

# A Study on the Nature of Themes in the Textbook “Conexões – Natural Sciences and Their Technologies”

## ABSTRACT

The National Textbook Program (PNLD) is a Brazilian public policy that ensures the free provision of textbooks to all public-school systems. In recent years, especially with the implementation of new curricular policies, the PNLD has undergone several changes. In the context of upper secondary education, textbooks have begun to be organized by areas of knowledge, aiming at an interdisciplinary approach. Within this framework, this study aims to analyze the nature of the themes present in the “Conexões – Natural Sciences and Their Technologies” collection from PNLD 2021, considering their conceptual, contextual, political, environmental, and social dimensions. To achieve this purpose, an analysis was conducted of the six textbooks that comprise the collection. The analysis was guided by the assumptions of Discursive Textual Analysis (DTA). Among the results obtained, the predominance of themes of a conceptual dimension stands out, privileging scientific conceptualization over the relationships between science and social, political, and/or economic aspects. Nevertheless, the textbooks address all thematic dimensions, albeit in an incipient manner. This may contribute, even if only occasionally, to the development of critical and problem-posing educational practices.

**KEYWORDS:** Teaching Materials. Science Education. BNCC.

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## 1 INTRODUCTION

Research in education has pointed to the need for reforms in the Brazilian educational curriculum, which has traditionally been marked by rigidity and linearity (Saul; Silva, 2009). In response to this demand, the Thematic Approach (TA) has been explored as an alternative to overcome the limitations of a curriculum approach centered on isolated disciplinary contents. From this perspective, themes emerge as the starting point for knowledge construction, enabling broader and more meaningful integration of contents (Delizoicov; Angotti; Pernambuco, 2011).

The recent implementation of the National Common Core Curriculum (BNCC) in the Brazilian educational context marks a significant change in the conception and organization of school curricula. The BNCC emphasizes the importance of incorporating contemporary and interdisciplinary themes, acknowledging the need for a more contextualized education aligned with the demands of contemporary society (Brasil, 2018). However, it is crucial to analyze how this guideline has been effectively implemented, considering the critiques raised by several scholars. Franco and Munford (2018), for instance, highlight the emphasis placed on conceptual aspects, without fostering articulations among the different elements that constitute the construction of science, which ultimately distances educational practices from current discussions in the field of Science Education.

In this context, the analysis of textbooks (LD) becomes fundamental to understanding how themes are integrated into school curricula. Textbooks, frequently used as central resources in pedagogical practices, play a relevant role in the organization and presentation of knowledge (Rosa, 2018). Nevertheless, it is pertinent to question how these materials relate to the BNCC proposal and whether they promote an approach that encourages critical reflection and interdisciplinarity.

A recent study conducted by Pereira and Muenchen (2023) highlights the mistaken understanding of textbooks as curriculum guides, as well as the tendency to follow, in a linear manner, the sequence presented in the books. In light of this, it is essential to overcome such conceptions and to recognize the role of teachers as curriculum builders (Hunsche, 2010), which involves a critical analysis of teaching materials and their adaptation to students' realities.

In this sense, it is relevant to analyze how new textbooks may influence more comprehensive and critical educational practices regarding content. Moreover, there is a need for studies that investigate Natural Sciences and Their Technologies textbooks after the implementation of the BNCC, considering the still limited number of scientific productions on this topic. Nilles and Leite (2022) identify this gap and indicate that it may be a consequence of the recent approval of the document; therefore, this is a field that requires extensive investigation. Based on such analyses, these materials may contribute more effectively to the formation of conscious, critical, and participatory citizens, capable of acting in a transformative manner within their reality (Freire, 2018).

Therefore, this study analyzes the nature of the themes present in the "Conexões – Natural Sciences and Their Technologies" collection (Moderna, 2021), part of the National Textbook Program (PNLD) 2021, considering their conceptual, contextual, social, political, and environmental dimensions. Through this analysis,

the study also seeks to indicate how textbooks may contribute to classes grounded in the Thematic Approach.

## **2 THEORETICAL FRAMEWORK**

The National Textbook Program (PNLD), officially established in 1985, emerged with the aim of democratizing access to education and pedagogical resources, becoming responsible for the free distribution of textbooks to public schools across the country (Zambon; Terrazzan, 2013). Since then, the PNLD has consolidated itself as a fundamental pillar of the Brazilian educational structure, ensuring access to knowledge and to quality teaching materials within public education networks.

The program provides a digital guide intended to assist teachers in selecting the most appropriate textbooks for their disciplinary work (Nascimento; Amestoy; Tolentino-Neto, 2018), seeking choices that are more closely aligned with the realities of students and schools. This process reflects a commitment to teachers' autonomy and pedagogical discernment.

Thus, the selection and distribution of textbooks by the PNLD should not be understood merely as a mechanism for supplying resources or for complying with a traditional curriculum (Saul; Silva, 2009), but rather as an opportunity to promote educational practices aligned with the principles of a more humanizing and emancipatory education (Freire, 2018).

The importance of textbooks goes beyond their function of providing educational content. They act as a link between teachers and students, facilitating the teaching–learning process and contributing to the critical and problem-posing formation of subjects (Amestoy; Tolentino-Neto, 2017). In this sense, it is necessary to recognize that textbooks are not the only resources to be used in the classroom, but they are among the main instruments available to support teaching activities (Souza, 2015). Within this context, textbooks play a relevant role by mediating dialogues, reflections, and critical questioning about reality.

The implementation of the BNCC and the New Upper Secondary Education has significantly influenced the development and selection of textbooks. The new books were produced based on the guidelines of the upper secondary education reform and are organized by areas of knowledge into a set of six volumes intended for students. These volumes encompass general and specific competencies, as well as the skills of each area, in addition to contemporary themes.

In this sense, it is important to analyze how the use of contemporary themes presented in the document has impacted the construction of theme-based curricula. Halmenschlager (2014), when analyzing the presence of pedagogical proposals based on themes in official documents, identified certain ambiguities regarding the nature of the themes and the suggested interdisciplinary approach, highlighting the need to rethink how these themes are presented in order to prevent them from becoming mere “masks” for the development of previously established contents. Therefore, it is necessary to analyze how the BNCC has been incorporated into textbooks.

### 3 METHODOLOGY

This study analyzed the “Conexões – Natural Sciences and Their Technologies” collection, intended for upper secondary education and approved by the PNLD 2021 (Moderna, 2021). The selection of the collection was motivated by its use in a school with which one of the authors is affiliated. The study consisted of analyzing the nature of the themes and their possible implications for educational processes. Themes were understood as the topics (chapter subtitles) and the interconnections, defined as sections intended to relate the chapter content to other areas of knowledge and to everyday situations. The designation “themes” is justified by two factors: the use of a theoretical framework that investigates the thematic approach and the fact that the collection itself adopts this terminology.

The analytical process was conducted using the Discursive Textual Analysis (DTA) methodology, which unfolds in stages: unitarization, categorization, and the production of metatexts (Moraes; Galiazzi, 2016). In the unitarization stage, textual excerpts were extracted from the textbooks—referred to as units of meaning—that evidenced the nature of the theme (topic/interconnection). During the analytical process, these units were identified through alphanumeric codes; for example, the code L1\_C1\_T1, in which the letter “L” refers to the textbook, the letter “C” to the chapter, and the letter “T” to the topic, or, in the case of an interconnection, the letter “I” (e.g., L1\_C1\_I1). Categorization corresponds to the process of approximating or distancing the units according to the elements that constitute them. In DTA, there are two types of categories: emergent and a priori (Moraes; Galiazzi, 2016). In this study, the option was to use a priori categories, defined prior to the analysis, whose selection is based on distinct criteria but must provide support for answering the research problem. Accordingly, the a priori categories adopted were the natures of the themes defined by Halmenschlager (2014).

The aforementioned author establishes parameters that enable the analysis of pedagogical proposals based on themes. Thus, the textbooks were analyzed according to the parameter Nature of Themes and their distinct dimensions (Halmenschlager, 2014), each considered an a priori category: (a) *conceptual dimension*: the theme is expressed based on a specific concept; (b) *contextual dimension*: relates to natural or technological phenomena and to situations representative of a given context, without explicitly addressing social and political issues; (c) *social dimension*: involves themes that, in some way, evidence or refer explicitly to social implications related to the theme; (d) *political dimension*: the issues and aspects developed from the theme aim primarily at raising awareness of the problem, including the discussion of perspectives for intervention in concrete reality; and (e) *environmental dimension*: involves environmental contradictions and problems and may simultaneously encompass the social and/or political dimension.

In the final stage of DTA, metatexts were produced, which represent the communication of a new emergent arising from the analysis of the categories. To this end, the data obtained and other theoretical references were used. It is worth noting that, in addition to qualitative analysis, the data were also examined quantitatively by verifying the occurrence of each thematic nature, in order to discuss their possible implications for educational processes.

## 4 RESULTS AND DISCUSSION

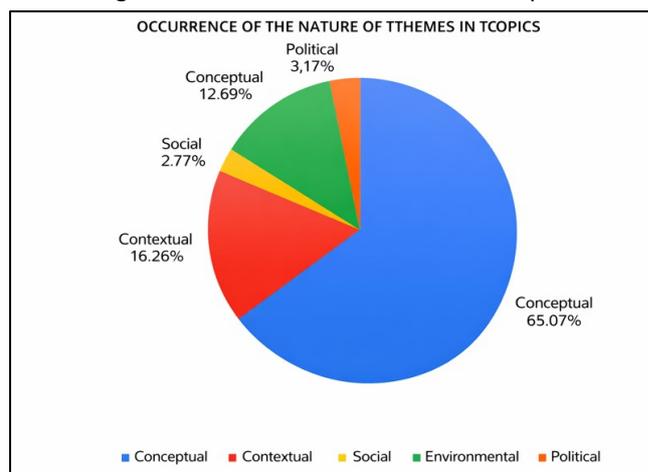
### 4.1 Occurrence of the Nature of Themes in Textbooks

This study analyzed the overall occurrence of each thematic dimension (Halmenschlager, 2014) in upper secondary education textbooks from the “Conexões – Natural Sciences and Their Technologies” collection (Moderna, 2021). To this end, the dimension or dimensions that appeared to be predominant in each theme were identified, considering both the topics and the interconnections. In cases in which certain natures appeared only sporadically—that is, restricted to a single word or phrase—they were not considered for classification purposes, since the aim was to conduct an analysis of the theme as a whole, taking into account what was presented as most prominent. Thus, the classification of themes into one or more dimensions does not imply the absence of relationships with the other dimensions.

It is observed that the conceptual nature accounts for a highly significant percentage, corresponding to 51.6% of the themes in the collection. In second place, although with a considerable difference, is the contextual dimension, with 28.8%. The remaining dimensions present considerably lower percentages, with the environmental dimension accounting for 11.3%, the social dimension for 4.7%, and the political dimension for only 3.6%.

The data obtained in this study converge with the results reported by Halmenschlager *et al.* (2015), who investigated the thematic approach in educational proposals developed by pre-service and in-service Physics teachers, in which a predominance of themes of a conceptual and contextual nature was also identified. When exclusively considering the topics, without including the interconnections present in the textbooks, these data become even more discrepant, as shown in the graph in Figure 1.

Figure 1. Occurrence of the nature of topics



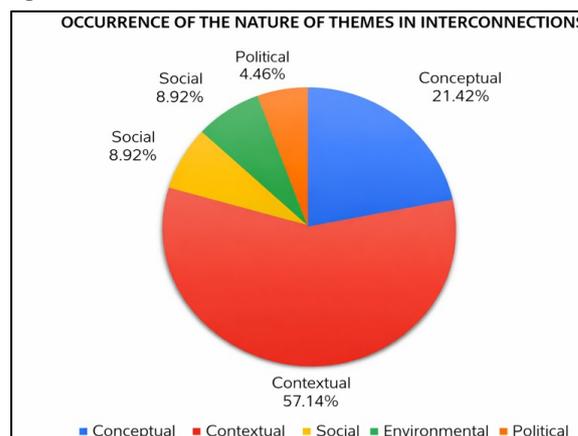
Source: Authors' own elaboration (2024).

Within this subset, the conceptual dimension corresponds to 65.07% of the themes analyzed, followed by the contextual dimension with 16.26%, the environmental dimension with 12.69%, the political dimension with 3.17%, and the social dimension with 2.77%. When defining each of these dimensions,

Halmenschlager (2014) points out that they present specific characteristics and, at the same time, complement one another. Thus, it is understood that there are distinct levels of criticality, beginning with the conceptual dimension, considered the most superficial level, and culminating in the political dimension, understood as the deepest level. However, in some approaches, the environmental dimension may encompass social and political aspects; when this occurs, it presents greater analytical depth. It is emphasized that, at each new level, elements of the previous level are not lost but rather new aspects are incorporated. In the conceptual dimension, the focus lies on the approach to scientific concepts, often presented in a manner detached from reality. In the contextual dimension, scientific concepts remain present but are articulated with everyday situations, that is, with lived reality. In the social dimension, beyond the context, social issues and relationships that permeate this locus are incorporated. With regard to the political dimension, it builds upon social aspects but goes beyond them by discussing forms of participation and transformation of and within society, governed by rights, duties, freedoms, and prohibitions. Finally, in the environmental dimension, the focus is on environmental problems, with the aim of understanding and overcoming them, and it may, or may not, incorporate discussions and practices of a social and political nature (Halmenschlager, 2014).

When the interconnections present in the collection were analyzed, a decline in the conceptual dimension was identified, which came to represent 21.42% of the themes. Although it remains expressive, this dimension moves to second place. In this analysis, the greatest emphasis falls on the contextual dimension, which accounts for 57.14% of the themes. Even so, the percentages of the social (8.92%), environmental (8.03%), and political (4.46%) dimensions remain lower, although they show a slight increase compared to the previously discussed analyses, as shown in the graph in Figure 2.

Figure 2. Occurrence of the nature of interconnections



Source: Authors' own elaboration (2024).

Due to the increase in the percentage of the contextual nature within the interconnections, it is considered that these didactic resources promote the contextualization of content and, consequently, may foster a broader understanding of scientific knowledge and its application in real-life situations. It is emphasized that the presence of the contextual nature also supports teaching practice, since overcoming a fragmented approach to knowledge facilitates teachers' efforts to establish connections between school content and everyday

issues. However, although the interconnections are present in all six volumes of the collection, they occupy a relatively small portion of the textbooks and are often overlooked or ignored by teachers. This situation may be associated with a traditional teaching logic, in which one is constantly “racing against time” to cover extensive lists of content.

## 4.2 Conceptual Dimension

As already highlighted in the discussions presented in the previous subsection, the conceptual nature is the most predominant in the collection analyzed. This nature is characterized by addressing exclusively aspects related to scientific conceptualization. Muenchen (2010) emphasizes that the conceptual approach is more restricted, as it constitutes an end in itself; that is, themes of a conceptual nature are often used solely for the understanding of scientific knowledge itself.

Based on the analyses conducted, it is evident that most themes already correspond, in their very designation, to scientific knowledge or to relationships among scientific concepts, in addition to being predominantly developed in a conceptual manner. In this sense, Chapter L1\_C3, entitled “Heat Is Energy”, is structured around five themes, all classified as conceptual in nature, namely: (i) Temperature, Thermal Equilibrium, and Heat; (ii) Heat Transfer; (iii) Temperature Scales; (iv) Heats Up Faster, Cools Down Faster; and (v) Heat and Mechanical Energy. It is thus observed that both the chapter title and the respective themes refer directly to knowledge from the field of Physics. Even so, these themes can be problematized, even from a conceptual perspective, since the statement “heat is energy” may inadvertently suggest a direct equivalence between the two concepts, whereas, in physics, heat is strictly defined as a process of energy transfer. The excerpts below exemplify how the themes are developed.

What is the correspondence between the Celsius and Fahrenheit scales? (L1\_C3\_T3).

It is important to emphasize that specific heat is characteristic of each substance. In other words, there are no two different substances with identical specific heats (L1\_C3\_T4).

The excerpt from theme L1\_C3\_T3 presents one of the activities proposed at the end of the theme “Temperature Scales.” As can be observed, even the suggested activities do not, in all cases, promote contextual application, distancing themselves from students’ lived experiences<sup>1</sup>.

Another example can be observed in Book L3\_C1, whose chapter is entitled “Comparative Anatomy and Physiology.” The themes developed are: (i) Respiration; (ii) How Do We Breathe?; (iii) Digestion; (iv) Circulation; and (v) Excretion. These themes correspond to concepts from the field of Biology. Moreover, their development throughout the pages prioritizes the explanation of biological concepts, such as the functioning of systems in living beings. The excerpts below illustrate this approach.

The exchange of gases that a living organism carries out with the environment is called systemic respiration. The term “respiration” is also used to refer to the intracellular process of energy production (cellular respiration) (L3\_C1\_T1). In the case of human beings, the circulatory system is called the cardiovascular system and includes the transport system of blood and lymph, as will be discussed below. Like that of other mammals, the human circulatory

system is closed, with double circulation and a four-chambered heart. There is no mixing of blood in the chambers; this is ensured by valves between them that prevent blood backflow (L3\_C1\_T4).

In addition, of the three interconnections—sections of the textbooks that generally seek to promote some type of contextualization or application—two were classified as conceptual in nature and only one as contextual. This situation can be observed in the excerpt from the interconnection entitled “Thermal Equilibrium,” presented below:

Blood is an important conductor of heat in our bodies. Associated with endocrine, neurological, and muscular reactions that contribute to heat generation, it is one of the main agents in the distribution of temperature in the human body. Temperature exerts a strong influence on living organisms and their metabolic processes (L3\_C1\_I3).

Furthermore, certain chapter titles initially appeared to address issues that transcended the conceptual sphere, even entering socioscientific themes. In this context, Chapter L2\_C1, entitled “Electricity: Where Does It Come from and Where Does It Go?” stands out. Based on this title, it would be plausible to infer that the chapter might address issues related to the production, transmission, distribution, and consumption of electrical energy, as well as discuss environmental impacts, climate change, access to electricity for low-income populations and remote areas, renewable energy sources, among other aspects. Such discussions are problematized, for example, in the book *Physics* (Delizoicov; Angotti, 1990). However, Chapter L2\_C1 is developed through five themes, namely: (i) What Is Electric Current?; (ii) Voltage, Potential Difference, or Electric Tension; (iii) Electric Power; (iv) Voltage, Current, and Electrical Resistance; and (v) Parallel and Series Circuits. All of these themes were classified as conceptual in nature, as evidenced in the excerpts below:

The source that supplies the electric circuit provides the potential difference, the voltage. This voltage is responsible for generating the electric field in the conductor and for the electric current that flows through the device (L2\_C1\_T3). By turning on the switch, a voltage of 1.5 V is established between the lamp terminals, and an electric current then flows through the circuit (L2\_C1\_T4).

In light of these excerpts, it is observed that the discussions remain restricted exclusively to the conceptual sphere. Excerpt L2\_C1\_T3 mentions that the source supplying the electric circuit provides the potential difference, yet it does not clarify what is meant by “source,” nor does it problematize the associated environmental impacts. Likewise, the excerpt referring to theme L2\_C1\_T4 presents an example distant from the reality of many students’ households, as it considers the activation of a switch that establishes a voltage of 1.5 V, corresponding to the voltage of a common battery.

Based on the discussions conducted, it is evident that the textbooks in the “Conexões – Natural Sciences and Their Technologies” collection (Moderna, 2021) are still developed with a predominantly conceptual focus, distancing themselves from the reality of thousands of students in Brazilian public schools. Nevertheless, when they seek to approach this reality, the textbooks most often resort to contextualization, an aspect that will be discussed in the following subsection.

### 4.3 Contextual Dimension

The importance of contextualization, especially with regard to the articulation among scientific concepts, is rooted in educational theories and pedagogical practices that recognize the need to make learning more meaningful and relevant for students. However, as pointed out by Ricardo (2005), contextualization should not be reduced to the mere simplified mention of everyday elements with the sole purpose of making the teaching of scientific concepts more appealing. In this analysis, whenever such an approach was identified, it was classified within the conceptual dimension.

The contextual dimension, based on Halmenschlager's (2014) category, encompasses an understanding of the context in which the theme is situated, considering the circumstances and elements surrounding it and placing it within a broader context, with the aim of facilitating its comprehension, without necessarily exploring associated social or political issues.

The analysis of the six books in the "Conexões" collection (Moderna, 2021) reveals that almost all chapters present at least one topic or interconnection with contextual aspects. However, as previously mentioned with regard to the themes, contextualization is generally explored in a limited manner. Within the chapter topics, the contextual dimension stands out in the third book of the collection, especially in chapters addressing health and medicine, namely: "Health: Physical, Mental, and Social Well-being" (L3\_C4); "Some Substances Used in the Health Field" (L3\_C5); and "Electromagnetic Waves and Medicine" (L3\_C6).

In addition, this book presents other contextualized topics that explore the human immune system (L3\_C4\_T5), by highlighting the importance of vaccines, as well as technologies used in disease treatment (L3\_C4\_T6), listing examples of technologies—both simple and complex—that assist in maintaining health. More frequently, contextualization manifests through historical relationships, as observed in Chapter L1\_C1, entitled "The World Around Us: What Is Matter Made Of?" In the subtopic "Oil in Brazil: A Brief History," the authors present a contextualization of the introduction of oil in the country, as well as the interests that drove its dissemination, as illustrated in the excerpt below:

What was the importance of this use of oil in the lives of Brazilians in the nineteenth century? Although oil has been known since Antiquity, when it was used in religious ceremonies, it was in the second half of the nineteenth century that the so-called black gold aroused worldwide interest [...] (L1\_C1\_T1).

In this topic, beyond the historical issue, the theme presents potential to explore social, environmental, and political questions. However, the way it is presented in the textbook proves to be superficial, without deepening such issues; for this reason, it remains restricted to the contextual dimension. Historical contextualization contributes to situating knowledge within a broader context, showing how it has developed over time and how scientific investigations have been influenced by historical and cultural events. Halmenschlager (2014) emphasizes that it is essential to address the dynamics of scientific production, recognizing the transitory nature of knowledge throughout history, since scientific theories are constructed within specific, temporally situated contexts. Nevertheless, historical relationships were more recurrent in the interconnections

than in the topics, and, as previously mentioned, these sections comprise only a fraction of the textbooks and are often neglected by teachers.

With regard to the interconnections, Chapter L1\_C2 stands out, as mentioned in the analysis of the conceptual dimension, for presenting the theme “Electricity” with the potential to go beyond that sphere. In this chapter, six of the seven interconnections were classified as contextual in nature. This finding suggests that the textbook authors recognize the broader relationships that can be explored based on this theme, yet choose to present them as “appendices” to the main content.

In addition, Chapters 2 and 3 of Book 6— “Polymers: Production, Uses, and Implications” and “Geological Time and Human Evolution,” respectively—also stood out for presenting interconnections of a contextual nature. In Chapter L6\_C2, all six interconnections were classified within this dimension, whereas in L6\_C3, five of the seven interconnections were contextual. The theme of polymers, as observed in other cases, has the potential to go beyond the conceptual dimension; however, once again, the authors chose to concentrate these relationships within the interconnections. As an example, in excerpt L6\_C2\_I4, entitled “The Age of Plastic,” contextualization occurs through a historical approach related to the trajectory of the inventor Leo Hendrik Baekeland, who, driven by economic interest, developed Bakelite, the first synthetic plastic, as an alternative to shellac in the electrical industry. However, when mentioning profit-driven interests, social and political issues could have been further explored. The same occurs in the interconnection related to biodegradable plastics, which is limited to the following definition:

Biodegradable plastic is that which, at the end of its life cycle, undergoes a composting process within up to 180 days through the action of microorganisms, under specific conditions of heat, humidity, light, oxygen, and organic nutrients (L6\_C2\_I1).

In this case, environmental relationships are scarcely explored. A more critical approach could include an in-depth discussion of the challenges related to biodegradable plastics, including the impacts of soil and water contamination resulting from improper disposal, as well as the consequences for ecosystems and human health. Moreover, issues related to the large-scale production of bioplastics could also be problematized.

In light of the above, it becomes evident that contextualization plays a fundamental role in promoting more meaningful learning, especially with regard to the articulation among scientific concepts. The analysis of topics and interconnections across different chapters of the textbooks reveals the recurrent presence of contextualization, although, in many cases, in a superficial or insufficiently developed manner. In this sense, it is necessary to advance beyond this level by more consistently incorporating social, environmental, and political issues, in order to broaden students’ understanding of the themes addressed.

#### 4.4 Social Dimension

The Thematic Approach (TA) constitutes an educational perspective that seeks to encompass socially relevant situations (Muenchen; Auler, 2007) involving society, such as social problems or “solutions,” the acquisition or denial of rights, the fulfillment or non-fulfillment of duties, the presence or absence of public policies, social (in)justices, (in)equalities, social agreements or conflicts, prejudice, cultural aspects, advances that promote improvements in quality of life, or even socio-scientific-technological limitations that cause harm to society and hinder its development. Understanding these situations occurs through their articulation with related scientific knowledge. Thus, the social nature of a theme can be defined as approaches that “refer to social implications involved in the theme, explicitly considered in the planning [...]. Their general purpose is to raise awareness of the social consequences embedded in the theme” (Halmenschlager, 2014, p. 137).

Considering that one of the purposes of the TA is to address aspects of students’ realities and, therefore, of the society in which they are embedded, it becomes essential to incorporate the social dimension in the construction of themes.

In this sense, this study identified that the textbooks in the “Conexões – Natural Sciences and Their Technologies” collection (Moderna, 2021) present a reduced percentage of themes classified within the social dimension, corresponding to 2.77% in the topics and 8.92% in the interconnections. This result is concerning, since the social dimension enables the problematization of aspects of students’ realities and their implications. In critical educational perspectives, the social dimension should occupy a central place, which is not sufficiently evident in the collection analyzed. This limitation may result in the absence of social approaches in the classroom, especially due to the scarcity of resources, limited time, and lack of teacher training, factors that hinder the critical adaptation of the teaching materials used.

The themes classified within this dimension address different aspects, with health standing out as the main axis of discussion. Among them are: “Concepts of Health” (L3\_C4\_T1), “Adolescent Health and Sexuality” (L3\_C4\_T2), “The Goiânia Nuclear Accident: Cesium-137” (L3\_C6\_I3), “Technology in Health” (L3\_C4\_T4), “Health in Brazil” (L3\_C4\_T7), “Quality of Life and Healthy Habits” (L3\_C4\_T8), “Women Pioneers in Brazilian Medicine” (L3\_C4\_I4), “Impact of Social Media on Health” (L3\_C4\_I6), and “Ethanol: A Depressant of the Nervous System” (L3\_C5\_I2). In addition, some themes discuss technologies aimed at improving society’s quality of life, such as: “New Filters: Improving the Lives of People Without Access to Drinking Water” (L1\_C1\_I2), “Warka Water – In Search of Water” (L1\_C6\_I3), “Solar Oven” (L2\_C6\_I2), and “Genetic Engineering” (L5\_C6\_T9). Some of these themes suggest that such technologies may contribute to reducing social inequalities, as observed in (L1\_C1\_I2), (L1\_C6\_I3), and (L2\_C6\_I2). To illustrate this approach, an excerpt from one of the interconnections is presented below:

By 2025, 1.8 billion people will live in regions with extreme water scarcity. One of the countries affected by this problem is Ethiopia, where 57% of the population lacks access to drinking water. As a measure to mitigate this

problem, the Warka Water project was created, which developed a low-cost artificial structure to obtain potable water (L1\_C6\_I3).

Furthermore, themes were identified that discuss the implications of scientific and technological advances for society, as well as the importance of the ethical and safe use of knowledge, such as “Genetic Engineering” (L5\_C6\_T9) and “Bioethics” (L5\_C6\_I1). In addition, some themes problematize issues related to discrimination and prejudice directed at specific social groups, such as women— “Women Pioneers in Brazilian Medicine” (L3\_C4\_I4); homosexuals— “The Misinterpretation of the Theory of Evolution” (L5\_C5\_I1); historically marginalized ethnic groups— “The Use and Abuse of the Theory of Evolution” (L5\_C5\_I3); as well as cultural aspects— “Culture and Differences Among Groups” (L6\_C3\_T7). Below are two excerpts taken from interconnections that justify their classification within the social dimension:

A highly controversial example concerns homosexuality. Among the arguments used by those who oppose it, it is common to claim that homosexuality is not natural, because such behavior in an animal species would lead to its extinction, as reproduction would not occur. Supposedly Darwinian arguments are also used to justify other attitudes considered anti-humanitarian, such as sexism and racism (L5\_C5\_I1).

Currently, the concept of social Darwinism is strongly criticized, especially when used by intolerant groups as justification for the violation of human rights. One of the most catastrophic examples was the Holocaust, the mass extermination of Jews promoted by the Nazi regime during World War II. This massacre was motivated by distorted ideals of eugenics, according to which the Aryan race, considered superior by the Nazis, should remain pure and dominate other races considered inferior by them, such as Jews and Roma, who should be exterminated (L5\_C5\_I3).

Finally, the theme “Culture and Differences Among Groups” (L6\_C3\_T7) addresses different cultural manifestations, highlighting their importance to society, as well as the need to respect and value them. Reflecting on the data obtained, it is recognized that the social dimension is present in the collection, albeit in an incipient manner. In cases where this dimension is addressed, its presence proves to be relevant, since scientific knowledge is mobilized as a means to reveal and understand social problems. Moreover, Science and Technology are presented as important tools for promoting a better quality of life; however, it is also evident that they may entail risks to humanity, which is why they must be used in a critical and responsible manner. In light of these contributions, it becomes fundamental to incorporate the social dimension into more problematizing educational approaches, such as the Thematic Approach.

#### **4.5 Political Dimension**

The political dimension emerges when the theme addressed goes beyond social aspects. In this analysis, situations related to dialogues, struggles, conflicts, demands, agreements, strategies, and actions aimed at generating changes in the rights, duties, freedoms, and prohibitions of the population in different spheres— municipalities, states, and countries—are considered as belonging to this dimension. It may also extend to the public and/or private spheres. When addressing such themes, it is necessary to problematize and deepen the dialogue, aiming not only at understanding but also at action directed toward social

transformation (Halmenschlager, 2014). This is because the political dimension is oriented toward active intervention in the face of a problem, considering the existing concrete reality. In this context, discussion is not limited to awareness-raising but extends to analyzing the ways in which different actors and institutions can intervene to promote meaningful change (Muenchen, 2010).

Throughout the collection, evidence can be identified of how political decisions directly influence environmental, economic, and social issues, even though these relationships appear in an incipient manner. In general, topics and interconnections are directed toward discussions related to agreements and treaties, as well as to business interests and profit motives, as exemplified in themes addressing oil as a natural resource and nylon.

The political dimension is addressed in thirteen themes—eight topics and five interconnections—which corresponds to only 3.6% of the total analyzed, making it the least present dimension in the collection. Given this low percentage, there is a high probability that this dimension is scarcely explored in the classroom, since insufficient coverage in teaching materials tends to be directly reflected in pedagogical practices—an aspect that would require further investigation.

An example that highlights the presence of historical agreements and treaties, referring to the political dimension analyzed here, is presented in the excerpt below:

In 1991, an agreement was signed between the United States and Canada to control the emission of substances that cause acid rain [...] The burning of coal with a high sulfur content at the Bagé (RS) thermoelectric power plant, for example, has been held responsible for the occurrence of acid rain in Uruguay (L2\_C5\_T5).

According to this excerpt, the theme addresses a political action—an agreement signed between countries—aimed at minimizing environmental impacts, in this case acid rain. In addition, relationships of an economic, political, and, in part, historical nature were identified, especially in themes related to oil and nylon. The material presents their origins and economic relations throughout their development process, as well as discussing their commercial value, as illustrated below:

Oil as an energy source, being an essential raw material for industries worldwide. It highlights the difficulty of thinking about economics and politics without relating them to oil (L1\_C1\_T1).

Within the general category entitled “Resources and Consumption,” the textbook highlights the importance of environmental legislation and international agreements. As expressed in one of the textbooks, the 1988 Federal Constitution determines the restoration of vegetation cover after the exploitation of mineral resources, while the Montreal Protocol of 1987 exemplifies global cooperation for the protection of the ozone layer. These elements illustrate how the political dimension related to consumption and the management of natural resources is addressed, as presented in L6\_C5\_I1.

As a measure to protect the ozone layer, the Montreal Protocol was approved in 1987, an agreement among representatives of several countries who committed themselves to progressively replacing the production and

consumption of chemical elements related to the destruction of the ozone layer (L6\_C5\_I1).

Thus, the political dimension proves to be fundamental for understanding the themes addressed in textbooks, as it influences the formulation of public policies and decision-making processes across different spheres of society. However, it is observed that this dimension is, in most cases, not sufficiently deepened, which limits students' understanding of the intrinsic relationships between the contents discussed and the political context. A significant gap concerns the absence of discussions on citizenship and social participation in decision-making processes. There are numerous historical examples of popular demands that resulted in relevant public policies, such as women's right to vote, which was achieved through a long and arduous collective struggle. Moreover, educational approaches have the potential to foster the development of a culture of social participation, capable of promoting the emergence of historically neglected demands, which may influence the formulation of public policies in Science and Technology, considering the specificities of the Latin American social context (Auler; Delizoicov, 2015). Nevertheless, such approaches remain quite limited in the analyzed textbooks, which predominantly restrict themselves to discussions of policies at the global level, silencing the role and importance of the population in these processes.

Therefore, a significant opportunity is identified for textbooks to offer broader and more critical analyses of the political dimension, contributing to students' understanding not only of theoretical aspects but also of practical implications and possible solutions to the challenges faced by society. By providing a more contextualized and problematizing perspective, textbooks may contribute to the formation of more critical, humanized, and politically conscious subjects (Freire, 2018).

#### **4.6 Environmental Dimension**

In the topics and interconnections classified within the environmental dimension, the most recurrent themes refer to sustainability, basic sanitation, atmospheric gases, deforestation and reforestation, fertilizers and agriculture, as well as others related to the contextualization and problematization of environmental issues. At present, a global environmental crisis is being experienced, marked by thousands of species threatened with extinction and by climate change resulting from human activities. Pollution of natural resources and environmental degradation directly affect population health and quality of life, placing all biodiversity at risk. For this reason, it is essential to bring these discussions into the school context (Lindemann, 2010), as they may foster an understanding of environmental problems and encourage the adoption of more sustainable actions.

By addressing environmental issues in schools, the understanding of situations and problems present in students' realities is promoted, favoring a critical reading of their own world. The relevance of this work is emphasized, especially because themes of this nature are often not addressed in the classroom at all (Maestrelli; Torres, 2014).

Furthermore, it is essential that these themes be present in the textbooks used, given the central role they play in students' education (Nascimento; Amestoy; Tolentino-Neto, 2018). By including environmental issues in teaching materials, access to essential knowledge related to environmental protection and the promotion of sustainability is ensured (Lindemann, 2010).

In quantitative terms, a total of 41 themes classified within the environmental dimension were identified, comprising 32 topics and 9 interconnections. At various points, the collection raises environmental issues, although, in some cases, they are addressed in a superficial or insufficient manner. Even so, the textbooks promote dialogue and present relevant knowledge related to this dimension. Discussions and problematizations concerning sustainability, for example, may represent a seed for building a more conscious and environmentally responsible future, as illustrated in the excerpt below:

The term sustainability has been used since the 1980s to refer to productive activities that do not degrade or deplete natural resources (L2\_C6\_T1).

The problematization of basic sanitation (L3\_C3\_I2) highlights the importance of adequate planning within communities, especially with regard to waste management and pollution, which often result both from individual actions and from the absence of public policies and collective community planning strategies. This approach can be observed in the excerpt below:

Therefore, not to mention the issue of toxic waste, which is in itself harmful to aquatic life, heated water originating from industrial effluents or nuclear reactors contributes to the death of fish and other organisms that depend on dissolved oxygen in the water to survive. In Brazil, in addition to this heated water, many rivers, lakes, and coastal areas also receive untreated domestic sewage (L3\_C3\_I2).

When raising problematizations related to environmental issues, themes such as deforestation, fertilizers, and agriculture are also addressed. For the discussion of these themes, the Science–Technology–Society (STS) education perspective proves to be fundamental, as it fosters the development of critical thinking and an understanding of the impacts of scientific and technological advances on the environment (Auler, 2012).

The use of fertilizers in agriculture, for example, constitutes a theme permeated by complexities and multiple impacts. From the STS education perspective, it is possible to discuss not only the benefits associated with these products—such as increased productivity and profitability—but also their negative implications, including health risks, loss of biodiversity, and contamination of natural resources. Through problematizing dialogues, reflection on more sustainable alternatives for agricultural production can be promoted. Such discussions go beyond a dichotomous approach of right versus wrong, allowing students to understand the complexity of these issues and to participate more actively in decision-making processes (Auler, 2012), especially with regard to consumption, production, and ways of contributing to improving the quality of life of the population and the environment. In this sense, by bringing these themes into the classroom, one contributes to the formation of more critical and conscious subjects, capable of acting in the construction of a more just and sustainable

society (Slonski; Torres, 2022). In the textbooks, these discussions are exemplified in the following excerpts:

The accumulation of nutrients in aquatic ecosystems is called eutrophication and may occur naturally, although it is generally associated with polluting human activities, such as the use of agricultural fertilizers that eventually reach groundwater, rivers, and seas (L6\_C5\_T8).

Textbooks also address issues related to atmospheric gases (L2\_C5\_T4), problematizing the need for environmental preservation and its direct relationship with human health, as illustrated below:

Scientific studies on the effects of atmospheric pollutants on human health have made it possible to define air quality parameters; these indicate maximum tolerable environmental concentrations for a group of such substances (L2\_C5\_T4).

Despite the presence of the environmental dimension in the collection, it is observed that it remains underrepresented, accounting for 11.3% of the themes analyzed. Its occurrence is concentrated mainly in the topics (12.69%), being less frequent in the interconnections (8.03%). Moreover, in many cases, the approaches remain limited in view of the dialogical potential that could emerge in the classroom with students and teachers. Finally, it is essential to emphasize that a dimension so intrinsically linked to human life cannot be treated as an uncritical or peripheral content. It must be prioritized and articulated with scientific concepts, in order to enable the understanding of different natural phenomena and the construction of knowledge that allows for conscious and transformative interventions in reality.

## 5 FINAL CONSIDERATIONS

With the aim of analyzing the nature of the themes present in the “Conexões – Natural Sciences and Their Technologies” collection (Moderna, 2021), part of the PNLD 2021, this study identified the predominance of a conceptual approach, in contrast to the Thematic Approach (TA) educational perspective advocated herein. In second place, the contextual dimension stands out, representing an advance in relation to exclusively conceptual approaches. However, as understood within the TA, the contextualization of knowledge, although relevant, proves insufficient to promote criticality and intervention in the lived environment. Thus, it becomes necessary to problematize reality by addressing scientific knowledge articulated with its contextual, social, political, and environmental aspects. One possibility for fostering the treatment of these dimensions lies in the critical incorporation of problems, situations, and phenomena drawn from students’ life contexts. Moreover, textbooks could propose suggestions for study activities, investigation, and community intervention, contributing to the understanding and overcoming of the situations identified. Nevertheless, the analysis showed a predominant focus on the conceptual and contextual dimensions, to the detriment of the social, political, and environmental dimensions, which appear in a rather limited manner in the collection analyzed.

With regard to the objective of indicating how textbooks may contribute to classes grounded in the Thematic Approach, it is suggested that there are

possibilities for using these materials, since all thematic natures were contemplated, albeit in an incipient way. In addition, many themes present significant potential to be problematized and articulated with students' realities. However, it is essential that the different thematic natures be addressed in a systematic manner, rather than only sporadically, considering that the TA seeks to break with the traditional logic of the conceptual approach, in which scientific concepts are conceived as ends in themselves, rather than as means for understanding themes (Delizoicov; Angotti; Pernambuco, 2011).

Given the complexity of the themes and the purpose of developing the criticality indispensable for transforming reality, more in-depth approaches become urgent, enabling a comprehensive understanding of the issues studied. In light of educational challenges related to teacher education, planning time allocation, the large number of students per class, and the shortage of human and material resources, textbooks ultimately become one of the main resources facilitating teachers' work. As pointed out by Delizoicov, Angotti, and Pernambuco (2011, p. 36), "in most classrooms, it continues to prevail as the teacher's main working instrument, significantly underpinning teaching practice." Corroborating Souza (2015), it is emphasized that textbooks, as pedagogical resources, are not self-sufficient and require adaptation to the realities of schools and students, as well as supplementation by teachers. Even so, the strong influential role of these materials in the approach to school knowledge is evident, since teaching often begins from what is proposed therein. Thus, considering the importance and centrality of textbooks in classrooms, it becomes fundamental that these instruments foster more comprehensive, critical, and integrative approaches to content, encompassing the different thematic natures discussed throughout this study.

Although the analyzed textbooks present limitations, it is important that they not be relegated to institutional libraries, but rather used as one of the main instruments available for the development of the teaching–learning process. The continuity and strengthening of the PNLD reflect the country's commitment to quality education as a right for all, signaling a promising path for future generations.

Finally, it is highlighted that this study is in the process of being expanded to other collections and levels of education, with the aim of broadening the data initially obtained. Furthermore, it is considered relevant to analyze how textbooks have been used by teachers who work with the Thematic Approach, as well as to identify the limits and possibilities arising from such uses.

# UM OLHAR PARA A NATUREZA DOS TEMAS NOS LIVROS DIDÁTICOS “CONEXÕES - CIÊNCIAS DA NATUREZA E SUAS TECNOLOGIAS”

## RESUMO

O Programa Nacional do Livro Didático (PNLD) é uma política pública brasileira que assegura o fornecimento gratuito de Livros Didáticos (LD) para todas as escolas das redes públicas. Nos últimos anos, especialmente com a implementação das novas políticas curriculares, o PNLD passou por algumas mudanças. No contexto do Ensino Médio, os LD passaram a ser construídos por áreas do conhecimento, visando o caráter interdisciplinar. Nesse contexto, este estudo tem como objetivo analisar a natureza dos temas presentes na coleção “Conexões- Ciências da Natureza e suas Tecnologias”, do PNLD 2021, considerando suas dimensões conceitual, contextual, política, ambiental e social. Para alcançar esse propósito, foi realizada uma análise dos seis LD que compõem a referida coleção. Essa análise foi balizada pelos pressupostos da Análise Textual Discursiva (ATD). Dentre os resultados obtidos, destaca-se o predomínio de temas de dimensão conceitual, os quais privilegiam mais a conceituação científica do que as relações da ciência com aspectos de ordem social, política e/ou econômica. Contudo, os LD contemplam todas as dimensões temáticas, ainda que de forma incipiente. Esse fato pode contribuir, mesmo que pontualmente, para o desenvolvimento de práticas educativas de caráter crítico-problematizador.

**PALAVRAS-CHAVE:** Materiais Didáticos. Educação em Ciências. BNCC.

## NOTES

**Author 1:** Methodological design; initial analysis of the works; review of the initial analyses; quantitative data analysis; qualitative data analysis; writing, revision, and editing of the manuscript.

**Author 2:** Review of the initial analyses; quantitative data analysis; qualitative data analysis; writing, revision, and editing of the manuscript.

**Author 3:** Methodological design; initial analysis of the works; review of the initial analyses; quantitative data analysis; qualitative data analysis; manuscript writing.

**Author 4:** Initial analysis of the works; review of the initial analyses; quantitative data analysis; qualitative data analysis; manuscript writing.

**Author 5:** Research supervision; methodological design; manuscript revision.

1. One possible way to foster the teaching–learning process would be to critically incorporate students’ realities into discussions within the conceptual field, as will be discussed in the final considerations of this study.

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