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National Textbook Program and Chemistry Curricula: Focusing on Oxidation-Reduction Content[1]

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ABSTRACT

The textbook stands as one of the primary teaching materials used in Brazilian classrooms. Due to this attributed importance, the research presented in this paper aimed to identify possible relations between the determinations of curricular policies and the works selected within the scope of the National Textbook Program. For this, the presentation of redox reaction content in Chemistry textbooks was investigated across various public notices for the PNLD of High School. The investigation observed that the new characteristics of the program conferred different aspects to the textbooks, mainly regarding the reduction of scientific concepts covered in the books in the latest public notice for High School.

KEYWORDS: PNLD. Redox Reactions. PCN. BNCC.

THE NATIONAL TEXTBOOK PROGRAM

The Textbook (TB) is considered a mediation and support tool in the teaching and learning process that occurs in both public and private schools. In the Brazilian context, the textbook assumes a central role in education, accompanying the development of schooling in Brazil and, in many cases, being the only cultural and educational instrument to which the student has access.

This importance is acknowledged not only in the academic educational context (MOREIRA, 2012; SCHIMER; SAUERWEIN, 2017) but also by the Ministry of Education (MEC), as it has a program to evaluate the quality of textbooks that reach Brazilian schools, the National Textbook Program (PNLD). The trajectory of the evaluation process of Brazilian textbooks, however, began in 1937 with the creation of the National Book Institute. In 1966, during the military regime, the Commission for Technical and Textbooks was created to ensure the production, editing, and distribution of LDs to schools. The novelty of the PNLD, instituted in 1985, was the participation of teachers in the selection of the book; its reuse; and financial control of the process, which became the responsibility of the Student Assistance Foundation (FAE). With the extinction of FAE in 1997, financial control passed to the National Fund for Educational Development (FNDE), controlled by MEC, which began to manage the Program in the format we have today (LIMA; CIASCA, 2020).

Since its institutionalization, the PNLD has undergone changes to adapt to the Brazilian socio-political context; however, some characteristics remain to this day, such as: the centralization of the PNLD in the federal government; the registration of books through public notices; the delivery of books to schools organized by the postal service; the definition of the quantity of books to be allocated to each school through the school census, with a 3% reserve for new enrollments; and the definition of technical specifications in the evaluation process that seeks to ensure the quality and durability of the books (LIMA; CIASCA, 2020).

According to these characteristics and technical specifications, the PNLD has already evaluated works for Early Childhood Education, Elementary Education, and High School, and has established itself as a state policy (a rarity in the Brazilian educational context). Despite the 37 years of PNLD's operation, High School works were evaluated recently, and with the 2021 public notice, they complete four editions, as shown in Table 1.

Due to the longevity of the PNLD, several resolutions have conferred new characteristics to the Program, especially in the evaluation process and adaptation to other Brazilian educational policies. For the purposes of this work, it was decided to discuss the most recent changes, specifically decree no. 9099 of July 18, 2017 (BRASIL, 2017) and public notice no. 03/2019 (BRASIL, 2019) for the selection of High School works.

Table 1 – High School Didactic Works Evaluated by the PNLD

PNLD	Works
2012	Portuguese Language, Mathematics, Geography, History, Sciences and Modern Foreign Language, Physics, Chemistry, Biology, Sociology, and Philosophy
2015	Portuguese Language, Mathematics, Geography, History, Sciences and Modern Foreign Language, Physics, Chemistry, Biology, Sociology, Philosophy, and Art
2018	Portuguese Language, Mathematics, History, Geography, Physics, Chemistry, Biology, Modern Foreign Language (English), Modern Foreign Language (Spanish), Sociology, Philosophy, and Art
2021	Integrative Projects in the area of Languages and their Technologies Integrative Projects in the area of Mathematics and their Technologies Integrative Projects in the area of Natural Sciences and their Technologies Integrative Projects in the area of Human and Social Sciences Life Project Didactic Works of Languages and their Technologies Didactic Works of Mathematics and their Technologies Didactic Works of Natural Sciences and their Technologies Didactic Works of Human Sciences and their Technologies Specific Didactic Works of Portuguese Language Specific Didactic Works of English Language Specific Didactic Works of Human and Social Sciences in dialogue with Mathematics Continuous Education Works for Management Teams Continuous Education Works for Portuguese, English, Physical Education, Music, Theater, Dance, Visual Arts Continuous Education Works for Mathematics and its Technologies, focusing on computational thinking Continuous Education Works for Biology, Physics, and Chemistry Continuous Education Works for Philosophy, Geography, History, Sociology Educational Digital Resources Literary Works

Source: National Fund for Educational Development.

THE PNLD AFTER BNCC

One of the first aspects modified by decree no. 9099/2017 (BRASIL, 2017) concerns the scope of institutions covered by the PNLD, extending its reach beyond public schools to also include community, religious, or philanthropic schools. The decree also introduced the annual distribution of literary materials starting in 2018, creating the Literary PNLD (BRASIL, 2017).

In addition to these aspects, there were changes in the frequency of pedagogical evaluation of materials, which went from every 3 years to every 4 years, and in the provision of consumable materials for the early years, which now do not need to be returned at the end of the school year. Decree no. 9099/2017 (BRASIL, 2017) also introduces the possibility of selecting a particular didactic collection by the education network, not just by individual teachers as was previously the case.

However, undoubtedly one of the main changes presented by decree no. 9099/2017 (BRASIL, 2017) is the use of the PNLD to support the implementation of the National Common Curricular Base (BRASIL, 2018b). Thus, public notice no. 03/2019 for the 2021 PNLD aimed to select works that included the competencies (both general and specific) of the National Common Curricular Base, being considered Unpublished Works: "those produced in alignment with the requirements of the High School Reform, as well as the National Common Curricular Base (BNCC), allowing for the partial use of works already evaluated by the Ministry of Education" (BRASIL, 2019).

Public notice no. 03/2019 (BRASIL, 2019) for High School also added other characteristics to the Program, especially in the number of works evaluated and the objects to which they refer, as shown in Table 1. Furthermore, in addition to textbooks, digital material for teachers and students and video tutorials for each volume associated with the registered objects must be submitted for evaluation.

Therefore, it can be seen that the new determinations of the PNLD confer additional characteristics to the Program, bringing more didactic works to schools and potentially exerting even more control over the teaching-learning process.

As a result of these new characteristics, various education organizations have reported insufficient dialogue in the production of the PNLD. *The National Front for a Democratic PNLD* presents some of these complaints:

> [...] it dilutes school knowledge through the so-called 'market skills and competencies,' reorganizing the logic of the curriculum by areas that aim to streamline teaching and, despite proposing to be integrative, deprives any authentic interdisciplinary pedagogical conception. The emphasis is on project books that replace curricular components, anchored in integrative projects and life projects reduced to the competencies of the BNCC, whose areas of knowledge, adapted to the New High School, replace specific disciplines (NATIONAL UNION OF FEDERAL EDUCATION BASIC, PROFESSIONAL AND TECHNOLOGICAL SERVANTS [SINASEFE], 2021, n/p).

For Fonseca and Tonini (2021), resistance movements against the textbooks of the 2021 PNLD initially revolved around non-adherence to item 1 of this public notice. However, according to the authors:

> Even though we consider movements such as the Front essential, as well as the publicizing of letters from groups of teachers who did not adhere to the PNLD, we perceive that the program will not be rejected by the majority of schools and that indeed teachers and students will have contact with materials from the PNLD 2021. Therefore, we believe it is necessary to reference possible resistances stemming from the textbook, creating fissures for the production of other discourses that bring forth a supportive, critical, and reflective subject (FONSECA; TONINI, 2021, p. 14).

Due to these changes and discussions, this study aims to present an investigation conducted on the high school textbooks of the PNLD, seeking to establish a relationship between the changes mandated by the PNLD and those imposed by Brazilian curriculum policies in these works. To achieve this, we chose to analyze chemistry didactic collections selected in all editions of the PNLD High School, focusing on the content of redox reactions.

CURRICULAR DOCUMENTS IN BRAZIL

As highlighted, this study aims to investigate the incorporation of changes in Chemistry textbooks throughout the assessment processes of the PNLD High School. Due to the scope of the work, we chose to analyze a specific content area within Chemistry collections: the content of redox reactions, given the researchers' proximity to studies addressing this content.

The content of oxidation-reduction includes an introductory part on redox reactions along with the topic of electrochemistry, which addresses the production of energy through these reactions. The introductory part covers definitions of oxidation, reduction, oxidizing and reducing agents, oxidation number calculations, and balancing these reactions. Electrochemistry includes topics on cells, batteries, and electrolysis.

Research indicates that this is a content area considered difficult to teach (DE JONG; TREAGUST, 2002) and difficult to learn (KLEIN; BRAIBANTE, 2017), but one with significant social importance associated with it (OCOTERO *et al*., 2015).

To understand the possible relationships between the content present in textbooks and the Chemistry curricula in Brazil, we chose to discuss the guidance of official curricular documents regarding the approach to oxidation-reduction content and the differences in the guidance they provide. It is important to note that we discuss the final version of the BNCC, although it differs significantly from its earlier production versions.

Since the promulgation of the 1988 Constitution (BRASIL, 1988) and the Law of Guidelines and Bases of National Education (BRASIL, 1996), several curricular documents have shaped discussions about the High School stage nationally: National Curriculum Parameters (PCN) (BRASIL, 1999), Supplementary Educational Guidelines to National Curriculum Parameters (PCN+) (BRASIL, 2002), Curricular Guidelines for High School Education (OCNEM) (BRASIL, 2006), National Curricular Guidelines for High School Education (DCNEM) (BRASIL, 1998; 2011; 2012; 2013; 2018a), and currently, the National Common Curricular Base (BNCC) (BRASIL, 2018b).

In the PCN (BRASIL, 1999), redox content would be found in the area of Natural Sciences, Mathematics, and their Technologies. However, the document only vaguely specifies the Chemistry content to be employed in classrooms, highlighting that quantitative relationships of mass, energy, and time in chemical transformations should be addressed, including "rapid reactions, such as combustion and explosion, and slow reactions, such as rusting and fruit ripening" (BRASIL, 1999, p. 30-33). These reactions may encompass oxidation-reduction content. Additionally, PCN emphasizes the importance of teaching redox reactions in a broader context, for example:

> A study on the issue of using or not using preservatives in food would address various aspects of chemical knowledge, such as the nature and speed of transformations responsible for food degradation, the chemical nature of preservatives, interactions occurring in the preservation process, such as oxidation and osmosis, interactions with the human body, toxicity or undesirable reactions, different preservation processes, such as dehydration and packaging (BRASIL, 1999, p. 35).

The document that emerges from the developments of the PCN discussions, known as PCN+ (BRASIL, 2002), better specifies the contents that could be addressed. The teaching of redox reactions appears in the thematic unit "Production and consumption of thermal and electrical energy in chemical transformations," where concepts such as reaction enthalpy (energy balance between bond breaking and formation); oxidation-reduction involved in the production and consumption of electrical energy; electrode potentials; and bond energy are related. The document also emphasizes the development of competencies and skills related to:

> Relating the electrical energy produced and consumed in chemical transformation to oxidation and reduction processes.
>
> Understanding oxidation and reduction processes based on ideas about the structure of matter.
>
> Predicting the electrical energy involved in a chemical transformation based on standard electrode potentials of oxidation and reduction transformations.
>
> Understanding the evolution of ideas about batteries and electrolysis, recognizing the relationships between empirical knowledge and explanatory models (BRASIL, 2002, p. 98, sic).

In the OCNEM (BRASIL, 2006), the number of skills related to oxidation-reduction content remains the same, with three of them closely resembling those from its predecessor document, PCN+:

> Recognition and understanding of chemical properties such as effervescence, fermentation, combustion, oxidation, corrosion, toxicity, degradability, polymerization, acidity, neutrality, and alkalinity.
>
> Understanding the relationship between electrical energy produced and consumed in chemical transformation and oxidation and reduction processes.
>
> Understanding oxidation and reduction processes based on ideas about the structure of matter.
>
> Qualitative understanding of the concepts of enthalpy, entropy, and standard electrode potentials (BRASIL, 2006, p. 113-114, sic).

The BNCC, as the most recent Brazilian curricular document, structures high school education into knowledge areas and presents specific competencies and skills for each area. The area of Natural Sciences has the fewest general competencies in high school, which is reflected in the skills for the area; for example, oxidation-reduction appears in only one skill:

> (EM13CNT107) Make qualitative and quantitative predictions about the functioning of generators, electric motors and their components, coils,

> transformers, batteries, and electronic devices, based on the analysis of the transformation and conduction processes of energy involved – with or without the use of digital devices and applications – to propose actions aimed at sustainability (BRASIL, 2018b, p. 555).

However, the content can encompass other skills, such as:

> (EM13CNT101) Analyzing and representing, with or without the use of specific digital devices and applications, transformations and conservations in systems involving quantity of matter, energy, and motion to make predictions about their behaviors in everyday situations and in productive processes that prioritize sustainable development, conscientious use of natural resources, and preservation of life in all its forms.
>
> (EM13CNT104) Evaluating the benefits and risks to health and the environment, considering the composition, toxicity, and reactivity of different materials and products, as well as the level of exposure to them, taking a critical stance and proposing individual and/or collective solutions for their responsible use and disposal (BRASIL, 2018b, p. 555).

Regarding the differences between the documents, the PCN+ and the OCNEM specified skills for teaching redox reactions: 1. Understanding oxidation and reduction processes based on ideas about the structure of matter; 2. Understanding the concept of standard electrode potentials; 3. Understanding the evolution of batteries and electrolysis; 4. Relating to and predicting the electrical energy involved in oxidation and reduction processes. However, it is observed that in the latest version of the BNCC, there is a drastic change in the skills related to this content.

Therefore, it is noted that the initial official educational documents aimed to be general, such as the PCN, but gradually incorporated objectives, competencies, and skills that specified each content to be addressed more explicitly. However, the latest version of the BNCC (BRASIL, 2018b) provides broader guidelines, leaving it to state-level documents to specify the contents more explicitly.

METHODOLOGY

In the qualitative study reported in this work, the assumptions of documentary research are employed, as the data are derived from Chemistry textbooks selected from the PNLD. According to Lima Junior and colleagues (2021), in documentary research:

> [...] the data obtained are solely from documents, with the purpose of obtaining information contained within them, in order to understand a phenomenon; it is a procedure that uses methods and techniques for capturing, understanding, and analyzing a universe of documents, with databases that are considered heterogeneous (LIMA JUNIOR *et al*., 2021, p. 42).

The authors also highlight aspects to consider in document analysis, starting with the choice of documents, access to them, and their analysis (LIMA *JUNIOR et al*., 2021).

Beginning with the choice of documents, it was decided to investigate collections that were analyzed and approved in different PNLD editions. The

decision was made to investigate Chemistry collections due to the researchers' predominantly Chemistry background. Additionally, collections were chosen that presented the content of oxidation-reduction in a differentiated manner, enabling comparison between collections. However, the primary criterion for selecting collections was those attributed to the same authors and approved in all PNLD editions for the High School level.

As shown in Table 1, throughout the existence of the PNLD, four editions covered the High School level of basic education, namely in 2012, 2015, 2018, and the most recent in 2021. According to the Textbook Guide, produced to assist teachers in choosing collections, in PNLD 2012, 5 collections were approved for the subject of Chemistry; in PNLD 2015, 4 collections were approved, while in the PNLD 2018 edition, 6 collections were approved.

However, collections from the PNLD 2021 edition were also investigated to identify significant changes in textbooks over the PNLD's history. Thus, works from Object 2 were selected through the Textbook Guide, corresponding to Didactic Works by Areas of Knowledge and Specific Didactic Works intended for high school students and teachers (BRASIL, 2019), as these works closely resemble previous collections.

In this second stage of book selection, a greater diversity of authors was observed, possibly due to the increase in works attributed to the public notice. Thus, only the collections Ser Protagonista (NERY; LIEGEL; AOKI, 2020) and Matéria, Energia e Vida (MORTIMER *et al*., 2020) were selected for this study, as they include authors whose works were also approved in the 2012, 2015, and 2018 editions.

Therefore, the chosen didactic collections, and thus the universe of documents for this study, were the Ser Protagonista collections (LISBOA, 2010; ANTUNES, 2013; LISBOA *et al*., 2016; NERY; LIEGEL; AOKI, 2020) and the collections attributed to authors Eduardo Mortimer and Andrea Machado (MORTIMER; MACHADO, 2010; MORTIMER; MACHADO, 2013; MORTIMER; MACHADO, 2016; MORTIMER *et al*., 2020), from the PNLD editions of 2012, 2015, 2018, and 2021. Access to these books was facilitated through the textbook database of the research group to which the researchers belong, as well as through the websites of the publishers responsible for these collections.

The documentary analysis conducted used the assumptions of the phases cycle in qualitative research (YIN, 2016). The phases cycle organizes the most commonly used analytical styles in qualitative research, comprising five phases: 1) compiling; 2) disassembling; 3) reassembling (and arranging); 4) interpreting; and 5) concluding.

In the compilation phase, an order is established for the collected data. The chosen order for this study relates to chapters dealing with the content of oxidatio-reduction and sections from teacher support books.

The disassembling phase involves breaking down the data into smaller elements, which may or may not be coded. In this study, decomposition was organized through phrases and paragraphs from the books referencing key concepts of oxidation-reduction, enabling a connection with the curriculum documents highlighted in the introduction of this work.

The third phase consists of reassembling or rearranging the data into different groupings from the original, relating to the research objectives. To aid in data reassembling, specific questions were identified for answering during the analysis of collections: a) How is contextualization performed? b) What relationship does the book establish with the student? c) How and which guiding documents are present? Seeking answers to these questions was crucial for understanding the main changes in education, particularly how curriculum policies influenced textbooks.

The fourth phase of the analytical procedure involves interpreting the reassembled data. The fifth phase deals with the study's conclusions. Both phases will be presented in the following sections of this work.

It is important to note that throughout all phases of the analysis, the MAXqda qualitative data analysis software was utilized. MAXqda is an academic software designed for qualitative data analysis and mixed methods research. It was used for organizing the data, selecting excerpts for analysis, and color-coding them. The software also facilitated the selection of excerpts corresponding to the questions established in the third phase, aiding in drawing conclusions from this study. Once the selected excerpts were extracted, interpretation was conducted accordingly.

OXIDATION-REDUCTION (REDOX) IN CHEMISTRY TEXTBOOKS FROM PNLD

As described in the introduction, the content of oxidation-reduction reactions encompasses concepts related to cells, batteries, electrolysis, as well as foundational concepts such as the definition of redox reactions, oxidation numbers, reaction balancing, among others. Traditionally, this content is taught in the last bimester of the second year of high school, which is reflected in the textbooks. The Ser Protagonista collection and the Chemistry-Mortimer and Machado collection address this content in the penultimate chapter of the second year of high school.

Both collections present the content quite similarly across the PNLD editions of 2012, 2015, and 2018. However, there are radical changes in the content presented in the PNLD 2021 edition, especially in terms of the quantity of concepts covered.

In the Ser Protagonista collection (LISBOA, 2010; ANTUNES, 2013; LISBOA *et al*., 2016), there is a focus on scientific content, sometimes categorized as 'content-oriented'. The collection features six experiments across the chapters on redox reactions in PNLD 2012, five in PNLD 2015, three in PNLD 2018, and one in PNLD 2021, indicating a decreasing emphasis on experimental activities in this collection over time.

Additionally, the Ser Protagonista collection (LISBOA, 2010; ANTUNES, 2013; LISBOA *et al*., 2016) covers the following topics in the PNLD 2012, 2015, and 2018 editions: Basic redox concepts (definition, oxidation number, oxidizing and reducing agents, reaction balancing); Production of electrical current (cell components, standard electrode, spontaneity of reactions); Types of cells and batteries; Metal corrosion and protection against corrosion; Electrolysis and its main applications; Quantitative aspects of electrolysis and cells. On the other hand, the PNLD 2021 edition covers only basic redox concepts (definition, oxidation

number, and reaction balancing) and the association of redox reactions with metabolism, content traditionally covered in Biology (NERY; LIEGEL; AOKI, 2020).

This reduction in covered concepts is also evident in the number of chapters and pages dedicated to the content: 97 pages in PNLD 2012, 75 pages in PNLD 2015, 63 pages in PNLD 2018, and only 13 pages in PNLD 2021 for the entire redox content in the Ser Protagonista collection.

On the other hand, the Chemistry – Mortimer and Machado collection (MORTIMER; MACHADO, 2010; 2013; 2016) chooses to address the content by exemplifying how vitamin C can act as an oxidizing or reducing agent, depending on the other reactant in the reaction. This approach is accompanied by a series of experiments involving vitamin C and other reagents. In the PNLD 2012 edition, 7 experimental activities are found, 8 in PNLD 2015, 8 in PNLD 2018, and 4 in PNLD 2021. Despite the decrease in the number of experimental proposals in the latest PNLD, the Chemistry – Mortimer and Machado collection (MORTIMER; MACHADO, 2010; 2013; 2016; MORTIMER *et al*., 2020) can be characterized as experimental in nature.

The books in the Chemistry – Mortimer and Machado collection (MORTIMER; MACHADO, 2010; 2013; 2016; MORTIMER, *et al*., 2020) are quite similar across the PNLD editions, maintaining a similar organization even in the latest edition. However, there is also a reduction in concepts covered, as the main topics addressed in the PNLD 2012, 2015, and 2018 editions were: Basic redox concepts (definition, oxidation number, oxidizing and reducing agents, reaction balancing); Naming of salts and bases; Standard reduction potentials; Production of electrical current (cell components, standard electrode, potential difference); Electrolysis and its main applications; and Metal corrosion.

In contrast, the PNLD 2021 edition, now titled 'Matter, Energy, and Life: An Interdisciplinary Approach', covers: Basic redox concepts (definition, oxidation number, oxidizing and reducing agents, reaction balancing); Standard Reduction Potential; cell components; and applications of electrolysis (MORTIMER *et al*., 2020).

Regarding the number of pages dedicated to covering redox concepts, in PNLD 2012 there were 48 pages, in PNLD 2015 and 2018 there were 53 pages each, and in PNLD 2021 there are a total of 25 pages (MORTIMER; MACHADO, 2010; 2013; 2016; MORTIMER *et al*., 2020).

However, it was also observed that in terms of textual content and conceptualization, the books remain largely unchanged, even in PNLD 2021. This means that the text for each chapter was written in 2010 and remains the same up to the current edition. An example of this can be seen in the definition of a redox reaction, as observed in Table 2.

Table 2 – Definition of Redox in Analyzed Collections

PNLD	Collection	Definition for a redox reaction
2012	Ser Protagonista	The processes of oxidation and reduction always occur together, and it can be said that the reaction involves electron transfer (LISBOA, 2010, p. 275).

2012	Mortimer e Machado	They are known as oxidation-reduction reactions, or redox. This means that these reactions involve the oxidation of one substance and the reduction of another (MORTIMER; MACHADO, 2010, p. 175).
2015	Ser Protagonista	The processes of oxidation and reduction always occur together, and it can be said that the reaction involves electron transfer (ANTUNES, 2013, p. 203).
2015	Mortimer e Machado	They are known as oxidation-reduction reactions, or redox. This means that these reactions involve the oxidation of one substance and the reduction of another (MORTIMER; MACHADO, 2013, p. 199).
2018	Ser Protagonista	The processes of oxidation and reduction always occur together, and it can be said that the reaction occurs through electron transfer (LISBOA *et al*., 2016, p. 185).
2018	Mortimer e Machado	They are known as oxidation-reduction reactions, or redox. This means that these reactions involve the oxidation of one substance and the reduction of another (MORTIMER; MACHADO, 2016, p. 194).
2021	Ser Protagonista	The processes of oxidation and reduction always occur simultaneously, and it can be said that the reaction occurs through electron transfer (NERY; LIEGEL; AOKI, 2020, p. 77).
2021	Mortimer e Machado	They are known as oxidation-reduction reactions, or redox. This means that these reactions involve the oxidation of one substance and the reduction of another (MORTIMER *et al*., 2020, p. 136).

Source: Data organized by the authors (2024).

HOW IS CONTEXTUALIZATION PERFORMED?

The Ser Protagonista collection (LISBOA, 2010) performs contextualization through the discussion of pertinent themes related to oxidation-reduction content that are highlighted. In PNLD 2012, the themes covered include the chemical principle of the breathalyzer, hydrogen as fuel, effects of corrosion worldwide, and electronic scrap recycling for copper extraction. There is also a text discussing acids in food and their preservation.

In the Ser Protagonista collection (ANTUNES, 2013), for the PNLD 2015 book, the same themes are addressed with some modifications. For instance, the topic of effects of corrosion worldwide is adjusted to focus on corrosion in coastal regions, particularly the Brazilian coast. Additionally, there is an inclusion of a text discussing waste reuse, alongside copper recycling.

Themes such as airbag functionality, rust formation, and equipment operating on batteries are other examples that appear throughout the oxidation-reduction chapter in the 2012, 2015, and 2018 editions. It is noted that the 2018 book includes topics like oxidative stress, lithium-air battery in automobiles, electronic waste disposal, and drone operation, presented in small colored boxes located in the corners of pages.

In the Ser Protagonista collection (LISBOA *et al*., 2016), however, contextualization is done through boxes placed at the end of the content approach, separate from the main narrative. Generally, these boxes contain texts extracted from scientific dissemination journals, notably Revista Química Nova na Escola.

Some questions are added regarding the discussed topic, with a research-oriented character, not necessarily demonstrating a direct relationship with the previously covered content.

In PNLD 2021 (NERY; LIEGEL; AOKI, 2020), only rust formation is used to contextualize the presented concepts, a theme present in the only experimental activity in the oxidation-reduction section. In a separate box, there is also a brief discussion on Brazil nut consumption and its relationship with free radicals. Contextualization seems to be left for the metabolism theme later in the chapter.

In the Química – Mortimer e Machado collection (MORTIMER; MACHADO, 2010; 2013; 2016), the main contextualization is done using the example of vitamin C in the conceptualization of redox topics across all PNLD editions. The book's approach follows an experimental proposal where vitamin C is tested as a reducing and oxidizing agent, depending on the other reactant in the reaction. Historical and chemical information about this vitamin is also added.

Furthermore, the industrial production of aluminum, its advantages, and risks is used to contextualize oxidation-reduction phenomena in the PNLD 2015 and 2018 books. This approach is expanded in the 2018 edition, where authors add information about electrolysis for obtaining other materials.

However, there is a difference in the contextualized approach to these themes in the Química – Mortimer e Machado collection (MORTIMER; MACHADO, 2016). The themes are addressed together with the chemical content, and contextualized information is used to address various aspects of oxidation-reduction reactions. The presence of elements from the history of batteries and battery cells is also a distinguishing feature of this collection.

In PNLD 2021 (MORTIMER *et al.*, 2020), despite presenting the same examples, there is a difference in approach compared to previous editions. For example, vitamin C is explored in only one experimental activity demonstrating its reaction as a reducing agent but not as an oxidizing agent, breaking the logic used in presenting concepts in previous PNLD editions. The production of aluminum, its risks, and advantages also appears in the 2021 book but with fewer details and briefly related to previously covered content.

In this sense, it is observed that contextualization in the books is carried out in two different ways. The first involves adding boxes at the end of chapters with texts, generally journalistic or academic, covering more everyday themes. The second relates to using themes to explain scientific concepts and demonstrate how it is possible to visualize the covered content in everyday life.

In any case, a decrease is observed in both approaches in the PNLD 2021 collections. In addition to a reduced diversity of themes related to oxidation-reduction reactions, when these themes appear, they are not used to address redox concepts. The reduction in covered concepts, and consequently in the number of pages, also reflects on the contextualization used in presenting the contents.

WHAT RELATION DOES THE BOOK ESTABLISH WITH THE STUDENT?

In the Ser Protagonista collection (LISBOA, 2010; ANTUNES, 2013; LISBOA *et al*., 2016), there is a noticeable evolution in the relation established with the student/reader across the PNLD editions. In PNLD 2012, 2015, and 2018, the text does not directly address the student, except at specific moments before exercises where students are asked not to write in the book and to answer questions in their notebooks. However, in PNLD 2021, right from the beginning, the student is invited to reflect on three questions, one of them being: "3. Reactions such as oxidation-reduction are studied in various sectors, such as metallurgical engineering and the chemical industry. Have you ever thought about pursuing any of these careers? Comment" (NERY; LIEGEL; AOKI, 2020, p. 74).

Another example can be cited in the presentation of the content to be covered in the chapter. In PNLD 2012, for instance, it is described that:

> In this unit, chemical transformations resulting from an electron transfer process are studied, which are called oxidation-reduction reactions. These reactions are responsible, for example, for generating images in old photographic films (LISBOA, 2010, p. 273).

In contrast, in the PNLD 2021 book of the Ser Protagonista collection (NERY; LIEGEL; AOKI, 2020), the student/reader is directly addressed:

> In this unit, you will understand that oxidation-reduction reactions and electron transfer processes occur not only in inanimate matter but also in phenomena that occur in living organisms, such as photosynthesis and energy supply to cells (NERY; LIEGEL; AOKI, 2020, p. 74).

References to students' Life Projects are common in the Ser Protagonista collection (NERY; LIEGEL; AOKI, 2020) of PNLD 2021. In the book's introductory pages, the editorial team addresses the student receiving the book and emphasizes:

> We are confident that, through your actions and interaction with the world, you will develop the competencies and skills necessary for full citizenship in the 21st century, following paths consistent with your Life Project (NERY; LIEGEL; AOKI, 2020, p. 3).

On the other hand, the Química – Mortimer e Machado collection presents the content similarly across all PNLD editions, opting to address the student body. An example can be observed in: "Have you understood how to balance chemical equations where there is no change in the oxidation number of the species involved in the transformation?" (MORTIMER *et al*., 2020, p. 151).

Moreover, in this collection, the book positions itself alongside the student, as if they are going to understand scientific concepts together: "As we delve into this study, we will realize how interesting it is to understand the movement of electrons between the species involved in these reactions" (MORTIMER; MACHADO, 2013, p. 198).

In the book for PNLD 2021, the construction of the Life Project is not explicitly mentioned for students, but there is an extensive discussion about the New High School and its relationship with the Life Project in the Teacher Support Manual.

However, there is no discussion of how the work contributes to the development of this aspect in basic education.

It is evident, therefore, that throughout the PNLD editions, the works positioned themselves between the student and scientific knowledge, serving as aids in the development of these knowledge areas, although the student was not directly addressed. In PNLD 2021, at least in the Ser Protagonista collection, the book is positioned as an aid not only in constructing scientific knowledge but also in developing students' Life Projects.

WHAT AND HOW ARE THE GUIDANCE DOCUMENTS PRESENT?

The relation with official curriculum documents can be observed more explicitly in the teacher's manual section of the book, generally found at the end. In this space, some documents are cited to the teacher, most commonly selecting objectives or skills to be developed in the chapter.

The National Curricular Parameters (PCN) are mentioned in the Ser Protagonista collection books for PNLD 2012, 2015, and 2018 (LISBOA, 2010; ANTUNES, 2013; LISBOA *et al*., 2016), primarily presenting which competencies and skills are addressed in each chapter. Furthermore, the authors select skills to be developed considering the three major sets of competencies proposed in the PCN-EM – representation and communication, investigation and understanding, and socio-cultural contextualization. In some cases, skills are created based on these documents, such as: "Understanding the vinegar production process as an example of the application of chemical knowledge about oxidation-reduction reactions in industrial production" (LISBOA, 2010, p. 57).

The manual continues by providing didactic guidelines for approaching each topic, adding academic information and references from the field of Chemistry education, as well as general news on the topics covered.

In the PNLD 2021 book of the Ser Protagonista collection (NERY; LIEGEL; AOKI, 2020), however, the BNCC (Common National Curricular Base) is extensively cited, not only in the teacher's section. At the beginning of each chapter, the specific BNCC skills to be addressed are described. Additionally, in the teacher's manual, the entire introduction presents the High School and the Base, the theoretical-methodological approach, and the teaching of Natural Sciences based on BNCC, indicating that the book is more of an adaptation to BNCC assumptions than an original production for High School.

In the case of the Química – Mortimer e Machado collection (MORTIMER; MACHADO, 2010; 2013; 2016), the teacher's manual presents the proposal highlighting research in the field of Science education, citing reference authors and discussing the proposal of "innovative" chemistry education in interviews with professionals in the Education field. In the editions of 2012, 2015, and 2018, there is also a topic that discusses the relationship between the collection's proposal, the PCN, and the ENEM (National High School Exam) Reference Matrix, stating that:

> Our proposal for High School Chemistry seeks to address fundamental conceptual and contextual aspects that allow understanding the constitution, properties, and transformations of materials, highlighting social implications related to their production and use. In this sense, it is fully in line with the

> new curricular guidelines contained in the National Curricular Parameters for High School (PCNEM), in the Additional Educational Guidelines to the National Curricular Parameters (PCN+), and in the Reference Matrices of the National High School Exam (MORTIMER; MACHADO, 2013, p. 304).

In the PNLD 2021 edition, the collection "Matter, Energy and Life: An Interdisciplinary Approach" (MORTIMER *et al*., 2020), refers to BNCC at various points. In the book's presentation, there is a section that specifies how BNCC is addressed in the volume:

> In addition to theoretical aspects, we propose several activities that, together, aim to develop the general competencies and specific competencies and skills in the Natural Sciences area provided for in the Common National Curricular Base (BNCC), articulating the Biology, Physics, and Chemistry curriculum components (MORTIMER *et al*., 2020, p. 6).

Subsequently, the authors highlight which general competencies of basic education will be addressed, in addition to describing the competencies of the Natural Sciences area and the selected specific skills.

In the chapter on oxidation-reduction content, there is a table highlighting that general competencies 1, 2, 4, and 9; specific competency 1; and skill EM13CNT106 from the Common National Curricular Base will be addressed.

In the teacher support manual for the PNLD 2021 edition, the Mortimer e Machado collection highlights only the Common National Curricular Base, without emphasizing the PCN and the ENEM Reference Matrix. In this sense, this space seeks to establish how the collection addresses the new guidelines of High School, organizing contributions from authors in the field of Science education in the form of general guidance.

According to the data from both collections, it is noticeable how the curricular guidance has changed over the years. It is noteworthy that the National Curricular Parameters had a significant influence on the books, even though they were not mandatory guidelines. The link to the ENEM Reference Matrix as a curriculum guide in the collections is also notable. In 2021, according to the goals of the call itself, there is a more explicit insertion of the BNCC framework in the adaptation of the collections.

CONCLUSIONS

Based on the analysis of the two selected collections, several characteristics of the works that were included in the PNLD calls can be observed. There is a similarity among the PNLD 2012, 2015, and 2018 editions regarding the concepts covered, the number of topics presented, and the experiments and exercises used. However, in the PNLD 2021 works, the number of concepts covered has decreased, and the amount of content devoted to these concepts is also reduced.

This factor can be attributed to the characteristics of this call for proposals aimed at supporting the implementation of the BNCC (Common National Curricular Base) and the High School Reform, which structures this stage of education into knowledge areas, with Chemistry now falling under the Natural Sciences area. The edict no. 03/2019 (BRASIL, 2019) foresees a set of 6 books for each collection within object 2, covering the entire Natural Sciences area. It is important to note

that previously, 3 works were evaluated for each discipline, covering each year of High School, resulting in 3 Chemistry books, 3 Physics books, and 3 Biology books in total. However, starting from the PNLD 2021 call, there are 6 works in total for the integration of Chemistry, Physics, and Biology, thus reducing the number of scientific concepts to be addressed, with some contents clearly being removed from the collections, including oxidation-reduction.

Another observed factor is the change in the relationship established with the student/reader in the collections. The Ser Protagonista collection explicitly indicates the influence of the BNCC in the work, especially in considering the student's Life Project, inviting them to reflect on which career path to follow in the world of work. The Química – Mortimer e Machado collection, on the other hand, maintains the dialogue used in previous works, positioning itself alongside students in the construction of knowledge.

Regarding the curricular documents considered in the production of the book, it was expected that the PNLD 2021 works would present the proposed adaptation for the BNCC. However, it is observed that in previous years, other documents were considered in the proposal development, such as the National Curricular Parameters (PCN) and the ENEM Reference Matrix, which served as curricular guidelines.

However, this relationship with curricular documents was previously presented only in the teacher's manual in dialogue with the structure of the work and the described pedagogical guidelines. Now, the skills and competencies to be developed are also exposed to the students, including sections where the entire list of competencies and skills in the Natural Sciences area of the BNCC is detailed.

In conclusion, the analysis of works selected from different PNLD calls allowed the identification of elements that bring different characteristics to the Program. Undoubtedly, the new curricular guidelines require a reformulation of textbooks. In this study, the most prominent change is the reduction in scientific concepts related to oxidation-reduction content covered in the books. Furthermore, there are indications of an attempt to change the role of the textbook, previously positioned as a resource that aided in the construction of scientific knowledge, now as a support element in the construction of students' Life Projects.

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PROGRAMA NACIONAL DO LIVRO DIDÁTICO E CURRÍCULOS DE QUÍMICA: FOCALIZANDO O CONTEÚDO DE OXIRREDUÇÃO

RESUMO

O livro didático figura como um dos principais materiais didáticos utilizados nas salas de aulas brasileiras. Devido a essa importância atribuída, a pesquisa apresentada neste trabalho teve como objetivo identificar possíveis relações entre as determinações das políticas curriculares com as obras selecionadas no âmbito do Programa Nacional do Livro Didático. Para isso, investigou-se como o conteúdo de reações de oxirredução é apresentado em livros didáticos de Química ao longo de vários editais do PNLD do Ensino Médio. Na investigação observou-se que as novas características do programa conferiram outros aspectos aos livros didáticos, principalmente com relação à diminuição dos conceitos científicos contemplados nos livros no último edital referente ao Ensino Médio.

PALAVRAS-CHAVE: PNLD. Reações Redox. PCN. BNCC.

NOTE

1. Full paper presented at the VII National Symposium on Science and Technology Education (SINECT).

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