os resultados foram interpretados por meio de inferências e comparações com estudos similares. O estudo revelou diversas lacunas e uma abordagem simplista sobre mudanças climáticas no novo ensino médio. Observamos a concentração dos conteúdos em um único volume, a ausência de interdisciplinaridade, o foco em fenômenos físicos sem contexto socioambiental, a escassez na discussão das consequências, a falta de proposições mitigatórias que instiguem ações ou orientem caminhos possíveis, bem como uma a grande quantidade de assuntos que não contextualizam explicações diretas sobre o tema. As limitações observadas nesta coleção, presentes tanto no livro do aluno quanto no manual do professor, evidenciam um contraste entre os objetivos e diretrizes propostos pela BNCC. Essa incongruência pode potencialmente comprometer a formação crítica dos estudantes e dificultar a compreensão adequada do tema na coleção analisada.

PALAVRAS-CHAVE: Ecologia; Livro Didático; Diretrizes Curriculares; Ensino de Ciências; Educação Ambiental.

INTRODUCTION

An education aimed at understanding natural processes and the ways in which human beings transform the Earth is essential for fostering a shift in attitudes and behaviors, both among the general population and within governments (Silva et al., 2013). In this context, schools play a central role in addressing climate change, a phenomenon resulting from the intensification of the greenhouse effect caused by gases such as carbon dioxide (CO_2) and methane (CH_4), which have been emitted on a large scale since the Industrial Revolution (Intergovernmental Panel on Climate Change [IPCC], 2021). The main sources of these emissions are the burning of fossil fuels and intensive land use, which involves the replacement of natural ecosystems with agricultural, urban, and industrial areas (IPCC, 2021).

The 1.55 °C increase in the global average temperature since the pre-industrial period (World Meteorological Organization [WMO], 2025) highlights the impacts of human activity on the biosphere and biogeochemical cycles, bringing the planet closer to critical thresholds regarding climate stability (Steffen et al., 2015; Tollefson, 2025). Heatwaves, droughts, and biodiversity loss already reflect these effects (IPCC, 2021). Given this scenario, education emerges as a key pathway for fostering understanding and awareness of the effects of climate change, enabling the development of a critical and informed society (Monroe et al., 2019).

In this regard, knowledge from the Natural Sciences and their Technologies plays a fundamental role in understanding environmental issues and in encouraging actions aimed at addressing them (Brasil, 2000). This is achieved through a contextualized approach, connected to students' everyday lives and focused on the development of logical reasoning and the understanding of natural phenomena (Brasil, 1997). In this way, students become capable of applying this knowledge across different social spheres, taking on an active role within their communities (Brasil, 1997).

As the main disseminator of knowledge in schools, the textbook holds a central position, serving as a reference for both teachers and students (Peyneau et al., 2022). It functions as an essential cross-curricular tool, integrating different areas of knowledge and supporting teaching practices through methodological guidance (Peyneau et al., 2022). However, environmental education, a contemporary and cross-cutting theme, was only formally incorporated into these materials following MEC Opinion 226/87 and the 1988 Federal Constitution (Arruda & Tomaz, 2009; Köb-Nogueira & Gonzalez, 2014). In the following decades, this inclusion intensified with the growing emphasis on environmental issues in education, driven by social movements focused on sustainable development and the mitigation of socio-environmental problems (Arruda & Tomaz, 2009; Köb-Nogueira & Gonzalez, 2014). As a result, nature-related topics were gradually integrated into school curricula and textbooks, aiming to strengthen their role in fostering a critical and engaged environmental consciousness (Arruda & Tomaz, 2009).

Due to the late adoption of environmental education in Brazil, the primary objective of this approach, which is recognizing humans as part of ecological interrelationships, was delayed (Ruscheinsky, 2009). Individual decisions, as

members of society, need to be made with a critical perspective that considers socio-environmental impacts (Grubba & Pellenz, 2024). To this end, it is necessary to question both the negligence toward degradation caused by economic and urban development and the lack of efforts to restore nature (Ruscheinsky, 2009). Because of the recent incorporation of environmental themes into brazilian education, textbooks still present rudimentary approaches and offer few practical and critical proposals (Rumenos et al., 2017). However, topics related to climate change are beginning to appear in the guidelines of the National Common Curricular Base (Base Nacional Comum Curricular, BNCC, in portuguese) (Brasil, 2018a, p. 556).

In the school curriculum, environmental topics are proposed in a cross-curricular manner, primarily within the Natural Sciences subjects, which include content aimed at understanding relevant environmental issues (Brasil, 2018a, p. 21). The BNCC indicates that, in high school, this area encourages reflections on global and local aspects of contemporary society (Brasil, 2018a). The content ranges from “biotechnology and environmental conservation” to “deforestation, climate change, nuclear energy, and the use of genetically modified organisms” (Brasil, 2018a, p. 547). Furthermore, the BNCC emphasizes that science and technology go beyond problem-solving, promoting new ways of understanding the world both individually and collectively (Brasil, 2018a). In this way, the Natural Sciences propose the integration of biological diversity, its relationship with the environment, and topics such as the greenhouse effect and climate change (Brasil, 2018a).

In this study, we analyze and describe how climate change is addressed in a collection of Natural Sciences textbooks for the new high school curriculum, approved by the 2021 National Textbook Program (Plano Nacional do Livro Didático, PNLD, in portuguese). The selection of this collection is justified by it being the first adopted by a public school in the region following the implementation of the new high school, as well as the easy access to both physical and digital versions. To this end, we conducted a textual analysis of the content related to the topic, evaluating the frequency of terms and contextual units concerning causes, consequences, mitigation measures, and units without context, as well as the approach and intentionality of the statements across the different volumes. We also examined the presence of these terms and units in student textbooks, teacher manuals, and the subjects of biology, chemistry, and physics to identify the degree of interdisciplinarity. Finally, the results were discussed in light of critiques of technicist and reductionist education, which fragments and decontextualizes socio-environmental issues, distancing them from the students' reality.

METHODOLOGY

In this study, which is documentary in nature and qualitative in approach, we analyzed a collection of textbooks in the field of Natural Sciences through Bardin’s (2011) content analysis. We examined six volumes of the work Natural Sciences and Their Technologies, by Lopes and Rosso (1st ed., 2020), including both teacher manuals and student textbooks. The collection, approved by the 2021 National Textbook Program (PNLD) and intended for the new high school curriculum, is part

of the PNLD 2021 Textbook Guide (Brasil, 2021) and was adopted by a public school in northwest Paraná during the 2021–2023 triennium. Figure 1 presents the analyzed volumes and their respective justifications (Brasil, 2021).

Figure 1

Titles of the analyzed collection volumes and their respective justifications.

Volume	Justification
Volume 1 – Evolution and the Universe	Recognizing the multiple roles of the relationship between science, technology, and society is fundamental for decision-making in the face of ethical, cultural, political, and socio-environmental challenges.
Volume 2 – Energy and Sustainable Consumption	Education for sustainable development encourages behavior changes and decisions focused on environmental integrity, economic viability, and social justice for current and future generations.
Volume 3 – Water, Agriculture, and Land Use	The depletion of natural resources and environmental degradation, such as desertification, droughts, biodiversity loss, and water scarcity, increase the challenges to be faced.
Volume 4 – Pollution and Movement	We are exposed to messages that promote unrestrained consumption, whose harmful impacts contribute to climate change, resource exploitation, and increased social inequalities.
Volume 5 – The Human Body and Healthy Living	Health is essential to sustainable development, influenced by economic, social, and environmental factors, including social determinants such as nutrition and education.
Volume 6 – Technological World and Applied Sciences	Technological innovation drives economic growth and development, offering solutions to economic and environmental challenges, and fosters skills for more flexible and creative human development.

Source: Lopes and Rosso (2020, p. 26) (adapted).

Bardin's (2011) content analysis method, adopted in this study, aims to reveal indicators beyond the explicit content of messages. The application of this method followed three stages, beginning with the pre-analysis, which involved a "floating reading" of the term "climate change" and identifying the frequency of related terms, taking into account the authors' interpretation to verify whether their use was effectively related to the phenomenon. For this purpose, we conducted an automated search across the six volumes for expressions such as "climate change(s)," "global warming," "greenhouse effect," "global climate," "climatic conditions," and "global climate change."

In the second stage, we examined the material by defining the analysis category "textual content" (Liotti & Campos, 2021), focusing on the body of the text and excluding activities and iconographic content. We adapted the subcategories proposed by Liotti and Campos (2021) to include causes, consequences, mitigation measures, and units without context related to climate change. In the third stage, we coded and classified the material by breaking the text into recording and context units, that is, sentences or paragraphs related to the topic (Liotti & Campos, 2021). To this end, the authors worked collaboratively to classify the context units, aiming to reduce subjectivity in composing the subcategories. To ensure that only units from the main body of the text were

included, we applied a filter to exclude terms found in activities, references, captions, titles, tables of contents, introductory questions, and answer keys from both the student and teacher editions (Figure 2).

Figure 2

Analysis category and description of analysis subcategories.

Analysis Category	Analysis Subcategories	Description
Textual Content	Causes of Climate Change	Possible contributing factors to climate change.
	Consequences of Climate Change	Potential scenarios resulting from climate change.
	Mitigation Measures Related to Climate Change	Adaptive strategies involving the development of alternatives to minimize the effects of climate change.
	Units Without Context Related to Climate Change	Do not present content related to climate change, consisting only of mentions.

Source: Adapted from Liotti and Campos (2021) and Rumenos et al. (2017).

In the final stage, characterized by the processing and interpretation of results, we organized the excerpts according to the established subcategories. We analyzed the frequency of terms and context units by volume, subject (biology, chemistry, physics, and "BCP"), type of material (student book or teacher's manual), and topic. We also examined the intentionality of the statements and the context in which they appear, grounding our interpretations in the theoretical framework to answer the research question through critical inferences.

RESULTS AND DISCUSSION

FREQUENCY OF TERMS BY VOLUME

A total of 88 terms related to climate change were identified in the student book (SB) sections and 81 in the teacher's manual (TM) sections of the collection. In both parts, the entries are concentrated in Volume 4: 76% in the student book and 89% in the manual. Volume 2 ranks second in number of occurrences, accounting for 18.2% of the terms in the student book and 7.4% in the teacher's manual. The other volumes showed only occasional occurrences, with Volumes 5 and 6 having no entries in the manual, and only Volume 5 absent from the student book, highlighting a significant concentration of terms in a single volume (see Figure 3).

Figure 3

Concentration of terms related to climate change by volume.

Terms	Climate Change(s)		Global Warming		Greenhouse Effect		Other Terms		Total	
Book Section / Volume	SB	TM	SB	TM	SB	TM	SB	TM	SB	TM
Volume 1	-	-	-	-	3	1	-	-	**3**	**1**
Volume 2	3	-	1	2	12	4	-	-	**16**	**6**
Volume 3	-	-	-	-	1	2	-	-	**1**	**2**
Volume 4	10	6	17	28	37	35	3	3	**67**	**72**
Volume 6	-	-	-	-	1	-	-	-	**1**	**-**
Total	**13**	**6**	**18**	**30**	**54**	**42**	**-**	**3**	**88**	**81**

Source: Prepared by the authors.

In both cases, the most frequent term was “greenhouse effect” (61.3% in the student book and 51.9% in the teacher’s manual), followed by “global warming” (20.5% and 37%, respectively) and “climate change(s)” (14.8% and 7.4%). More generic expressions, such as “global environmental change” or “climate shift,” were rare, totaling about 3% in both. The distribution emphasizes specific physical phenomena, like the greenhouse effect and global warming, rather than broader or more central terms related to climate change. Liotti and Campos (2021) also identified this trend, highlighting an approach more focused on terms linked to chemical transformations and geochemical cycles than on contextualized and critical discussions.

Most volumes contained few or none of the terms mentioned, with a concentration in only two. Although these books have distinct learning objectives, the collection’s proposal addresses topics that are related, to some extent, to climate change, such as “positioning and decision-making in the face of socio-environmental challenges,” “behavioral change focused on environmental integrity,” “challenges posed by the depletion of natural resources,” and “consumption impacts that contribute to global climate change” (Lopes & Rosso, 2020, p. 26). However, these connections are not adequately highlighted throughout the collection, as the terms appear concentrated rather than evenly distributed among the volumes.

The superficiality observed can be understood in the context of brazilian high school education, which, despite educational policies aimed at including environmental issues in the curriculum, such as the National Education Plan (Brasil, 1999), the National Curriculum Guidelines for Environmental Education (Brasil, 2012), and Law No. 14,926 of April 10, 2024 (Brasil, 2024a), still faces challenges regarding a critical and in-depth approach to this topic. Thus, education remains primarily structured to meet labor market demands and corporate interests (Malanchen & Zank, 2020). In this collection, the frequency of the term reflects the distance from climate change as an environmental theme in both parts of the book, even though climate change is central to contemporary environmental discussions.

Regarding the teacher’s manual, the curriculum establishes the guidelines for what should be taught, while the textbook reproduces this content, serving as a

resource that the teacher can use, adapt, or complement (Rosa, 2018). However, teaching staff are often overlooked in the development of these materials, limiting support for classroom planning and practice (Rosa, 2018). Although the teacher's manual is not the sole source for educators and serves different functions than the student book, it is essential that it provides clear and useful guidance for lesson preparation (Peyneau, 2022). The lack of direction can lead to insecurity and superficial or incorrect approaches. The concentration of topics in a single volume also restricts discussion time, confining "climate change" to one bimester and one chapter, despite its cross-cutting nature as part of environmental education. While there are various possibilities to build knowledge, the predominance of technical material with little focus on the climatic phenomenon, as seen in the analyzed collection, may hinder deeper understanding of the subject.

FREQUENCY OF RECORDING AND CONTEXT UNITS BY VOLUME

A total of 81 occurrences related to climate change were recorded in the collection, distributed among causes (C), consequences (CC), mitigation measures (MM), and units without context (UWC). In the student book (SB), there were 40 entries, and in the teacher's manual (TM), 41. Most were concentrated in Volume 4, accounting for 75% of entries in the student book and 85.4% in the teacher's manual. Volume 2 also showed significant participation, with 17.5% and 12.2%, respectively. The remaining volumes presented few or no occurrences, notably with no entries at all in Volumes 1, 5, and 6 of the teacher's manual and Volume 5 of the student book (see Figure 4).

Figure 4

Concentration of registration and context units in subcategories by volume.

Context Units	C		CC		MM		UWC		Total	
Book Section / Volume	SB	TM	SB	TM	SB	TM	SB	TM	SB	TM
Volume 1	1	-	-	-	-	-	-	-	**1**	**-**
Volume 2	-	2	-	-	6	3	1	-	**7**	**5**
Volume 3	1	1	-	-	-	-	-	-	**1**	**1**
Volume 4	17	10	5	-	2	5	6	20	**30**	**35**
Volume 6	-	-	-	-	1	-	-	-	**1**	**-**
Total	**19**	**13**	**5**	**-**	**9**	**8**	**7**	**20**	**40**	**41**

Source: Prepared by the authors.

In the student book, causes of climate change were the most frequent subcategory (47.5%), followed by mitigation measures (22.5%), consequences (12.5%), and units without context (17.5%), that is, terms without clear connection to causes, effects, or solutions. In the teacher's manual, most occurrences were units without context (48.8%), with causes accounting for 31.7% and mitigation measures for 19.5%. No records of consequences were found. This distribution indicates an emphasis on causal explanations in the student book and a more fragmented presence in the manual, alongside a scarcity of references to impacts and strategies to address climate change.

The subcategory "units without context" was created to classify mentions or fragments without a direct relation to climate change, replacing the

subcategory “definition of climate change,” inspired by Liotti and Campos (2021), which did not appear in the collection. According to Dahlberg (1978), defining something means establishing the boundaries of a concept or idea. The absence of this definition compromises the clarity and depth of the topic, showing that the collection neglects an essential aspect of scientific literacy and critical thinking in basic education.

The BNCC (2018a) proposal to promote the understanding of scientific terminology in high school contrasts with the absence of a definition of “climate change” in this collection. Although the curriculum framework emphasizes the importance of familiarizing students with fundamental scientific concepts, the material does not provide a clear explanation of the term, assuming prior knowledge. This is problematic because the topic is addressed through causes, consequences, and mitigation measures, which require an understanding of the central concept. Thus, there is an incongruity with the specific competencies of the BNCC in Natural Sciences and their Technologies, which states:

> The contextualization of knowledge in the area goes beyond simply exemplifying concepts with facts or everyday situations. Thus, learning should value [...] the protagonism of students in addressing issues related to consumption, energy, security, environment, health, among others. (BNCC, 2018a, p. 549)

Our findings also corroborate Liotti and Campos (2021), who point out that reductionist and conventional information about the topic permeates the volumes they analyzed. As evidenced, the predominant focus on the causes of climate change can directly interfere with the development of the skill proposed for the Natural Sciences area, which involves not only the technical understanding of natural phenomena, but also the critical analysis of their consequences and possible human actions to mitigate them:

> “(EM13CNT105) Analyze biogeochemical cycles and interpret the effects of natural phenomena and human interference on these cycles, in order to promote individual and/or collective actions that minimize harmful consequences to life." (BNCC, 2018a, p. 555).

In addition to the concentration of recording units in a single volume, we also highlight the high incidence of occurrences classified as “units without context” in the teacher’s manual, as well as the absence or very limited presence of records concerning the consequences of climate change in both parts of the book. These findings reveal a significant gap in how the topic is addressed in the student book and indicate that the teacher’s manual lacks adequate didactic resources to support the preparation of contextualized lessons aligned with the general competencies of the BNCC. Such as the following one:

> Argue based on facts, data, and reliable information in order to formulate, negotiate, and defend ideas, viewpoints, and shared decisions that respect and promote human rights, socio-environmental awareness, and responsible consumption at the local, regional, and global levels, with an ethical stance toward caring for oneself, others, and the planet. (BNCC, 2018a, p. 9)

Saviani (2008) states that learning depends on a deliberate and systematic process in which the curriculum organizes time, agents, and instruments so that students’ efforts can be successful. In the teacher’s manual of this collection, there is a gap between the curricular proposal and the didactic support, with

limited guidance and a lack of relevant contexts. This may hinder learning, as students will struggle to understand climate change if teachers are not critically and structurally guided by the main curricular tool: the textbook. Although Volume 4 contains more entries, many are units without context, contributing little to knowledge construction and revealing a void that undermines the goals of education.

UNITS OF REGISTRATION AND CONTEXT AND INTERDISCIPLINARITY

A total of 81 units of registration and context were identified in the analyzed materials, with 40 in the student book (SB) and 41 in the teacher's manual (TM), distributed across biology, chemistry, physics and interdisciplinary content (BCP), which refers to content common to all three disciplines. In both materials, biology accounted for the majority of the records, with 62.5% in the student book and 53.7% in the teacher's manual. Chemistry represented 20% in the student book and 21.9% in the manual. The interdisciplinary BCP content appeared in 12.5% of the student book entries and 21.9% of the teacher's manual. Physics was the least represented, with 5% in the student book and 2.4% in the manual (see Figure 5).

Figure 5

Concentration of registration/context units by discipline.

Context Units	C		CC		MM		UWC		Total	
Book Section / Disciplina	SB	TM	SB	TM	SB	TM	SB	TM	SB	TM
Biology	12	9	3	-	3	4	7	9	**25**	**22**
Chemistry	4	3	1	-	3	-	-	6	**8**	**9**
Physics	-	-	-	-	2	1	-	-	**2**	**1**
Biology, Chemistry and Physics (BCP)	3	1	1	-	1	3	-	5	**5**	**9**
Total	**19**	**13**	**5**	**-**	**9**	**8**	**7**	**20**	**40**	**41**

Source: Prepared by the authors.

In the student book, causes correspond to 47.5%, followed by mitigation measures (22.5%), units without context (17.5%), and consequences (12.5%). In the teacher's manual, units without context represent 46.3%, followed by causes (31.7%) and mitigation measures (19.5%), with no occurrences of consequences. The analysis shows that the interdisciplinarity proposed by the BNCC for high school, which integrates Natural Sciences and Technologies to address socio-environmental issues such as climate change, remains more theoretical than practical. In the analyzed collection, the theme appears mainly in biology, with sporadic and limited presence in physics, chemistry, and the integrated sections. In the study by Liotti and Campos (2021), the theme was also less present in physics, but its highest frequency was found in chemistry books, contrasting with the findings of this study.

Federal Resolution No. 4/2018, in Article 7, item II, mandates that curricula and pedagogical proposals follow the guidelines of the BNCC, which include the interdisciplinary organization of curricular components (Brasil, 2018b). This guideline presupposes more "dynamic, interactive, and collaborative" strategies

in the teaching-learning process (Brasil, 2018b, p. 16). However, the discrepancy between the guidelines and their implementation in teaching materials, such as in this collection, reveals the contradiction highlighted by Orso (2020), who critically points out the supposed interdisciplinarity promoted by the BNCC:

> In the name of supposed interdisciplinarity and a hypothetical articulation between knowledge areas, contents are transformed into an indistinct, nebulous, and undifferentiated amalgam where everything is everything and nothing is anything. Thus, one can work and teach anything in any way, without any obligation or scientific rigor. (Orso, 2020, p. 43)

In this sense, the "articulated perspective" among biology, chemistry, and physics, as foreseen by the BNCC to address socio-environmental themes such as climate change, does not materialize in the analyzed didactic collection. This limitation directly compromises the proposal of transversal contemporary themes, such as environmental education, which, according to the collection itself,

> "[...] aims to contribute so that school education is effective as an efficient strategy in building student citizenship and their active participation in social life, rather than as an end in itself, giving these contents a broader and more relevant meaning." (Lopes & Rosso, 2020, p. 8).

However, in practice, the topic of "climate change" remains limited and underexplored in two of the three disciplines that make up the Natural Sciences curriculum component. Even in sections intended for integration between areas, interdisciplinarity does not occur, despite the fact that contemporary cross-cutting themes "[...] do not belong to a specific discipline, but rather transcend and are relevant to all of them" (Lopes & Rosso, 2020, p. 8). This deficiency is even more concerning in the teacher's manual, which should provide solid and articulated support to ensure learning consistent with the BNCC guidelines.

The large number of units without context in the teacher's manual suggests that, although the topic is present, it is treated in a scattered, uncoordinated, and superficial manner. The predominance of causes, along with the absence of consequences in the teacher's manual and their low presence in the student's book, reveals a simplistic causal approach that ignores the impacts and possible responses to the climate crisis. Orso (2020) warns that this superficiality may favor capitalist interests by avoiding debates about structural changes in production and consumption patterns. Thus, the interdisciplinarity proposed by the BNCC loses strength in the face of material that does not guide the teacher critically and formatively, but instead reproduces gaps in the educational process (Orso, 2020).

CAUSES OF CLIMATE CHANGE

Among the main factors causing climate change identified in the units of record and context, the following stand out: intensification of greenhouse gases (32), anthropogenic actions (15), fossil fuel combustion (14), and carbon dioxide release (13). Other causes, such as consumption patterns, methane emissions, volcanic activity, and carbon footprint, also appeared but were excluded from the figure due to having three or fewer occurrences. In these approaches, an emphasis

on more general causes, to the detriment of specific causes such as agriculture (6), wildfires (4), and deforestation (4), can be observed in the following examples (Figure 6).

Figure 6

Examples of the causes of climate change in the analyzed textbooks.

> [...] It is important for students to understand that the greenhouse effect is essential for the existence and maintenance of life on Earth and to recognize that the intensification of this phenomenon is caused by human actions and results in environmental problems such as global warming. (vol. 4, p. 55)
>
> [...] The Earth is getting warmer! This is because, for over a century, humanity has been releasing a huge amount of carbon dioxide and other greenhouse gases into the atmosphere. (vol. 4, p. 125)
>
> [...] Various human activities release aerosols into the atmosphere. The incomplete burning of fossil fuels and the clearing and burning of biomass due to deforestation not only emit greenhouse gases but also produce a large amount of aerosols incorporated into smoke, especially soot or black carbon. (vol. 4, p. 183)

Source: Lopes and Rosso (2020)

The analysis revealed that the causes of climate change are addressed superficially, with general terms rather than more specific explanations such as deforestation, industrial activities, and consumption patterns. Wildfires, deforestation and agricultural expansion, the main sources of CO_2 in Brazil (about 75% of emissions, according to the Climate Observatory, 2023), were rarely mentioned. This pattern was also identified by Souza (2022), who highlights the emphasis on carbon dioxide (CO_2) emissions without delving into their origins.

Carbon dioxide (CO_2) is the most frequently mentioned greenhouse gas in references to the burning of fossil fuels, as also noted by Liotti and Campos (2021) and Souza (2022). It accounts for about 67% of emissions, followed by methane (CH_4) with 24%, nitrous oxide (N_2O) with 8%, and fluorinated gases such as HFCs and PFCs with 1% (Observatório do Clima, 2023). However, CH_4 and N_2O are rarely mentioned as causes of climate change, which may lead to the idea that the problem is limited to CO_2. This is significant since the conversion of natural areas to agriculture accounts for about 27% of emissions in Brazil, with methane standing out as one of the main gases emitted in this process (Observatório do Clima, 2023).

Another relevant point is the use of generic terms, such as “anthropogenic actions,” without detailing which human groups are involved. This can hinder students from recognizing the main drivers of these emissions and the major production chains responsible. Souza (2022) highlights that textbooks tend to perpetuate capitalist logic by assigning blame to human actions in a generic way, ignoring socioeconomic inequalities and differentiated responsibilities among countries and social classes. Thus, the unequal structure of society is silenced, even with data showing that the wealthiest emit twice as much carbon as the poorest (Souza, 2022). This omission undermines the development of the skill foreseen in the BNCC to analyze the effects of natural phenomena, such as climate change:

> (EM13CNT105) Analyze biogeochemical cycles and interpret the effects of natural phenomena and human interference on these cycles, in order to promote individual and/or collective actions that minimize harmful consequences to life. (BNCC, 2018a, p. 557).

CONSEQUENCES OF CLIMATE CHANGE

The most frequently discussed topics related to the consequences of climate change included: global temperature rise (3); ocean acidification (3); sea level rise (2); and coral extinction (2). Other consequences, such as polar ice cap melting and changes in climate patterns, appeared only once.

The consequences of climate change were the subcategory with the lowest frequency of contextual units. Moreover, the topics addressed reveal a superficial approach, with brief discussions on issues that could have severe impacts on humanity. As such, the theme was addressed in a limited manner, falling short of the complexity and seriousness it demands. This pattern, also identified by Liotti and Campos (2021) and Souza (2022), highlights the omission of fundamental aspects of reality. As a result, consequences that could directly affect people's daily lives are often overlooked and concealed. Some examples illustrate this situation (Figure 7):

Figure 7

Examples of the consequences of climate change in the analyzed textbooks.

[...] According to the World Meteorological Organization (WMO) and the Intergovernmental Panel on Climate Change (IPCC), in 2018 the planet was 1°C warmer than average pre-Industrial Revolution levels, a warning for countries to adopt mitigation measures and prevent catastrophic changes, such as sea level rise and increasing ocean temperature and acidity. (v. 4, p. 124)

[...] Its message, based on studies by hundreds of scientists, is both simple and alarming, and for some, even terrifying: if nothing is done to reduce carbon dioxide emissions and other greenhouse gases, global temperatures will continue to rise, the polar ice caps will melt, sea levels will rise, and the planet's climate patterns will undergo profound, and in many cases, devastating changes. (v. 4, p. 188)

[...] It contributes to the increase in carbon dioxide (CO_2) emissions into the atmosphere, intensifying the greenhouse effect and global warming. One of the consequences of this rise is the extinction of corals, as CO_2 dissolves in water and reacts with it, increasing ocean acidity. This process causes the destruction of these marine species, whose skeletons are primarily composed of calcium carbonate." (v. 4, p. 171)

Source: Lopes and Rosso (2020).

Here, we highlight a focus on the consequences of climate change for seas and oceans, which may distance students from reality, considering that around 50% of the brazilian population lives in inland areas or urban centers far from the coast (Instituto Brasileiro de Geografia e Estatística [IBGE], 2024). Rumenos et al. (2017), in their analysis of textbooks from the 2014 PNLD, also found that climate change was primarily represented through its impacts on the oceans. Although conducted prior to the implementation of the BNCC, that study supports the findings of this research. Loureiro et al. (2025) and Liotti and Campos (2021) also identified similar patterns in iconographic (PNLD 2021) and textual (PNLD 2015) content, respectively.

Rumenos et al. (2017) emphasize that the savannization of the Amazon and biodiversity loss received greater attention when addressing global temperature increase. In this study, the main focus was on sea level rise due to the melting of polar ice caps and ocean acidification, which causes coral extinction. The analyzed collection also lacks a social approach, discussing climate consequences primarily from a marine perspective and ignoring impacts on society, such as environmental injustices affecting marginalized populations (Souza, 2022). Liotti and Campos (2021) also highlighted this absence of broad contextualization, which considers the complexity of physical factors and their social implications.

Although the BNCC presents guidelines that value critical thinking, evidence-based argumentation, and socio-environmental understanding (BNCC, 2018a, p. 9), authors such as Orso (2020) highlight structural contradictions. According to him, curriculum reformers perpetuate inequalities and weaken public education. This criticism becomes even more relevant when we observe that, despite seemingly progressive guidelines, there is a tendency to dilute scientific content, as evidenced in the analyzed collection. The lack of connection with social reality and consumption patterns contradicts the competencies set forth and prevents students from understanding their political role in facing environmental challenges. Thus, the disparity between the BNCC and the textbooks reveals the limitations of the curricular framework and the possible market influences on educational material production.

MITIGATION MEASURES FOR CLIMATE CHANGE

Among the strategies to minimize the effects of the climate crisis, the following stand out: international environmental policies and agreements (7); use of clean energy or rechargeable batteries (4); and reforestation or carbon sequestration (3). Other initiatives, such as electric cars, supercomputer projections, and protection of natural areas, were mentioned only once. The content in this subcategory addressed mitigation measures at both macro and micro scales, aligning with Rumenos et al. (2017), who identified technological, political, and individual mitigation measures, such as the use of renewable sources and carbon sequestration. Similarly, Souza (2022) highlighted international agreements like the Kyoto Protocol, youth activism, and the replacement of fossil fuels, reflecting the results of this collection. Some examples are shown in Figure 8.

Figure 8

Examples of mitigation measures for climate change in the analyzed textbooks.

[...] Thus, if some countries continue to emit large amounts of greenhouse gases, the consequence will affect the entire planet. Therefore, it is essential that discussions involve countries with the commitment of all. Hence the need to reflect, at a collective level, on public policies aimed at reducing each nation's contribution to the climate catastrophe, since individual measures contribute only minimally to solving these problems. (v. 4, p. 60)

[...] Emphasize that mitigation actions should be as specific as possible; for example, walking to school or turning off the shower while soaping during a bath. At the intersection, an action that has the power to mitigate and reduce the damage already caused should be proposed. These actions generally involve restoring natural environments or protecting natural areas. (v. 4, p. 57)

> [...] a new generation of young activists is leading movements demanding decisive and swift measures in response to the urgency of curbing global warming and stressing the need to preserve biodiversity. (v. 4, p. 124)

Source: Lopes and Rosso (2020).

Despite the breadth of the mitigation measures presented as positive, the material does not explain how these actions can be effectively implemented. Solutions are highlighted, but without deepening their importance or the pathways to initiate or put them into practice. For example, the material mentions the role of youth in activism and sustainable behaviors, national commitments, and reforestation, but does not detail how to start public policies or truly engage young people. Additionally, the energy matrix transition is mentioned without discussing its complexity or sufficiency. Therefore, we identify a gap between presenting initiatives and encouraging their critical and feasible development.

This gap reinforces the need for active, critical, and emancipatory pedagogical practices that shape more conscious and engaged students (Freire, 2001). Education, in the face of the climate crisis, is both a hope and a product of human action, being essential to stimulate reflection and critical action in response to environmental challenges (Freire, 2001). Although it does not represent an isolated solution, education is a central element in a collective response. However, in this collection, there is a lack of consistent encouragement for critical thinking that goes beyond the individual scope, promoting an understanding of the political and social role of new generations in the face of the climate emergency.

Souza (2022) points out that educational proposals are influenced by major funders who, lacking pedagogical training, hire companies that treat the curriculum as an industrial product aligned with capitalist logic and their own interests. Addressing socio-environmental problems is inconvenient for these funders because it would require structural changes and investments that could affect their profits and production models. Therefore, it is strategic for teaching materials produced under this logic, such as the analyzed collection, to avoid promoting a critical and transformative approach to these issues (Silva et al., 2025), which undermines specific competencies outlined in the BNCC for Natural Sciences, such as the following:

> Investigate problem situations and evaluate applications of scientific and technological knowledge and their implications in the world, using procedures and languages specific to the Natural Sciences, to propose solutions that consider local, regional, and/or global demands. (BNCC, 2018a, p. 555)

UNITS WITHOUT CONTEXT OF CLIMATE CHANGE

In this subcategory, topics such as the relationship between climate change and sustainable development; a suggested video on decarbonization; international meetings; a judge's opinion on a film about the topic; didactic questions and objectives; debate on anthropogenic influence; definition of the greenhouse effect; and environmental impacts of food stand out. However, these themes do not show a representative frequency, as each occurs only once (Figure 9).

Figure 9

Examples of climate change units without context in the analyzed textbooks.

> [...] This group listed, in 2015, nine planetary boundaries whose limits should be considered when proposing sustainable development:
>
> • climate change [...]; (v. 2, p. 217)
>
> [...] You may refer to the video 'A way out of the crisis Is to decarbonize', suggested in the support for pedagogical work section, about the decarbonization policy (New Green Deal) as a national and global public policy against climate change, and as a contribution to overcoming economic crises, given the number of jobs such an agreement could generate." (v. 4, p. 61)
>
> [...] There is much discussion on this topic, but the reality of global warming is not up for debate. Global warming is widely evidenced, including by direct measurements. The controversy lies in whether it is an inevitable natural process or the result of human activities. The available data on various factors that can affect the atmospheric temperature at the Earth's surface point to the latter. (v. 4, p. 183)

Source: Lopes and Rosso (2020).

Here, the predominance is of isolated mentions of the topic, often disconnected from any deeper explanation. This is somewhat understandable in the teacher's guide, which focuses more on activities and lesson planning than on conceptual depth, as in the example: "*What were the main difficulties in representing global warming?"* (Lopes & Rosso, 2021). However, there are excerpts that contribute little to the understanding of the phenomenon, such as: "*It was the new global context, addressing terrorism and the political and social instability in the Middle East and, as a kind of anticipation of COP-21, the consequences of climate change pointed out by scientists were discussed*", which merely mentions the topic without further development.

A relevant point is the way the textbook collection suggests the possibility that global warming may not be caused by anthropogenic actions. Although it acknowledges that data strongly indicate this origin, the text maintains an argumentative structure that leaves room for doubt. Climate change, however, is anthropogenic in origin and is advancing at an alarming rate, with severe impacts on humanity and ecosystems (IPCC, 2021). Although the collection was produced before the publication of the 2021 IPCC report, which unequivocally established human responsibility (IPCC, 2021), it is essential that materials aimed at basic education reflect the current scientific consensus, avoiding the perpetuation of controversies that have already been resolved.

In light of the above, this textbook collection presents a decontextualized approach by suggesting disagreement regarding the anthropogenic origin of global warming, thereby weakening the scientific rigor expected of educational materials (Figure 9). Such resources should be based on evidence and avoid reinforcing controversies that have already been resolved by the scientific community. As Junges and Massoni (2018) highlight, climate reports are serious and scientific in nature, and they aim to transfer this knowledge to society. Therefore, this stance contradicts the general competencies outlined in the BNCC, which emphasize that one of the foundations of these competencies and learning objectives is to argue based on scientific evidence, starting from:

> Reliable facts, data, and information to formulate, negotiate, and defend ideas, viewpoints, and common decisions that respect and promote human rights, socio-environmental awareness, and responsible consumption at local, regional, and global levels, with an ethical stance concerning care for oneself, others, and the planet. (Brasil, 2018a, p. 9)

Another relevant perspective concerns the number of statements about climate change that contribute little to deepening knowledge. Superficiality is recurrent, especially in the teacher's manual, which lacks a solid foundation to foster critical thinking in the classroom. Orso (2020) points out that curriculum reformers do not prioritize scientific content, focusing instead on the "life project." According to the author, this choice is contradictory, since the documents themselves state that their goal is to "promote the comprehensive education of students, forming critical citizens who respect others and are prepared for collective life in the 21st century" (Orso, 2020, p. 43).

Although Orso's (2020) critique refers to the 2017 high school reform, some setbacks, such as the reduction of content and the mandatory subjects limited to portuguese, mathematics, and english, were revoked by Law No. 14,945/2024, which restored the workload to 3,000 hours for the Basic General Education (Brasil, 2024b). Even so, the persistence of shallow and decontextualized teaching materials, despite the new guidelines, indicates that challenges remain. Malanchen and Matos (2020) highlight that although high school is presented as "new" to society, educators recognize the essence of the reform, aimed at training future workers, being "a déjà-vu of a failed policy used at the end of the 1990s" (p. 238).

FINAL CONSIDERATIONS

Climate change constitutes a scientific consensus and represents a true climate emergency, whose effects are already felt in extreme events such as biodiversity loss, food insecurity, water crises, and population displacements. However, despite its contemporary relevance, the topic was not satisfactorily addressed in this collection of textbooks. We highlight the concentration of terms and units of record in only one volume of the collection, the lack of interdisciplinarity, approaches focused on physical phenomena without socio-environmental contextualization, limitations in discussing consequences, and absence of feasible mitigation proposals. These limitations were present both in the student book and the teacher's manual, failing to provide students in the new high school with adequate knowledge on the subject within this collection.

We highlight, therefore, that the way the theme is presented by the BNCC proves to be insufficient, superficial, simplistic, and flawed. This occurs because the material, both for students and teachers, does not provide adequate support for understanding the scope of the climate crisis, lacking didactic and methodological backing. Furthermore, although the BNCC advocates interdisciplinarity, this proposal remains, in practice, limited to theory. The topic, even when addressed in a limited way, tends to fall exclusively on the biology teacher, without proper integration with the fields of chemistry and physics. Another critical point is how the content is presented, often disconnected from reality, with superficial information that omits important aspects of the climate crisis. This dilution compromises the formative role of education, which should promote the

development of critical, ecologically conscious, emancipated citizens with autonomy of thought.

The results of this research point to the need for a more comprehensive investigation into how the theme of climate change is addressed in the different collections of textbooks approved by the PNLD, in order to verify whether the gaps identified in this specific collection also appear in other works, especially in light of the guidelines established by the BNCC. Furthermore, based on the theoretical framework adopted, it becomes relevant to reflect on the role of education professionals in the face of market pressures and interests that permeate educational reforms, such as the new high school reform. Additionally, the importance of a strong initial teacher training and ongoing professional development is highlighted, capable of contributing to the reformulation of concepts that are constantly evolving. Finally, a greater transversal focus on this theme in textbooks is necessary, considering that it spans all areas of knowledge, since the consequences of climate change will affect all sectors of society and must be discussed across different fields of knowledge.

Thus, the development of textbooks requires a careful reformulation, led by education professionals and specialists who understand and know how to convey knowledge about climate change in light of scientific understanding. It is essential that the content of these materials is neither scarce nor excessive, but functions as a balanced guide capable of fostering students' socio-environmental awareness. As a pedagogical tool, it is important to reflect on the limitations and possibilities of the textbook for teachers, understanding that it should not serve as an instruction manual, but rather as one resource among many, considering the diverse school realities and methodological possibilities. In this way, the textbook can establish itself as an important tool for teaching climate change. However, it can also be integrated with other sources of knowledge, such as the internet and digital technologies, which are relevant to the pedagogical process. These new ways of exploring the teaching-learning process are especially relevant given the tendencies of new generations and their modes of accessing and constructing knowledge.

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