RBECT
Revista Brasileira de Ensino de Ciência e Tecnologia

Revista Brasileira de Ensino de Ciência e Tecnologia
ISSN: 1982-873X

https://periodicos.utfpr.edu.br/rbect

From disciplinary to interdisciplinary: paradigms of high school textbooks in the field of natural sciences – 2021 PNLD

Grasiele Ruiz Silva
ruiz.grasi@gmail.com
0009-0006-0971-1783
Universidade Federal do Rio Grande - FURG, Rio Grande, Rio Grande do Sul, Brasil.

Rafaele Rodrigues de Araujo
rafaelearaujo@furg.br
0000-0003-4901-6196
Universidade Federal do Rio Grande - FURG, Rio Grande, Rio Grande do Sul, Brasil.

ABSTRACT

The objective of this investigation was to analyze how the guidelines presented in high school textbooks in the field of Natural Sciences from 2021PNLD operate with an interdisciplinary perspective. To achieve this, we conducted documentary research on the textbooks chosen by state schools in the municipality of Rio Grande/RS in the field of Natural Sciences. We used as a reference for the analysis the foundations for interdisciplinary practice outlined by researcher Ivani Fazenda, engaging with Edgar Morin's complex thinking. Thus, we established three categories to analyze the textbooks: From memories to context; The I, you, and us; and The "how to" in the classroom. We found that the material presents, in its proposal, interdisciplinarity, highlighting the importance of dialogue, exchanges, and partnerships while also considering multiple perspectives on knowledge. However, even with the possibilities of the interdisciplinary perspective present in the books, we emphasized that it can only be achieved through practice in the classroom.

KEYWORDS: Science Education. Knowledge Construction. Ecosystem Thinking. Document Analysis.

1 INTRODUCTION

Textbooks play a relevant role in the Brazilian education scenario since they can be seen as a learning ancillary tool with several functions. Choppin (2004) explained that essential functions of the textbook might vary according to the sociocultural environment, the time, the subjects, the education levels, the methods, and the ways it is used. For that author, it might fulfill the following functions: referential – supporting contents to be worked and abilities to be developed; instrumental – regarding methods, exercises and activities; ideological and cultural – textbook understood as one of the essential vectors of culture of values and the ruling classes' language; and documental function – addressing its potential to develop students' critical skills.

For being a material that is one of the symbols of teaching, being present in most classrooms throughout the country, the textbook is seen as a resource supporting the teaching activity. According to Paixão and Mariano (2023, p. 15), "the textbook must provide the construction and critical reflection upon scientific concepts [...] one of its objectives is to guide teachers and contribute to the progress of teaching strategies". It is a tool loaded with meanings regarding understandings about teaching and learning, and its structure results from the knowledge construction process current understanding

Over the years, changes have occurred in textbooks accompanying the transformations experienced in thinking. Morin (2022, p. 96) introduced the "[...] principle of reintroduction of knowledge in every knowledge", insofar as "all knowledge is a reconstruction /translation carried out by a mind /brain" (idem). Therefore, changes in thinking are understood as a paradigmatic issue.

For that author, individuals are products and producers of society. This relationship is also noticed at schools, and the textbook is one of the means to understand changes in society related to knowledge. Propositions about Morin's "complex thinking" enable some reflection upon the relationships established between the biological, social, cultural and psychological, making it possible to understand the one and the many (Moraes, 2021).

The complex paradigm seeks to overcome the simplifier paradigm, which focuses on the reduction principle, separating the being from reality, fragmenting knowledge and prevailing a linear causality strict order focusing the object (Moraes, 2021). On the other hand, complex thinking integrates the ways of thinking, aspiring to multidimensional thought, but with the awareness of the impossibility of complete knowledge, and omniscience being unattainable (Morin, 2015a).

> Complex thinking attempts to reconnect what disciplinary and compartmentalized thought has disjointed and fragmented. It reconnects not only separate domains of knowledge, but also – dialogically – antagonistic concepts such as order and disorder, certainty and uncertainty, logic and the transgression of logic (Morin, 1997, p. 11).

Among the paths taken by changes in thinking, interdisciplinarity has become appeared in the fields of educational research, in an attempt to remedy the fragmentation of knowledge (Barbosa; Ferreira; Karlo-Gomes, 2024). Interdisciplinarity is understood as a matter of integration/organization in the pursuit of new knowledge. According to Fazenda (2011, p. 21), it can be

understood as "[...] a new attitude towards the question of knowledge, an openness to understanding hidden aspects of the act of learning and those that are apparently expressed, questioning them". For that author, it is necessary to develop sensitivity and adequate training that "[...] presupposed training in the art of understanding and waiting, a development in the sense of creation and imagination" (idem, p. 11). In the New High School curriculum context, interdisciplinarity has been highlighted as a central element, but its effectiveness still depends on formative and structural conditions in the school environment (Santos; Janerine; Fernandes, 2024).

Paviani (2014) explained that interdisciplinarity seeks the "integration of knowledge and people, units and syntheses of knowledge or 'contents', the use or application of theories and methods and collaboration (principle of cooperation) among teachers or researchers" (p. 16). In this respect, an interdisciplinary approach in the classroom clearly involves many factors, making it necessary to reflect on what one wishes to achieve in order to launch actions and interactions in each situation that allow for the construction of broader knowledge, involving different areas of knowledge. That author also reinforces the need to consider new epistemologies, citing complexity as one of them. Therefore, the following question arises: How is this new textbook model structured from an interdisciplinary perspective, considering the guidelines presented to teachers?

Based on the assumptions presented, the focus shifted to the PNLD 2021 High School Science textbook, since this material presents a new organization for the knowledge addressed, taking into account the concepts of Biology, Physics, and Chemistry in its construction. Thus, this study aims to deepen the understanding of the didactic guidelines, the suggested methodologies, and the foundations that support the interdisciplinary proposal, seeking to contribute to the advancement of studies that address the combination of curriculum, teaching materials, and epistemologies. The investigation becomes relevant to the classroom insofar as it highlights how the material can support the teacher in their practice, indicating possibilities for re-signifying pedagogical practice and favoring the construction of contextualized teaching interacting with students' realities, with potential impact on the quality of basic education. Therefore, this research aims to understand how this textbook model is structured from an interdisciplinary perspective, based on the guidelines presented, which provide information about the material, its proposals, its objectives and, in some cases, teaching methodologies.

2 METHODOLOGY

This study involves documentary research (Sá-Silva; Almeida; Guindani, 2009) using high school textbooks chosen by the schools of the municipality of Rio Grande/RS for the Natural Sciences area. The documentary research, according to Sá-Silva, Almeida and Guindani (2009), comprises scientific investigation based on critical analysis, developed via collection, organization and analysis of documents, aiming to understand social, historical and cultural phenomena, producing syntheses and new knowledge. Therefore, we investigated how interdisciplinarity becomes a possible potential for teaching practices in the guiding texts for teachers found in the textbook.

To carry out the data analysis, Documentary Analysis was employed since this method meets the requirements of the research, once the analysis elements can be adapted to each need (Cechinel *et al.*, 2016). Thus, the guiding texts for teachers found in the selected collections were read. Observing thoroughly, we adopted as reference, for the construction of *a priori* categories, the foundations for an interdisciplinary practice listed by Fazenda (2017), as follows: 1) the Dialectical movement; 2) The Memory; 3) The Partnerships; 4) The classroom; 5) The projects' foundation; 6) The interdisciplinary research development. The foundations presented are described below.

1) The dialectical movement: When referring to interdisciplinary practice, it is important to consider the look into knowledge, with which the dialectical movement is observed, thus building a relationship between old and new. These include revisiting, dialogues and experiences lived that allow new understandings. They are new paths built based on the re-signification of looks and understandings established. Therefore, the importance of previous knowledge for the construction of the new one is revealed.

2) The Memory: There are two types of memory that support interdisciplinary teaching, namely, the register-memory and the lived-memory. The former is linked to writing, "[...] done in books, articles, reviews, synopses, communications, classroom notes, and summaries of courses and lectures" (Fazenda, 2017, p. 94). The latter is the one redone in dialogue. Memory selects subjectively, whatever "[...] was, or seems to have been more significant" (idem, p. 95), creating a movement of making the past into present through a future view. Thus, a critical reading of multiperspectives becomes possible.

From this look, one can understand that contextualization becomes an ally in the search to bring such memory to the interdisciplinary practice. However, this does not refer to the simple fact of providing a context to the themes proposed, but rather provide meaning to what is being worked on, to promote a revisiting of memories and building connections between "old" and "new" knowledge.

3) The partnerships: In the interdisciplinary practice, it is necessary to connect knowledge and build understandings from different views of knowledge. To achieve that, doing together is fundamental, based on conscious sharing and intentional dialogue. The construction of partnerships allows a view of the whole in parts and the parts in the whole. Therefore, understandings are deepened and connected, speech, spaces and presences are shared. Thus, partnerships are sought between teachers and students, so that they are together in the knowledge construction process.

4) The classroom: The interdisciplinary teacher must show a "posture" that generates a cooperative, participant and committed classroom. Thus, authority must be conquered not demanded. In addition, it aims at the type of work that produces satisfaction in the doing, in the cooperation, humbleness and knowledge production.

5) The project's foundation: For the practice to be considered interdisciplinary, it must be based on understanding of the importance of multiple views, bringing in its project the subjects' presence and bibliographic flexibility. Therefore, science cannot be understood as something linear and absolute. Knowledge is built from interactions developed seeking to deepen one's view of the world.

6) The interdisciplinary research development: We can learn research through practice, and this should start in pre-school according to Fazenda (2017). In this process, the student, as researcher subject, starts to develop their skills, building competencies and enabling the collective construction of knowledge. This is search for thinking, questioning and building.

The studies and the initial analysis of textbooks, we observed the approximation between some principles found in the material. It is worth mentioning that the principles put forward by Fazenda, engaged with Morin's complex thinking, enable a deeper understanding of the relations established based on the textbook. Therefore, we opted for joining the principles 1 and 2, 3 and 5, 4 and 6, thus building categories for the analysis of textbooks.

1 and 2) From memories to context: Dialectical movement of construction and reconstruction of knowledge, without abandoning previous knowledge and experience (memories) lived by the students, which support new meanings. This perspective leads to conceptions presented by Morin (2015c) from the Biology of Knowledge. For that author, one can only realize and understand what is introduced in a chained conceptual reorganization. However, this knowledge is found in life, in a contextualized way, included in its multiple profiles in nature. Recognizing that it is inseparable from the living being is paramount.

3 and 5) I, you and us: Being interdisciplinary implies doing together, dialoguing and consciously sharing. It promotes exchanges between teacher-student, student-student and teacher-teacher which enriches the knowledge construction process. Understanding the importance of multiple views, bearing in mind that "[...] human beings are, at the same time, biological, psychic, social, affective and rational" (Morin, 2013, p. 38), is a way of making the interdisciplinary practice possible. It is impossible to isolate factors that determine knowledge construction since the participation of each part makes up the whole as much as the whole constitutes the parts.

4 and 6) The "how to do" in the classroom: For the textbook to help an interdisciplinary approach, it must guide the teacher to propose experiences that favor research, dialogue and students' protagonism, thus developing competencies and building collectively new meanings for knowledge and promoting teacher's reflection upon their own practice. In such perspective, a path is created for a recursive process (Morin, 2015a, 2022) by looking into teachers' work since the actions promoted in the classroom might generate a knowledge construction process, and this result shall guide the teacher's future actions.

Indicators were built, based on the reflections carried out, and were used to guide the data collection process during the analysis of each textbook. Table 1 shows the indicators for each category.

Table 1 – Categories and indicators for the interdisciplinary textbook

Categories	Indicators
From memories to context	Instructions to investigate previous knowledge; Structure providing theme contextualization; Examples of teaching proposals that value everyday knowledge.
Te I, you and us	Appreciation of dialogue between teacher and student;

	Teaching proposals valuing exchanges and dialogue; Encouraging teamwork among teachers; Respecting individualities.
The "how to do" in the classroom	Instructions about classroom procedures; Suggestions of how to promote students' protagonism; Reinforcing the role of reflection upon the teaching practice.

Source: The authors.

As observed in Table 1, each category contains indicators that allow a deeper analysis of the instructions found in textbooks. Based on the, it is possible to describe the relations established and expected so that interdisciplinarity is included in processes involving teaching and learning in the classroom.

DISCUSSION OF RESULTS

The choice of textbooks was carried out from the analysis of the report of textbooks distributed in the city. The information was obtained from the Fundo Nacional de Desenvolvimento da Educação[1] [National Education Development Fund] webpage. The search system employed the following filters: 2022, PNLD, Administração Pública Estadual [State Public Administration], Região Urbana [Urban Region], Estado do Rio Grande do Sul [State of Rio Grande do Sul] and cidade do Rio Grande [city of Rio Grande], obtaining 13 high schools, which had received one of the collections approved by the 2021 PNLD. Table 2 shows the collections distributed to those schools.

Table 2 – Distribution of textbooks to schools in the city of Rio Grande

Code[2]	Collection Title	Authors	Publisher	Number of schools which adopted the collection
L1	Multiversos [Multiverses]	GODOY, L. P de; DELL'AGNOLO, R. M.; MELO, W. C de.	FTD	8
L2	Diálogos [Dialogues]	SANTOS, K. C. dos (Ed. Responsável[3])	Moderna	2
L3	Ser Protagonista [Being a protagonista]	ZAMBONI, A.; BEZERRA, L. M. (Ed. Responsáveis)	SM Educação	1
L4	Matéria, Energia e Vida [Matter, Energy and Life]	MORTIMER, A. *et al*.	Editora Scipione	1
L5	Moderna Plus	AMABIS, J. M. *et al*.	Moderna	1

	[Modern Plus]			

Source: The authors.

Regarding the information in Table 2, it is worth mentioning that three of the collections were delivered to one high school only. We decided to keep them as data sources for the research since they are part of the choices made by teachers.

Therefore, from the thorough reading of the guiding documents found in the collections, information was obtained about the points characterizing each category previously introduced. For presentation purposes, the information was organized per collection, presenting excerpts that characterize how each of the categories appeared in the material. Thus, the analysis of documents was systematized using the indicators as reference.

From memories to context

Memory appears as a starting point to the interactions needed to build up knowledge. Based on it, students are recognized, as well as their realities and perceptions of the world. This process enables the establishment of the classroom context, promoting teaching and learning that interact with what is meaningful for students.

Pinto (2002), when referring to Morin's understanding of memory, indicated that "[...] it is through it that we can make data and memories of the past interfere in the perception of present [...]; present knowledge depends on past knowledge, which requires present knowledge" (Pinto, 2002, p. 115).

Regarding guidance to investigate students' previous knowledge, the *Moderna Plus* collection is the only one that has little reference to the theme. On the other hand, the other collections explain the importance of students' previous knowledge, not only as a starting point to approach the themes worked, but also as a means to develop contextualized work. The *Diálogos* collection indicates the importance of "[...] relating classroom themes to the students' close reality, questioning experiences lived and aligning contents to the students' interests" (L2, p. XI). The *Multiversos, Ser Protagonista* and *Matéria, Energia e Vida* collections, emphasize:

> Strategies such as eliciting previous knowledge, providing contextualization, promoting questioning, practice and other strategies enrichen the approach to themes and contents and the work with competencies and skills (L1, p. 184).
>
> The approximation between scientific and everyday life starts with recognizing that there is empirical knowledge accumulated by high school students and that such knowledge results from their experiences, their personal history and their insertion in the world (L3, p. 168).
>
> [...] in our collection, not only do we suggest ways of expliciting students' previous knowledge, but we also provide guidance regarding how teachers can deal with such knowledge while building scientific view (L4, p. 184).

The *Ser Protagonista* collection guiding material indicates that, when exploring knowledge built by students throughout their lives and interactions with the world, it is possible to involve them more effectively in the teaching and learning process. Therefore, it enables contextualized teaching aligned with

students' realities to help in the classroom. The same discourse appears in the *Multiversos* collection.

> The idea that what each student already knows is the foundation that makes learning more possible is recurrent. Therefore, an initial task for the teacher, when addressing a new topic, should be to map students' prior knowledge on the subjects covered, identifying some values, certain skills and abilities already being developed or not by them, which allows the teacher to have some notions about how students perceive themselves and conceive the world, as well as their ideas for the future (L1, p. 184).

The book *Matéria, Energia e Vida* draws attention to the fact that this knowledge is sometimes a factor hampering the learning of scientific knowledge. Morin (2015c) indicates that knowledge is "[...] sparse, scattered, multiple in nature, even where there are neither sensory receptors, nor nervous systems, nor cognitive functions." (Morin, 2015c, p. 56).

Aiming to make learning more meaningful to students, contextualization appears in all collections, however, with different emphasis. The *Ser Protagonista* collection defends that the attempt to investigate students' previous knowledge enables contextualized teaching in the classroom. Showing the relations established between students' realities and the themes worked in the classroom is a way of indicating the relevance of past events and experiences (L2).

Furthermore, it is by means of a contextualized approach that the *Multiversos* collection seeks to achieve the development of skills and competencies. Therefore, Morin (2015c) pointed out the need to reintegrate "[...] ideas of being, the individual, the subject, rather than erasing or withdrawing them" (p. 61). This view suggests that by including knowledge in the students' everyday life by means of contextualization, understood as a process of attribution of meanings based on relations with reality, it is possible to promote actions that aim at the development of subjects who are present and active in the teaching and learning process.

The *Matéria, Energia e Vida* collection defends that "[...] the more contextualized the approach to a topic (any topic) is, the greater the chances they will consider aspects of other subjects are" (L4, p. 196). Thus, one of the characteristics of the books in that collection are interdisciplinary activities seeking to deepen, connect, and contextualize knowledge.

According to Tufano (2002), contextualization creates a favorable and welcoming environment, enabling the construction of ideas and contributing to the re-signification of the classroom space. The *Moderna Plus* collection only explains that students' experiences and realities are valued following the Base Nacional Comum Curricular (BNCC) [National Common Curriculum Base] guidelines. However, it raises a question: how do these issues appear in practice? This question involves the last indicator of the category, showing that only two collections provide guidance for teaching proposals.

The *Diálogo* collection, seeks to provoke students' interest, making them the protagonists in the knowledge construction process. It indicates that they must be incentivized "[...] to explore the image and text and express their previous knowledge about the content to be studied" (L2, p. V). According to Morin (2022, p. 15), "[...] knowledge progresses not only via sophistication, formalization and abstraction, but mainly though the ability to contextualize and encompass". For this reason, the collection starts each unit with the theme introduction by means

of images and texts, aiming to provoke students' interest, contextualize the topic and approximate that content to the students' everyday lives (L2). Thus, the intention of joining school knowledge and life experiences is revealed. It aims at favoring a more meaningful learning that is open to dialogue with different contexts.

The material provided by the *Matéria, Energia e Vida* collection indicates introductory texts aimed at allowing students to express what they know or think about the topic, making learning easier and more attractive. The document also suggests the use of contextualized projects and proposals of investigative and interdisciplinary character to promote greater interaction. The use of questions linked to the students' context helps to promote greater involvement in the teaching and learning process.

The biology of knowledge (Morin, 2015c) points out that:

> [...] Even though knowledge becomes differentiated and automated, it will remain inseparable from organization, action, and being. Being, doing, and knowing are, in the realm of life, originally undifferentiated, and even when they become differentiated, they will remain inseparable (Morin, 2015c, p. 57).

Knowledge is part of the subject's constitution. The being is what it is; it is transformed, built and modified through the knowledge developed. World understandings are built from experiences lived, such knowledge is highly important for the understanding of something new. For this reason, in teaching based on an interdisciplinary approach, the use of textbooks should provide means to promote contextualized teaching, taking into account the different areas of knowledge.

The I, you and us

The second category – The I, you and us – refers to the relations established to promote dialogue and exchange between the subjects involved in the teaching and learning process. Through this movement, new knowledge is found, which contributes to the deepening of relations with one's own knowledge. In addition, we are social subjects, living in a world of multiple cultures and multiples understandings of nature and its relations. Therefore, looking at parts and at the whole is necessary to recognize the importance of each subject, teachers and students.

According to this ideia, textbooks appear as the support for the promotion of teaching based on collective work through dialogue. In the instructions to teachers, the *Matéria, Energia e Vida* collection signals the importance of incentivizing exchanges, respecting and promoting individualities, and each one's knowledge and discoveries.

> [...]the individualities and specificities of each student must be considered so that education is not a process of massification, but rather of emancipation of students, so that they can exercise citizenship and find their place in society (L4, p. 164).

Morin (2022), when addressing the reform of thinking, indicates solidarity among humans for the construction of new understandings of the world, thus

allowing defragmenting knowledge. One of the indicators describing the category is related to dialogue between teachers and students. Regarding this point, the *Diálogos* collection, provides guidance with some arguments and strategies that aim to promote dialogue and exchange between students. The material indicates activities involving debates, argumentation and exchange of ideas, as "pair or groupwork, involving discussions, debates, exchange of personal experiences, among other strategies" (L2, p. VI). With the same view, the material highlights the importance of:

> Understanding these multiple youth cultures that permeate the school context is part of the innovation process that has marked the educational course in recent years. Instead of "transmitting knowledge" to young people, why not exchange and share, opening spaces and creating conditions for youth cultures to express themselves in the school environment? (L2, p. X).

The *Moderna Plus* collection, addresses interactions but limits its views to how they benefit students' learning without deepening the reflection. Regarding this aspect, Morin (2015a) understands that "an isolated subject becomes trapped in the insurmountable difficulties of solipsism[4]. The notion of subject only makes sense within an ecosystem (natural, social, familial etc.) and must be integrated with a metasystem" (Morin, 2015ª, p. 47). When the subject is open to the world, they stablish relations and understandings as belonging to a collective.

Focusing on teachers, the *Matéria, Energia e Vida* collection highlights the importance of sharing experiences and support among teachers as a way of "guaranteeing" the search for interdisciplinary teaching. The material complements stating that "[...] debate must be fostered combined with the need for rational persuasion of peers and/or by peers and/or by the teacher" (L4, p. 177). It seems relevant to emphasize that "[...] interdisciplinarity is not only the integration of a set of relations between the parts and the whole, but it is also the Discovery of properties that are neither reduced to the whole or to isolated parts" (Paviani, 2014, p. 48). Interdisciplinarity requires the teacher to go beyond the simple integration of contents, recognizing the relations and properties that only appear when different types of knowledge are in interaction.

In the instructions presented in the *Ser Protagonista* collection, the importance of joint work between teachers is recognized, both in the natural sciences and other teaching areas. Considering interdisciplinarity is a way of promoting such interaction. Thus, learning starts to result from partnerships and exchanges, deriving from "[...] affection and respect, typical features of interdisciplinarity" (Justina, 2002, p. 161). In the same line of thought, the *Multiversos* collection points out that collaborative work among teachers is vital, since "[...] by sharing resources and pedagogical actions, it turns planning into an investigative record which favors innovation, considering that learning is something dynamic" (L1, p. 190).

On the other hand, Paviani (2014) explains that it is not worth stating that interdisciplinarity is related to the integration of subjects and teachers, among others, without due explanation of how this integration is made possible. Taking that into account, one indicator that appeared in all collections was that involving teaching proposals that value exchange and dialogue. All materials emphasize the importance of teaching based on dialogue, so that students' express their thoughts, allowing them to demonstrate their understanding of the world,

different types of knowledge and their realities. Interdisciplinarity is a category of action (Paviani, 2014). Therefore, it requires detailed and procedures aligned with the logic structure of teaching targeted, placing students in the center of the process, occupying the place of "I", learning to position themselves in the world, so as to learn how to deal with themselves and the world (Morin, 2015a).

The *Matéria, Energia e Vida* collection points out the need for proposals focusing on active learning, promoting reflection and, mainly, dialogue between students. As the material states: "The different proposals seek to promote active learning [...] always accompanied with questions that promote reflection upon the phenomenon being studied and provoke dialogue between students" (L4, p. 180). In addition, "group discussion promotes the development of skills such as listening, negotiations consensus, respecting each other's opinions, presenting arguments and elaborating rational justifications for their opinions" (L4, p. 196), creating essentially dialogical formative situations.

As a suggestion, the *Moderna Plus* collection included a section called "group activities" in each chapter and indicates the importance of developing skills related to research, argument presentation, communication, among others. The *Diálogos* collection suggests dynamics that can help intensify interactions. These include *sorting strips*[5] and *turn and talk*[6]. Following this ideia, the material explains that incentivizing socialization and students' involvement is an eficiente strategy in the teaching, learning and evaluating processes. The *Ser Protagonista, Multiversos* and *Matéria, Energia e Vida* collections are aligned in pointing out the need for proposals focusing on reflection, the development of competencies, Exchange, dialogue, collaborative and creative work, thus preparing students for life demands and their complexities. The *Ser Protagonista* collection states clearly: "dialogue and active listening, combined with approaches involving discussions, groupwork and work with other teachers, etc., are essential" (L3, p. 169). The *Multiversos* collection emphasizes that "working collectively in planning promotes the necessary integration between subjects" (L1, p. 190). Therefore, learning together, exchanging ideas and collaborating, is an efficient way of building new knowledge.

Through a dialogical approach, according to the *Matéria, Energia e Vida* collection, students start to have contact with multiple views of the world, and are forced to learn and present arguments to defend their own ideas. With this approach, individualities are taken into account, turning teaching into a students' emancipation process. Consequently, skills such as "listening, negotiating consensus, respecting the other, presenting arguments and seeking rational justifications for their opinions" are promoted (L4, p. 196). It is worth noting that "[...] neither the subject nor the object makes a pedagogical-scientific activity interdisciplinary, but the processual aspects of the activity do" (Paviani, 2014, p. 51).

The way of thinking is able to join separate knowledge, thus promoting the "[...] ethics of union and solidarity among human beings" (Morin, 2022, p. 97). The reform of thinking, valuing multiple knowledge, which expand and considers time and spaces, inserts in the classroom the possibility of existential, ethical and civic constructions (Morin, 2022).

Therefore, it becomes clear that "the I, you and us" are interconnected. It is not possible to understand what one knows without the other, who questions or proposes a view about the knowledge being discussed. "The **I** only exist in relation

with **you** and **us** originates from them: fom limits and respect, in the complementarity of life" (Petraglia, 2013, p. 42, author's emphasis). Thus, textbooks focusing on the interdisciplinary perspective must take into consideration the multiple knowledge that makes up complex thinking.

Complex thinking helps to understand such pre-established relations since it sees knowledge as a web, where all its components play a highly relevant role for the existence of the other and for the understanding of the whole. From this perspective, the textbook presents itself as a component in the construction of this web, a factor that can assist in the interaction between subjects, bringing proposals that promote dialogue and exchange, making it possible to bring to the classroom understandings about the parts and the whole that constitute knowledge.

The "how to do" in the classroom

The textbook analysis last category, in the pursuit of an interdisciplinary approach, regards instructions and suggestions provided by the materials for the teaching practice. With the understanding that interdisciplinarity, as pointed out by Fazenda (2011), assumes attitude, action and reflection, aiming to promote interaction between knowledge and subjects. This requires an attentive look at what is expected from the relations established between teacher and students, aiming at teaching supported by the search for an interdisciplinary lesson.

All materials analyzed revealed some concern with classroom procedures, indicating to teachers the kind of attitude that promotes students' proximity, making them active subjects in the teaching and learning process. This aspect emerges in the *Diálogos* collection, where, according to the material, teachers must abandon the posture of the one who has knowledge and take over "[...] more and more the role of mediator of relations between students and knowledge, guiding them in the path to be adopted in the teaching-learning process" (L2, p. X). This characterizes a type of conduct that takes reflection, interaction, dynamism and collaboration to the classroom. However, to achieve that, "[...] one of the teachers' fundamental tasks is to present his arguments to students rather than impose them based on authority, which must be recognized, but not used to impose a single view" (L4, p. 173).

Seeking to promote a horizontal relationship between teacher and students, the *Matéria, Energia e Vida* collection reinforces that "not only does society have more space for a more horizontal teacher-student relationship, but it also requires such relationship from both [...], founded on the need for mutual respect and partnership" (L4, p. 164). According to Morin (2013, p. 24), "[...] the development of intelligence is inseparable from the affection world [...]. Affection might suffocate knowledge, but it can also strengthen it". Attention must be given to the preparation of proposals seeking to promote some desirable attitude since this is an emotion, a favorable or unfavorable response to a provoked confrontation (Trindade, 2002). Therefore, interdisciplinary practice "[...] demands that the teacher is constantly evaluating their work, verifying whether it is suitable for that reality, whether it results in happiness in the teacher-student relationship, and whether it leads to significant learning" (Josgrilbert, 2002, 85).

Also considering the teacher's role, the *Ser Protagonista* and *Multiversos* collections point out teacher's mediating posture as fundamental in the development of an interdisciplinary approach. The former highlights taht:

> This work with competencies and skills, in addition to reinforcing the interdisciplinary aspect, stimulates students' autonomy, protagonism and critical thinking, leading them [students] to a central role as subjects of their own learning (L3, p. 169).

The *Multiversos* collection emphasizes that "the teacher's essential role joins that of learning mediator, pointing ways to students so that they can become protagonists in the construction of their knowledge and personal development" (L4, p. 177). Taking that into account, teachers start to play the role of guide and mediator, promoting actions that might lead students to become more active and autonomous in the teaching and learning process.

Petraglia (1993) draws attention to the relevance of re-learning to be a teacher, seeking a broader view of the world and education. In a recursive process, teachers' actions will influence students' doing, who will demonstrate new demands that will also determine teachers' doing. In such context, teachers take over the responsibility of incentivizing the construction of links between different types of knowledge, since "[...] interdisciplinary and integrative work is not limited to linking the contents of subjects, but must also propose changes of habits, resources, methods and teaching practices" (L5, p. VII).

However, for such interaction to occur, teachers must reflect constantly, with the purpose of rethinking and reformulating their actions, seeking a significant knowledge construction process (Godoy; Dell'Agnolo; Melo, 2020). According to the *Matéria, Energia e Vida*, collection, teachers must think strategies that guarantee students' participation, thus including different ways of thinking. The document highlights that "Once it is ensured that students become accustomed to participating in class, so that interaction and dialogue can take place, it is up to the teacher to consider what needs to be done to guarantee and monitor this participation" (L4, p. 184). Petraglia (1993) insists that, interdisciplinarity depends on going beyond a purpose or an intention. For this reason, students must be stimulated regarding the development of their critical thinking, creativity and taste for learning, understanding the importance of research, investigation and the establishment of relations.

In order to help the development of an interdisciplinary classroom, the collections presented suggestions of how to incentivize students' protagonism. The *Diálogos* collection presents contemporary cross-cutting themes and suggests an approach focused on reflection and dialogue:

> [...] Students should adopt an active and critical stance in constructing their knowledge. To achieve this, the idea of a teacher as the sole possessor of knowledge must be moved away, and the teacher will instead act as a facilitator of learning, providing opportunities for questioning and the expression of ideas and opinions (L2, p. XII).

Likewise, in the isntructions found in the *Ser Protagonista* collection, there is some concern about developing reflection and investigation skills and critical attitude, suggesting "[...] tests and experiments, demonstrations, media studies, interviews, and research in books and multimedia" (L5, p. 172).

To achieve that, it suggests that teachers present arguments, point out flaws in students' arguments, create a collective environment, promote interaction and ask questions according to the students' profile. The *Matéria, Energia e Vida* collection highlights that "teachers must create a proper collective environment and indicate the types of interaction involved when different arguments are considered" (L4, p. 177). By knowing students, understanding their preferences and learning styles, teachers can "[...] choose explanatory or demonstrative approaches and materials adapted to the different learning styles of the students in a group" (L5, p. X). Thus, dialogue becomes relevant to create this space of Exchange, allowing the teacher to plan suitable actions to cater for those students' needs.

When adopting an interdisciplinary attitude, teachers, according to Fazenda (2002, p. 20-21), "[...] identify aspects closer to human knowledge [...] realizing that things are not exhausted in themselves". This leads to individuals to break free from the mechanistic model, perceiving "[...] the processes, the affectivity, the effect of forces and the force of effects" (idem, p. 21). A different view of learning is seen, one that makes it possible to understand diversity and the interactions generated in the teaching process.

Another suggestion presented refers to the approach to Natural Sciences, which:

> [...] should be understood not only by the traditional content used in classes, but also by the possibility of applying in practice the logic of knowledge production used in the Natural Sciences, which is based on investigation, research, logical reasoning, critical thinking, the elaboration and verification of hypotheses, among other strategies (L3, p. 168).

In this regard, the *Matéria, Energia e Vida* collection indicates that, when teachers use a textbook that favor argumentation and presents reliable sources, "students are able to establish a relationship of trust with the contents of their textbook" (L4, p. 173) for knowledge construction. Thus, students start to feel more confident when using the material, resorting to it to clarify their doubts and deepen their knowledge.

In addition, aspects related to the construction of scientific knowledge must be unveiled, "[...] emphasizing how knowledge is produced, hypothesis verification strategies, uncertainties associated with measurements, how specific properties of different materials are determined, etc" (L4, p. 187). This allows students to be aware that science is not something finished and that, like their own knowledge, it goes through several processes of concept construction and reconstruction.

Therefore, we understand that a textbook that follows an interdisciplinary perspective is the one that seeks to meet society's demands, leading students to occupy a central position in the teaching and learning process. Students are incentivized, by means of questions and mediations, to explore contents they are exposed to. However, for this to occur, textbooks must support teachers, providing them with approaches that favor a process of dialogue and exchange, and enabling students' protagonism. Therefore, we observed that the results obtianed are in agreement with recente studies taht indicate that interdisciplinary approach in textbooks is still partially explored, with few collections really following such perspective (Silva; Moraes; Vaz, 2025).

FINAL CONSIDERATIONS

To enable an interdisciplinary perspective, textbooks must be flexible materials that take into account contexts, spaces, and cultures. Through them, alternatives for teaching that break down the barriers of fragmented knowledge become apparent. The book becomes a support tool for teachers, offering proposals that can serve as a basis for pedagogical planning and strengthening an interdisciplinary approach. For students, the textbook becomes a support material for understanding the complex relationships of knowledge, bringing it closer to their reality and favoring the deepening of new knowledge.

The results show that textbooks can be important mediators of interdisciplinary practices in science education, provided they are used critically and in a contextualized manner. Thus, it is understood that the analyzed textbook collections incorporate interdisciplinarity in their approach; however, this can only be achieved in practice, through actions and interactions promoted in the daily classroom routine that reduce the fragmentation of knowledge. For this reason, it becomes essential to reflect on how textbooks can contribute to teaching grounded in an interdisciplinary perspective, considering the need to analyze the processes involved in knowledge construction.

Based on these reflections, some questions arise as follows: to what extent are teachers able to explore the interdisciplinary potential of the book, considering that their education is still predominantly disciplinary? How can an interdisciplinary approach be achieved if there is, at the same time, an extensive list of learning objectives to be covered in each grade? Therefore, a necessary, and often tense, dialogue exists between the guidelines proposed in the books, the lists of learning objectives, and the public policies that govern the curriculum, going beyond a mere look at the material. For this reason, we recognize the need for continued dialogue on the factors that comprise teaching practice and the public policies that permeate the school.

Based on the established indicators, this study demonstrates that the *Matter, Energy, and Life* collection presents significant potential for promoting an interdisciplinary approach. This is because it discusses the sociocultural and historical context of scientific knowledge, values local, environmental, and social issues, proposes integrative and interdisciplinary projects, emphasizes the resolution of open problems, and promotes a plurality of languages. However, it is important to note that even with access to the best books, interdisciplinary work depends on teaching practice. Therefore, teacher education, whether initial or ongoing, is fundamental so that teachers can use textbooks as allies in the teaching and learning process, moving towards a truly interdisciplinary practice.

DO DISCIPLINAR AO INTERDISCIPLINAR: PARADIGMAS DO LIVRO DIDÁTICO DO ENSINO MÉDIO DA ÁREA DE CIÊNCIAS DA NATUREZA – PNLD 2021

RESUMO

O objetivo desta investigação foi analisar como as orientações apresentadas nos livros didáticos do Ensino Médio da área de Ciências da Natureza do PNLD 2021 operam com a perspectiva interdisciplinar. Para isso, realizou-se uma pesquisa documental nos livros didáticos escolhidos pelas escolas estaduais do município de Rio Grande/RS, na área de Ciências da Natureza. Utilizou-se como referência para a análise os fundamentos de uma prática interdisciplinar elencados pela professora e pesquisadora Ivani Fazenda, em diálogo com o pensamento complexo de Edgar Morin. A partir disso, constituíram-se três categorias para a análise dos livros didáticos: Das memórias ao contexto; O eu, o você e o nós; O "como fazer" na sala de aula. Constatou-se que o material traz, em sua proposta, a interdisciplinaridade, ressaltando a importância do diálogo, das trocas e das parcerias, além de considerar os múltiplos olhares sobre o conhecimento. No entanto, mesmo com as possibilidades da perspectiva interdisciplinar presentes nos livros, explicita-se que ela somente pode ser concretizada no fazer da sala de aula.

PALAVRAS-CHAVE: Ensino de Ciências. Construção do conhecimento. Pensamento ecossistêmico. Análise documental.

NOTES

1 FUNDO NACIONAL DE DESENVOLVIMENTO DA EDUCAÇÃO (FNDE). **Distribuição PNLD 2020 a 2025**. Gov.br, [s.d.]. Available at: https://www.gov.br/fnde/pt-br/acesso-a-informacao/acoes-e-programas/programas/programas-do-livro/pnld/distribuicao-pnld-2020-a-2025. Accessed on: May 2, 2026.

2 Codes used throughout the writing of the topic "Discussion of Results".

3 The textbook presents, in its information section, the editor responsible for the collection.

4 Morin uses the term *solipsism* (*solus ipse*) in reference to the philosophical doctrine focused on the empirical self, in which only the subject matters. "Only he himself counts, exists. He is the Only One for himself; only he occupies the space of computation. He is the center of his universe" (Morin, 2015b, p. 305).

5 "In the sorting strips strategy, pieces of information or content are separated into paper strips to be organized in sequence or classified into categories" (L2, p. XXII).

6 "In the turn and talk strategy, the teacher asks students a question, and they turn to discuss the answer with the classmate beside them" (L2, p. XXIII).

BIBLIOGRAPHIC REFERENCES

AMABIS, José Mariano; MARTHO, Gilberto Rodrigues; FERRARO, Nicolau Gilberto; PENTEADO, Paulo Cesar Martins; TORRES, Carlos Magno; SOARES, Júlio; CANTO, Eduardo; LEITE, Laura Cellote Canto. **Moderna plus**: ciências da natureza e suas tecnologias: manual do professor. São Paulo: Moderna, 2020.

CECHINEL, André; FONTANA, Silvia Aparecida Pereira.; DELLA, Kelli Giustina Pazeto; PEREIRA, Antônio Serafim; PRADO, Silvia Salvador do. Estudo/Análise Documental: uma revisão teórica e metodológica. **Criar Educação**. Revista do Programa de Pós-Graduação em Educação – UNESC. Criciúma, SC, v. 5, n. 1, p. 1-7, 2016. Available at: https://periodicos.unesc.net/ojs/index.php/criaredu/article/view/2446. Access on: Jan. 10th, 2024.

CHOPPIN, Alain. História dos livros e das edições didáticas: sobre o estado da arte. **Educação e Pesquisa**, São Paulo, v. 30, n. 3, p. 549-566, 2004.

BARBOSA, Ingrid Torres; FERREIRA, Anna Wannessa Nunes; KARLO-GOMES, Geam. Interdisciplinaridade na pesquisa científica em educação: revisão integrativa. **Revista Eletrônica de Educação**, *[S. l.]*, v. 18, n. 1, p. e6389198, 2024. Available at: https://doi.org/10.14244/reveduc.v18i1.6389. Access on: May 2nd, 2023.

FAZENDA, Ivani. (Org.). **Diário em construção**: interdisciplinaridade. 2ª ed. São Paulo: Cortez, 2002.

FAZENDA, Ivani. **Integração e interdisciplinaridade no ensino brasileiro**: efetividade ou ideologia. 6. ed. São Paulo: Loyola, 2011.

FAZENDA, Ivani. **Interdisciplinaridade**: História, teoria e pesquisa. São Paulo: Papirus Editora, 2017.

GODOY, Leandro Pereira de; DELL'AGNOLO, Rosana Maria; MELO, Wolney Candido de. **Multiversos**: ciências da natureza: ensino médio. São Paulo: Editora FTD, 2020.

JOSGRILBERT, Maria de Fátima Viegas. Atitude. *In*: FAZENDA, Ivani (Org.). **Diário em construção**: interdisciplinaridade. 2ª ed. São Paulo: Cortez, 2002.

JUSTINA, Reginaldo Dalla. Parceria. *In*: FAZENDA, Ivani (Org.). **Diário em construção**: interdisciplinaridade. 2ª ed. São Paulo: Cortez, 2002.

MORAES, Maria Cândida de. **Paradigma educacional ecossistêmico**: por uma ecologia da aprendizagem humana. Rio de Janeiro: Wak Editora, 2021.

MORIN, Edgar. Abertura. *In*: CASTRO, Gustavo de; CARVALHO, Edgard de Assis; ALMEIDA, Maria da Conceição (Org.). **Ensaios de Complexidade**. Porto Alegre: Sulina, 1997.

MORIN, Edgar. **Os sete saberes necessários à educação do futuro**. 1. ed. Cortez. UNESCO, 2013.

MORIN, Edgar. **Introdução ao pensamento complexo**. 5. Porto Alegre: ed. Sulina, 2015a.

MORIN, Edgar. **O método 2**: a vida da vida. 5.ed. Trad. Marina Lobo. Porto Alegre: Sulina, 2015b.

MORIN, Edgar. **O método 3**: conhecimento do conhecimento. 5.ed. Trad. Marina Lobo. Porto Alegre: Sulina, 2015c.

MORIN, Edgar. **A cabeça bem-feita**: repensar a reforma, reformar o pensamento. 28ª ed. Rio de Janeiro: Bertrand Brasil, 2022.

MORTIMER, Eduardo; HORTA, Andréa; MATEUS, Alfredo; MUNFORD, Danusa; FRANCO, Luiz; MATOS, Santer; PANZERA, Arjuna; GARCIA, Esdras.; PIMENTA, Marcos. **Matéria, energia e vida**: uma abordagem interdisciplinar. São Paulo: Scipione, 2020.

PAIXÃO, Karollyne Santana; MARIANO, Wagner dos Santos. O livro didático de Ciências do ensino fundamental anos finais: análise do conteúdo de arboviroses. **Revista Prática Docente**, *[S. l.]*, v. 8, n. Especial, p. e23106, 2023. Available at: https://doi.org/10.23926/RPD.2023.v8.nEspecial.e23106.id823. Access on: May 2nd, 2026.

PAVIANI, Jayme. **Interdisciplinaridade**: conceitos e distinções. ed. rev. 3. Caxias do Sul: Educs, 2014.

PETRAGLIA, Izabel. **Pensamento complexo e educação**. São Paulo: Editora Livraria da Física, 2013.

PETRAGLIA, Izabel. **Interdisciplinaridade**: o cultivo do professor. São Paulo: Pioneira: Universidade São Francisco, 1993.

PINTO, Maria Célia Barros Virgolino. Memória. *In*: FAZENDA, Ivani (Org.). **Diário em construção**: interdisciplinaridade. 2ª ed. São Paulo: Cortez, 2002.

SÁ-SILVA, Jackson Ronie; ALMEIDA, Cristóvão Domingos; GUINDANI, Joel Felipe. Pesquisa documental: pistas teóricas e metodológicas. **Revista Brasileira de História e Ciências Sociais**, São Leopoldo, RS, Ano 1, n. 1, jul., 2009. Available at: https://doi.org/10.63595/rbhcs.v1i1.10351. Access on: May 2nd, 2026.

SANTOS, Danilo Lopes; JANERINE, Aline de Souza; FERNANDES, Geraldo Wellington Rocha. O novo ensino médio e a interdisciplinaridade escolar: a preparação dos professores de ciências naturais. **Alexandria**: Revista de Educação em Ciência e Tecnologia, Florianópolis, v. 17, p. 1-22, 2024. Available at: https://doi.org/10.5007/1982-5153.2024.e96225. Access on: May 2nd, 2026.

SANTOS, Kelly Cristina dos (editora responsável). **Diálogo**: ciências da natureza e suas tecnologias: manual do professor. São Paulo: Moderna, 2020.

SILVA, Rafaela Alexandra da; MORAES, Fernando Aparecido de; VAZ, Wesley Fernandes. O livro didático de ciências da natureza: o conteúdo de eletroquímica e a interdisciplinaridade. **Educação Química en Punto de Vista**, *[S. l.]*, v. 9, n. 10, p. 209–231, 2025. Available at: https://doi.org/10.30705/eqpv.v9i10.4499. Access on: May 2nd, 2026.

TUFANO, Wagner. Contextualização. *In*: FAZENDA, Ivani. (Org.). **Diário em construção**: interdisciplinaridade. 2ª ed. São Paulo: Cortez, 2002.

TRINDADE, Vitor. Atitude. *In*: FAZENDA, Ivani. (Org.). **Diário em construção**: interdisciplinaridade. 2ª ed. São Paulo: Cortez, 2002.

ZAMBONI, André.; BEZERRA, Lia Monguilhott. (editores responsáveis). **Ser protagonista**: ciências da natureza e suas tecnologias: ensino médio. São Paulo: Edições SM, 2020.

Received: Sep. 5th, 2024.
Approved: May 2nd, 2026.
DOI: 10.3895/rbect.v19n1.19061
How to cite: SILVA, G. R.; ARAUJO, R. R. From disciplinary to interdisciplinary: paradigms of high school textbooks in the field of natural sciences – 2021 PNLD. **Brazilian Journal of Science Teaching and Technology**, Ponta Grossa, v.19, p. 1-21, 2026. Available at: <https://periodicos.utfpr.edu.br/rbect/article/view/19061>. Access on: XXX.
Mailing address: Grasiele Ruiz Silva - ruiz.grasi@gmail.com