

20 Years of History: What do Teachers Say About the Implementation of Transversality in Science Education?

20 Anos de História: O Que Dizem os Professores Sobre a Implementação da Transversalidade na Educação em Ciências?

20 Años de Historia: ¿Qué Dicen los Profesores Sobre la Aplicación de la Transversalidad en la Enseñanza de las Ciencias?

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Abstract

This research aimed to understand how the speeches of teachers, who work in High School, in the area currently called Natural Sciences and their Technologies, are configured regarding the implementation of Transversal Themes, considering the 20 years of validity of the National Curricular Parameters. In view of this, we developed research with a qualitative approach and were anchored in the theoretical-methodological assumptions of French Discourse Analysis. The corpus of analysis was constituted through the application of an online research instrument to teachers from the Tocantins state network who worked, in subjects in the area, in High School in any period between 1998 and 2020. Regarding the concept of Transdisciplinarity, the teachers' speeches revealed meanings that refer to cooperation/dialogue/interaction between different areas of knowledge/disciplines in approaching content/themes. The analysis of the concept of Transversality, in turn, shows that the statements express meanings of connection/integration and the need for contextualization and approach to everyday issues. We evidence, on the one hand, that teaching discourses converge with the meanings found in official documents from the 1990s onwards, which assume citizenship as the guiding axis of education and highlight social issues as fundamental themes in the process of curricular organization. Such meanings, on the other hand, are based on the centrality of curricular content, while social themes, although seen as important, are understood as supporting elements and not integrating axes of the different areas.

Keywords: transdisciplinarity, Science Teaching, transversal education

Resumo

Esta pesquisa teve como objetivo compreender como se configuram os discursos de professores que atuam no Ensino Médio, na área denominada atualmente Ciências da Natureza e suas Tecnologias, acerca da implementação dos Temas Transversais, considerando os 20 anos de vigência dos Parâmetros Curriculares Nacionais. À vista disso, desenvolvemos uma pesquisa de abordagem qualitativa e nos ancoramos nos pressupostos teórico-metodológicos da Análise do Discurso de linha francesa. O *corpus* de análise foi constituído por meio da aplicação de um instrumento de pesquisa *on-line* aos professores da rede estadual do Tocantins que atuaram em disciplinas da área no Ensino Médio em qualquer período compreendido entre 1998 e 2020. Quanto ao conceito de Transdisciplinaridade, os discursos dos docentes revelaram sentidos que remetem à cooperação, diálogo e interação entre diferentes áreas do conhecimento/disciplinas na abordagem de conteúdos/temas. A análise do conceito de Transversalidade, por sua vez, mostra que os enunciados expressam sentidos de conexão, integração e necessidade de contextualização e abordagem das questões cotidianas. Evidenciamos, de um lado, que os discursos docentes convergem com os sentidos encontrados nos documentos oficiais a partir dos anos 1990, que assumem a cidadania como eixo orientador da educação e destacam as questões sociais

como temas fundamentais no processo de organização curricular. Tais sentidos, por outro lado, estão pautados na centralidade dos conteúdos curriculares, enquanto os temas sociais, embora sejam vistos como importantes, são entendidos como coadjuvantes e não como eixos integradores das diversas áreas.

Palavras-chave: transdisciplinaridade, Ensino de Ciências, educação transversal

Resumen

Esta investigación tuvo como objetivo comprender cómo se configuran los discursos de los docentes que actúan en la Enseñanza Media, en el área actualmente denominada Ciencias Naturales y sus Tecnologías, respecto de la implementación de Temas Transversales, considerando los 20 años de vigencia de los Parámetros Curriculares Nacionales. Ante esto, desarrollamos una investigación con enfoque cualitativo y nos anclamos en los supuestos teórico-metodológicos del Análisis del Discurso francés. El corpus de análisis se constituyó mediante la aplicación de un instrumento de investigación en línea a profesores de la red estatal de Tocantins que actuaron, en materias del área, en la Escuela Secundaria en cualquier período entre 1998 y 2020. En cuanto al concepto de Transdisciplinariedad, los profesores, los discursos revelaron significados que se refieren a la cooperación/diálogo/interacción entre diferentes áreas de conocimiento/disciplinas en el abordaje de contenidos/temas. El análisis del concepto de Transversalidad, a su vez, muestra que los enunciados expresan significados de conexión/integración y la necesidad de contextualización y abordaje de cuestiones cotidianas. Evidenciamos, por un lado, que los discursos docentes convergen con los significados encontrados en documentos oficiales de la década de 1990 en adelante, que asumen la ciudadanía como eje rector de la educación y resaltan las cuestiones sociales como temas fundamentales en el proceso de organización curricular. Tales significados, por otra parte, se basan en la centralidad de los contenidos curriculares, mientras que los temas sociales, aunque vistos como importantes, son entendidos como elementos de apoyo y no como ejes integradores de las diferentes áreas.

Palabras clave: transdisciplinariedad, Enseñanza de las Ciencias, educación transversal

Introduction

The curriculum reforms that have occurred in several countries worldwide since the 1990s have proposed the need to establish a relationship between scientific knowledge and the exercise of citizenship, as well as the formation of critical subjects capable of mobilizing this knowledge to solve concrete problems. Furthermore, the construction and implementation of educational policies and guidelines in the Brazilian scenario also emphasized, and still emphasizes, the need for an education that allows the full development of the student, meeting the principles of justice, ethics, and citizenship, with the school being committed to a comprehensive education (Ministério da Educação, 1997, 1998, 1999a, 2018).

As for the teaching of Science, many authors have focused on discussions that relate scientific education and citizenship education, proposing that the understanding of scientific knowledge contributes to the development of the ability to think and decide on issues involving science, technology, and society (Cachapuz et al., 2004; Krasilchik

& Marandino, 2007). From this perspective, the discussions are close to the proposal of educating for the development of what has been called Scientific Literacy by some authors or Scientific Enculturation or Scientific and Technological Literacy by others (Silva & Sasseron, 2021). In any case, regardless of the denomination, these approaches emphasize the social function of science teaching, focusing on the formation of critical and autonomous citizens, who know how to use scientific knowledge in decision-making on issues that surround them (Chassot, 2000; Lorenzetti & Delizoicov, 2001; Krasilchick & Marandino, 2007; Sasseron & Carvalho, 2011; Marques & Marandino, 2018; Silva & Sasseron, 2021).

In the context presented, in which the emphasis on an education that allows the subject to act in a complex and permanently changing society is highlighted, the discussions on transversality and the approach to Transversal Themes are inserted. These themes do not constitute new subjects in the curriculum, but areas of knowledge that cross the disciplinary, interdisciplinary, and transdisciplinary fields (Araújo, 2014). According to Moreno (1999) and Yus (1998), to achieve their objectives and allow the formation of students who think, understand, and act in the world, the Transversal Themes must be considered structuring axes of the curriculum, and the curriculum subjects need to revolve around them. The idea is to overcome fragmented teaching, in which contents are not related or integrated, as proposed in Edgar Morin's (2007) paradigm of systemic complexity, about the exploration of knowledge in a broad way, breaking with traditional disciplinary divisions. In this sense, the approach to the Transversal Themes must be concretized in a dynamic perspective, from which there is the notion of permanent transformation and relationship of all things, in order to translate, in practice, the idea of the so-called complex thinking defended by Morin, when considering that everything is connected.

The Transversal Themes should guarantee transversal practices and be included through the so-called *transversality*, and not as new school subjects. Thus, these issues of social urgency should be part of the formal subjects, permeating the disciplinary, interdisciplinary, and transdisciplinary fields (Nicolescu, 1999). This integrative proposal, which brought a notion of the school as an institution that promotes the transformations of the world, relating knowledge and uniting different ways of thinking, converges with what Morin (2000) says about the knowledge necessary for the education of the future:

As our education has taught us to separate, compartmentalize, isolate, and not to unite knowledge, the set of them constitutes an unintelligible puzzle. The interactions, feedback, contexts, and complexities found in man's land between school subjects become invisible. The great human problems disappear in favor of the particular technical problems. The inability to organize dispersed and separated knowledge leads to the atrophy of the natural mental disposition to contextualize and globalize (Morin, 2000, pp. 42–43, our translation).

That said, it is necessary to consider that the transversal approach to social issues in the field of education emerged, at the end of the 1960s, from discussions of organized groups in various countries around the world, which proposed to think about the role of the school and the contents that should be prioritized in an increasingly plural and globalized society (Araújo, 2014). From these reflections, questions emerged about the current curriculum organization and how it could be configured to effectively meet the new demands (Araújo, 1999). Therefore, the inclusion of themes, in a transversal condition, emerges as an alternative, considering that they represent urgent issues in the scope of school and social life and, therefore, require, in terms of pedagogical approach, the articulation of contents of the different areas of knowledge that make up the school curriculum.

In legal terms, in Brazil, the Law of Guidelines and Bases of Education — LDB (Ministry of Education, 1996), with regard to the curricula of Elementary and Secondary Education, determines, in its article 26, that there is a common national base to be complemented by a diversified part, which meets the regional and local characteristics of society. The seventh item of this article proposes that curricular integration may include, at the discretion of the education systems, projects and research involving transversal themes. Also in this sense, the National Curriculum Parameters — PCN (Ministry of Education, 1997, 1998) guided Science Teaching in articulated axes and the approach of transversal themes for an education that allows the subject to be active and participative in the face of the complexities of the society, which is in constant transformation. They highlighted, as objectives of the inclusion of these themes in the curricular structure of Brazilian schools, “the rescue of the dignity of the human being, equal rights, active participation in society and co-responsibility for social life” (Araújo, 1999, p. 10, our translation).

Thus, according to the idea that guides the PCN, the Transversal Themes should be seen as viable opportunities for the inclusion of current social issues, not as another subject, but inserted in all educational moments (Inoue et al., 1999). With this, schools would be concerned with contemplating the world transformations and the different realities and, in addition, detached from the analytical formative character and closer to the development of a contextualized pedagogical work directly related to the everyday issues of life. For this, it is necessary to integrate the contents addressed in the different curricular components with different themes, through practices that are effective inside and outside the school space.

In the High School context, initially, in 1999, there was an emphasis on the transversality of themes relevant to society, without, however, indicating specific themes. It was over the years that other legal documents emerged guiding the transversal approach to specific themes related to students’ daily lives and considered to be of social urgency. Among them, it is highlighted, for example, the creation of laws, decrees and resolutions that supported the mandatory approach to some themes in High School, such as Environmental Education (Law nº 9.795, 1999), Human Rights Education (Ministry of

Education, 2012a) and Food and Nutrition Education (Brasil, 2009), or Resolution CNE/CEB No. 5/2011, which determines the inclusion of these subjects in the curricula on a permanent basis (Law nº 11.947, 2012). More recently, in 2018, with the publication of the National Common Curricular Base (BNCC), the Transversal Themes were expanded and became known as Contemporary Transversal Themes, consisting of six thematic macro-areas and 15 themes chosen, according to the document, for influencing human life at local, regional, and global scales, namely: Citizenship and Civism (Family and Social Life, Traffic Education, Human Rights Education, Child and Adolescent Rights, Aging Process, Respect and Appreciation of the Elderly); Science and Technology; Economics (Work, Financial Education, Tax Education); Environment (Environmental Education, Consumer Education); Multiculturalism (Cultural Diversity, Education for the appreciation of multiculturalism in Brazilian historical and cultural matrices); and Health (Health, Food and Nutrition Education) (Ministry of Education, 2018).

Given the reality presented, we understand that it is of great relevance that transversality is the object of study of academic research in teaching, so that it can be understood how it has been addressed, as well as the difficulties and challenges faced by teachers, especially in High School, for the insertion of these themes in their pedagogical practices. Thus, when we think about how this process has been developed in the school, we understand that our investigation must have as its main focus the teachers' perceptions. To this end, we sought to answer the following question: based on the discursive functioning, what are the discourses of teachers in the area of Natural Sciences who work in High School about the implementation of Transversality in the two decades of validity of the National Curriculum Parameters?

Taking as a starting point what some previous studies that have also been concerned with these issues in different contexts point out, such as those by Zarth (2013), Benites et al. (2018), Azambuja et al. (2016), and Goulart et al. (2020), we evidence that there are many doubts and discussions between undergraduates and Basic Education teachers about how to address the themes in a transversal way and to enable the development of teaching and learning processes based on it.

Thus, although the Brazilian educational legislation has taken important steps in the discussions on curriculum design, emphasizing the need for education for citizenship and providing guidelines for teaching to be focused on the reality of the students, in practice, teaching is still done in a fragmented and disciplinary way (Mundim & Santos, 2012). In addition, we cannot disregard that, even though the official documents have added a discourse that points to a new educational paradigm, in view of the transformations of the contemporary world, the context in which these laws are elaborated shows an undeniable contradiction, since, at the same time that it justifies the need for an education that guarantees the formation of autonomous and critical citizens, meeting the needs of a complex world, it also emphasizes an education that maintains the *status quo* of a society dominated by capitalist ideals and social inequalities.

The disciplinary model cannot be the only way of action, because a fragmented school curriculum does not offer a vision of the whole or of a unified and integrated knowledge. As an alternative, Morin (2003) proposes the exploration of knowledge in a systemic way, overcoming the traditional disciplinary divisions, typical of the paradigm of modern science, since knowledge of the world is an intellectual and vital necessity for the citizens of this millennium who need to understand how to obtain information, articulate it, organize it and use it effectively in everyday situations. Such a process requires the world's problems to be recognized or known and, likewise, a reform of thought to occur, considering that there is a profound inadequacy between knowledge, which is disjointed and compartmentalized, and current problems are “increasingly multidisciplinary, transversal, multidimensional, transnational, global and planetary” (Morin, 2000, p. 36, our translation). In this way, we understand that, by valuing the vision of the complexity of the world, it is possible to associate the scientific knowledge historically produced with the knowledge built from current problems with social relevance.

Considering that the proposal to address issues of social relevance in a transversal perspective aims to overcome fragmented teaching, promoting the exploration of knowledge in a broad way by breaking with disciplinary divisions and taking into account the plurality of knowledge and the issues of the students' daily life, and that such a proposal has been part of the official Brazilian curriculum documents for at least 20 years, we believe it is necessary to identify and reflect on the many challenges faced by Natural Sciences teachers in their pedagogical practices to make such an approach effective, since we still have a disciplinary curriculum organization, which extends from Basic Education to Higher Education, and which also characterizes the initial training processes of the teachers themselves.

Methodological Path

To respond to the objective of this study, we developed a study, primarily with a qualitative approach, based on the concept of Creswell (2014), according to which qualitative research addresses the meanings attributed by individuals or groups to a social or human problem. In this path, the researcher interacts with his/her research problem in different ways, establishes relationships with the participants, makes discoveries, and, often, considers the need to redesign the theoretical-methodological paths, reformulate the questions, and adjust the instruments. Having as the object of our research the teachers' discourses, it is worth noting that these are also impermanent and are in constant movement, given the social and political transformations that affect the context in which these discourses are produced (Orlandi, 2000).

The constitution of the *corpus* of analysis took place through empirical research carried out with teachers in the area of Natural Sciences who work in High School in schools of the State Education Network of the state of Tocantins and who taught between 1998 and 2020. By adopting this inclusion criterion, we intended to focus our analysis on

the reports of teachers who joined after the implementation of the Law of Guidelines and Bases of Education (LDB) (Law No. 9.394, 1996) and the PCN (Ministry of Education, 1997), documents that, for the first time, brought the proposal of Transversality and emphasized the need for transdisciplinary approaches in teaching.

The delimitation of the inclusion of subjects until 2020 is because this year marks the implementation of the BNCC (Ministry of Education, 2018), another curriculum guideline that, although it presents the so-called Transversal Contemporary Themes, makes them mandatory and changes the themes addressed. Thus, we seek to understand the approach to the themes in the teaching of subjects in the area of Natural Sciences and its developments over the two decades of the PCN.

Considering that, despite the discourse on the integration/transversalization of themes being present in official documents, the current curriculum organization still keeps the school subjects at the center of the educational process, we ask ourselves: what has been the role of the Natural Sciences in the implementation of practices involving transversal teaching proposals? Although it may seem contradictory to analyze only the discourses of teachers in the area of Natural Sciences about transversality in High School, since this area represents a set of school subjects, we clarify to the reader that our delimitation seeks to better understand the approach to social issues in a transversal perspective from the scientific subjects.

For the constitution of the *corpus* of analysis, an online instrument was made available to teachers in the area of Natural Sciences who work in High School in the state of Tocantins. The responses of the first 50 participants who met the inclusion criteria described above were considered. The research instrument contains questions aimed at apprehending the meanings that permeate the subjects' discourses regarding the concept of Transversality. For this article, the *corpus* of the subjects' answers to the following questions was considered: (1) What do you understand by Transdisciplinarity? and (2) What do you understand by Transversality in Science Education?

In compliance with CNS Resolution No. 510/2016 (Ministry of Health, 2016), which provides for the rules applicable to research in the Human and Social Sciences, whose methodological procedures involve the use of data directly obtained from the participants, identifiable information or information that may entail greater risks than those existing in everyday life, the participants of this research signed the Informed Consent Form (*Termo de Consentimento Livre e Esclarecido* — TCLE). In addition, the research project was submitted for evaluation via *Plataforma Brasil* and was approved by the Research Ethics Committee on April 4, 2023, with substantiated opinion number 5,982,689.

The empirical material produced together with the participants was systematized using IRaMuTeQ software (*Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires*). For systematization purposes, in this case, the *textual corpus* was presented using a word cloud and similarity analysis. According to Camargo & Justo (2013, p. 516, our translation), “the word cloud groups them and organizes them

graphically according to their frequency. It is a simpler lexical analysis, [...] which allows for quick identification of the keywords of a *corpus*". As for the similarity analysis, it allows the identification of co-occurrences and "brings indications of the connection between words, helping to identify the structure of a *textual corpus*, also distinguishing the common parts and specificities" (Camargo & Justo, 2013, p. 516, our translation).

In the course of the research, in order to achieve the proposed objectives, we assumed a theoretical and methodological basis of discursive essence. For this reason, we analyzed the texts to understand the mechanisms of discourse functioning, based on Discourse Analysis (DA) grounded on the contributions of the French line of Michel Pêcheux and the works of Eni Orlandi, in Brazil. As its name indicates, DA's object is the discourse itself, which brings with it the idea of a path, of movement. Thus, when we study discourse, we are observing man speaking, that is, we are analyzing the practice of language (Orlandi, 2000) that is done considering man in his history and language as an effect of a historical process. For Pêcheux (1975 cited in Orlandi, 2000, p. 17, our translation), "there is no discourse without a subject and there is no subject without ideology". For this reason, discourse is considered the place where the relationship between language and ideology is observed and, likewise, the place where language produces meanings by and for the subjects.

From this perspective, language is not transparent and "the language/thought/world relationship is not univocal. That is, it is not a direct relationship that is made term-to-term, that is, it does not pass directly from one to the Other" (Orlandi, 2000, p. 19, our translation). Thus, it is assumed that, in any manifestation of language, interpretation is present and, therefore, when seeking to understand a discourse, we try to explain the ways in which it produces meanings. It was based on this assumption that we sought to understand, through the discourses of the teachers participating in this research, the possible effects of meanings attributed to Transdisciplinarity and Transversality as a result of the implementation, at the end of the 1990s, of the PCN and the Transversal Themes.

Discursive Functioning: Perceptions of Teachers in the Area of Science Education About the Implementation of Transversality

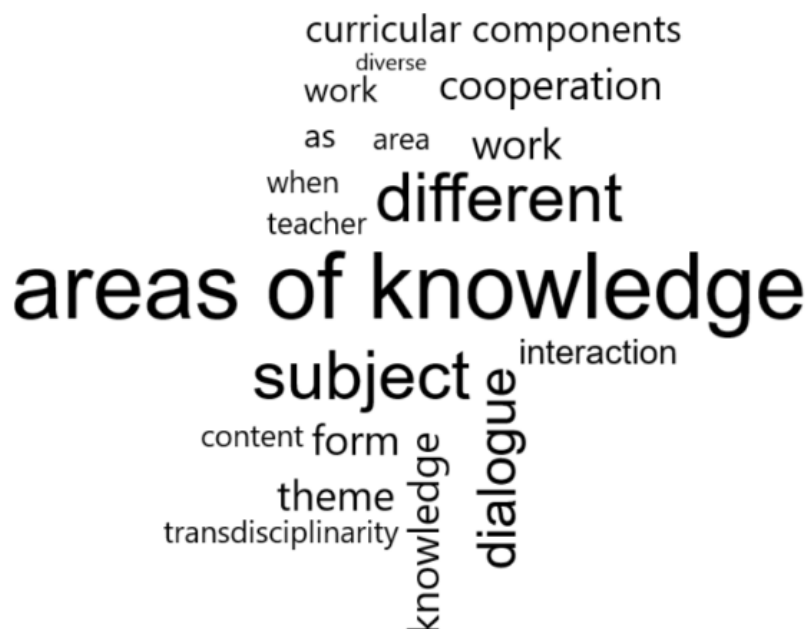
In this section, we will present the description and interpretation of the *corpus* arising from the subjects' answers to the following questions: (1) What do you understand by Transdisciplinarity? and (2) What do you understand by Transversality in Science Education? For Orlandi (2000), the *corpus* should not be understood as data, but as a construction, a fact, and, therefore, "to look at the texts as facts — and not as data — is to observe how they function as a symbolic object" (Souza, 2014, p. 57, our translation). This analytical movement allowed us to understand how the discourses build meaning about Transdisciplinarity and Transversality and the process of implementation of the Transversal Themes, given the two decades of validity of the PCN.

In Figures 1 and 2, specifically, we have the word cloud and similarity analysis with the answers attributed to the first question, which sought to know the subjects' perceptions of the concept of **Transdisciplinarity**. Then, in Figures 3 and 4, we present the word cloud and similarity analysis elaborated from the answers obtained to the question: "What do you understand by **Transversality** in Science Education?"

From the description of Figures 1 and 2 about the meaning of Transdisciplinarity, we highlight some important marks from the research subjects' answers. The word cloud highlights the words with the highest recurrence (Figure 1), and the similarity analysis reveals a close relationship between the term "areas of knowledge" and the words "dialogue", "different", "cooperation" and "diverse". The word "subject" is associated with the words "theme", "content" and "interaction" (Figure 2).

Figure 1

Teachers' understanding of Transdisciplinarity



Source: the authors.

Figure 2*Teachers' understanding of Transdisciplinarity*

Source: the authors.

From the interpretation exercise, in turn, Figures 1 and 2 show the understanding of the theme, since they reveal meanings of cooperation, dialogue, and interaction between different areas of knowledge/subjects in the approach to contents/themes. The answers that we highlight below ratify and exemplify the above: *“I understand it as the joint work of the different curricular components, with a view to the work of a specific theme”* (P05); or *“Teamwork, involving dialogue and cooperation between different areas of knowledge, that is, different subjects in favor of the teaching-learning process”* (P13); or *“Transdisciplinarity has been essential to foster and provide work together with other areas of knowledge, enabling the student to achieve better development in learning. Thus, teachers can also work in partnership on a certain theme or several ones”* (P19).

We emphasize that the understanding of how the concept of transdisciplinarity is presented in the discourse of the subjects of this research is of great relevance because the construction of this concept took place during a movement of discussions that

guided the need for paradigmatic changes in education. The idea of a transdisciplinary education is part of the various efforts made to break disciplinary boundaries through educational models that promote the integration of knowledge from different areas. Thus, this concept is part of the set of several others that emerged from the 1970s onwards (Piaget, 1973 cited in Sommerman, 2014; Morin, 2000; Nicolescu, 1999) and that translate the need to understand knowledge in a unified, systemic way, overcoming the traditional disciplinary divisions, typical of the paradigm of modern science (Morin, 2007).

The term transdisciplinarity was initially mentioned by Jean Piaget in the 1970s, after having presented his definitions for multidisciplinary and interdisciplinarity. Piaget stated that transdisciplinarity would be a higher stage that would succeed the stages of interdisciplinary relations since it “would not be content with achieving interactions or reciprocity between specialized subjects, but would situate these connections within a total system without stable boundaries between subjects” (Piaget, 1973 cited in Sommerman, 2014, p. 22, our translation). Given the scope of this concept, Piaget (1973 cited in Sommerman, 2014) concludes that transdisciplinarity would be a general theory of systems and structures. It was up to physicist Basarab Nicolescu to formulate the pillars for the transdisciplinary research methodology, defining transdisciplinarity as a new type of knowledge, which became known as epistemological-paradigmatic transdisciplinarity (Nicolescu, 1999).

There was, therefore, a long process of construction of the concept of transdisciplinarity that began in the 1970s, resulting in documents and publications that sought to treat this field from an epistemological perspective. When considering this process, Suanno (2014, p. 14, our translation) states that transdisciplinarity

seeks to reconnect knowledge and, in this process, values disciplinary and specialized knowledge as a part, however, it transcends it by investing in human formation, characterized by being multidimensional, multireferential, and self-referential. Such formation demands a way of thinking that reconnects knowledge that is at the same time between, through, and beyond any subject, thus constituting itself as an integrating instance of knowledge and knowledge constituted by humanity.

This process of reconnecting and integrating knowledge converges with the thought of Morin (2000) when he argues that the knowledge of the parts depends on the knowledge of the whole, just as the knowledge of the whole depends on the knowledge of the parts.

In addition, it is worth noting that the term became part of the official curriculum documents in the 1990s, due to the reform movement that occurred during this period. That said, we understand that teachers in the area of Natural Sciences have, at some point in their training or teaching career, come into contact with the idea of Transdisciplinarity. However, we noticed that, although the concept appears in the texts with some frequency, the term is not deepened, being used more as a methodological

assumption than an epistemological one. The PCN for High School (Law No. 9.795, 1999), for example, mentions transdisciplinarity without deepening its concept, relating it to interdisciplinarity and contextualization:

Through the curriculum organization by areas and the understanding of the **transdisciplinary** and matrix conception, which articulates languages, Philosophy, natural and human sciences, and technologies, we intend to contribute so that, gradually, the impervious and compartmentalized treatment that characterizes school knowledge is gradually overcome [...]. From the school perspective, interdisciplinarity does not intend to create subjects or knowledge but to use the knowledge of various subjects to solve a concrete problem or understand a certain phenomenon from different points of view. In short, interdisciplinarity has an instrumental function. It is a matter of resorting to knowledge that is directly useful and usable to respond to contemporary social issues and problems (Law No. 9.795, 1999, p. 21, emphasis added, our translation).

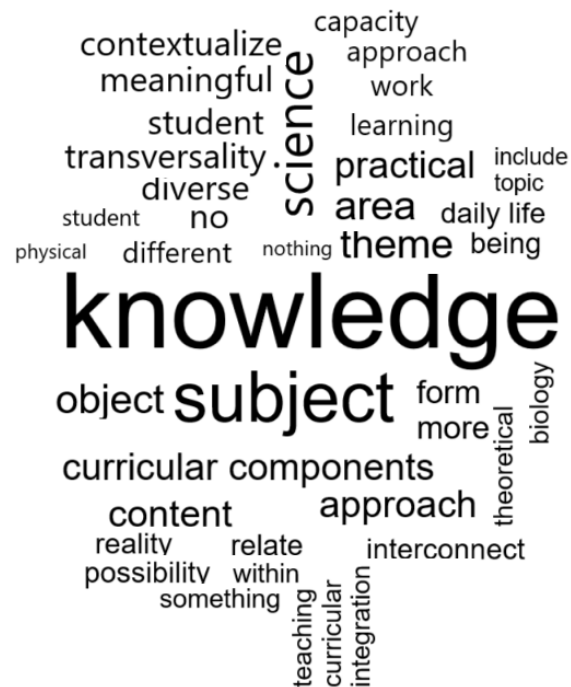
The teachers' discourse coincides with the meanings attributed to Transdisciplinarity evidenced in the curriculum documents published from the 1990s onwards and in the curricular proposals of the state of Tocantins for High School, as the understanding seems to be centered only on the methodological perspective and not on the epistemological one. In other words, the discourses characterize transdisciplinarity, in the strict sense, as a possibility to promote pedagogical practices, but not, in a broad sense, of curricular integration. In other words, from these meanings emerges an idea of connection between the areas in the approach to the contents, but not in the articulation of knowledge. This perception is confirmed by the following answers: "*Transdisciplinarity can be seen as a **pedagogical approach** that crosses all curricular components, allowing for integrated collaboration among teachers*" (P45); "*To work contents in an integrated way between subjects*" (P49); "*It means **working on a theme** that is not only linked to one subject, but that promotes a dialogue in various areas of knowledge*" (P14).

Continuing our interpretative movement, we identified, as shown in Figures 3 and 4, how the meaning of Transversality in Science Education is constructed for the research subjects.

Therefore, and considering that the processes of construction of meanings can be revealed through the analysis of discursive manifestations, it is important to highlight that we identified some recurrent words expressed in the word cloud (Figure 3) that have close relationships (Figure 4), forming nuclei of association. The following groupings stand out: "**knowledge**" associated with the words "area", "reality", "daily life", and "student"; the term "**subject**" related to "approach" and "different"; "**theme**" in association with "work", "curricular", and "student"; the word "**content**" associated with the words "relate", "subject", "interconnect", "learning" and "meaningful"; the term "**practical**" in proximity to "theoretical", "possibility", "and contextualize"; and, finally, the word "**Science**" associated with "include", "diverse", "within" and "integration".

Figure 3

Teachers' understanding of Transversality in Science Education



Source: the authors.

Figure 4

Teachers' understanding of Transversality in Science Education



Source: the authors.

The systematization of words through the similarity analysis allowed us to carry out the movement of interpretation that reveals several meanings of transversality: (i) approach to knowledge/subjects/contents/themes based on the students' reality and daily life; (ii) relate, interconnect, and integrate science knowledge and topics for meaningful learning; and (iii) possibility of contextualization and relating theory and practice.

The following statements of the subjects exemplify the above: *"I understand that it is the ability to relate the different concepts to reality, in order to contextualize and employ knowledge in an integral and not fragmented and systematized way"* (P05); *"Something that goes beyond the school subject, that is, it is not related to something technical in the area, but that addresses knowledge of everyday life, of daily practice and prepares the student for the social context in view of the theme worked"* (P15); *"I believe it would be recognizing that scientific knowledge is not isolated, but interconnected with other areas of knowledge and with everyday life"* (P41); *"It is to address objects of knowledge that raise debates that lead students to reflect on their actions and their role as citizens, for decision-making on social issues"* (P47).

The teachers' statements about Transversality express meanings of connection and integration, and the importance of contextualization or approach to everyday issues. Thus, we observe, once again, that there is a discourse crossed by the approaches adopted in official documents from the 1990s onwards (Ministry of Education, 1998, 1999, 2002, 2006, 2013, 2018), which elected citizenship as the guiding axis of education and inserted social issues as urgent themes in the curriculum, through transversality, by advising to "integrate conventional areas in order to be present in all of them, relating them to current issues and that they also guide school life" (Ministry of Education, 1998, p. 27, our translation).

It is notorious, therefore, that over the decades of the PCN, discussions on education have highlighted the need to develop the individuals' social and environmental responsibility, as well as training for citizenship. In this way, Science teaching came to be conceived as a possibility to develop in students criticality, the ability to analyze different worldviews and the consequences of individual and collective decisions and actions on the planet.

Given the above, it is important to note that these teachers have acted, at least in a part of their professional career, under the influence of a series of changes in curricular policies, both at the national and state levels. As a result, their discourses are intertwined with the defense of a curriculum organization that takes into account social issues, seeking to break with the traditional curriculum organization, as prescribed by official documents. That is, discourses that refer to the idea of breaking the disciplinary paradigm, aligned with the idea of curricular integration and transversality, which are based on the theory of complexity, on communication between different areas and on opposition to reductionism and simplification of knowledge, as advocated by Morin (2000).

The central idea of transversality, as exposed in the thought of Morin (2000), is to situate knowledge in context, valuing ways of thinking that consider not only a restricted part of reality but that are capable of encompassing the whole, giving visibility to what is between and through the school subjects, as well as to the connections that may exist between them. Thus, this idea did not arise to eliminate formal subjects, which are important and have helped in the advancement of knowledge, but to mobilize them around central themes, which seek answers to current problems that society considers worrying at a given time and place. For Morin (2003), it is necessary to “make school subjects ecological, that is, to take into account everything that is contextual to them, including cultural and social conditions, that is, to see in what environment they are born, raise problems, become sclerotic and transform” (p. 115, our translation). In the same sense, Nicolescu (1999, p. 52, our translation) points out that

Transdisciplinarity and transversality, as the prefix “trans” indicates, concerns what is at the same time between school subjects, across different subjects, and beyond all subjects. Therefore, its purpose is the understanding of the current world, and one of the imperatives for this is the unity of knowledge.

In the research subjects’ discourses on Transdisciplinarity and Transversality, there is a tendency to approximate the concepts of the contents of the areas of knowledge/subjects already established in the curriculum. In other words, it is possible to notice a concern with “fitting” everyday themes to the contents already established in the curriculum. Some of the subjects’ answers about Transversality ratify the above, as follows: “*Relating the **theoretical** to the practical **contents**, making the concepts have a meaning*” (P08); “*To go through the **subjects contents**, interconnecting the topics to other curricular components*” (P11); “*The way of teaching **theoretical content** with something from the practice experienced by the citizen in the most varied situations*” (P12); “***Themes that fit within objects of knowledge** of the curriculum matrix*” (P15); “*To connect the **object of knowledge** to everyday matters, making learning motivating and meaningful for the student*” (P26).

Also concerning transversality, according to Araújo (1999), there are two different ways of understanding this concept. First, the traditional subjects form the longitudinal axis and, around them, must permeate the themes of social urgency. In this conception, the curriculum subjects are maintained, but there must be an impregnation of the Transversal Themes in their contents. In the second conception, adopted by Busquets et al. (1999), transversality is not only a methodological assumption, where there is an intersection of knowledge but also an epistemological assumption, by questioning what knowledge should be produced by science and taught in school. From this perspective, themes of social relevance should be at the center of concerns and be on the longitudinal axis, on which school knowledge should revolve. This inversion places the school subjects no longer as ends in themselves, but as means to achieve objectives related to the needs of the population (Araújo, 1999, 2014).

By analyzing these different ways of understanding transversality, we observed that the Brazilian curriculum documents opted for the first conception. The PCN, for example, when proposing for the first time the insertion of Transversal Themes in Brazilian Basic Education, indicated the integration of these social themes into the curriculum through transversality, advising that they “integrate the conventional areas in order to be present in all of them, relating them to current issues and that they also guide school life” (Ministry of Education, 1998, p. 27, our translation). However, when we analyze the conception of transversality adopted in the document, we highlight the option to keep the subjects at the center of the education system, with social issues impregnated in the school contents:

Conventional areas must welcome the Transversal Themes issues in such a way that their contents explain them and that their objectives are contemplated. For example, the area of Natural Sciences includes the comparison between the main organs and functions of the male and female reproductive system, relating their maturation to changes in the body and behavior of boys and girls during puberty and respecting individual differences. In this way, the study of the human body is not restricted to the biological dimension but puts this knowledge at the service of understanding gender difference (Sexual Orientation content) and respect for difference (Ethics content). Thus, it is not a matter of teachers of different areas having to “stop” their programming to work on the themes, but rather that they explain the relationships between them and **include them as contents of their area**, articulating the purpose of school study with social issues, enabling students to use school knowledge in their extracurricular life. It is not a matter of working on them in parallel, but **of bringing the perspective of the themes to the contents and methodology of the area** (Ministry of Education, 1998, p. 27, emphasis added, our translation).

In this way, social themes would not be the integrating axes around which disciplinary knowledge should revolve, but the subjects would remain at the center of educational processes and would only incorporate the themes. Thus, as observed in the teachers’ discourses on Transdisciplinarity, it is evident that their statements are associated with a perception that understands it in a procedural and not an epistemological methodological dimension, as Araújo (2014) observes.

By seeking to understand which other discourses (interdiscourses) permeate the statements of teachers in the area of Natural Sciences about Transdisciplinarity and Transversality, we realized that the elements identified in their answers show meanings that are located in the official curriculum documents and guidelines. In this way, the teachers’ words reveal paraphrastic processes, in which there is always a return to what has already been said at another time, that is, to the memory of the sedimented saying (Orlandi, 2000).

Conclusions and Implications

In this study, we sought to understand how the discourses of teachers in the area of Natural Sciences who work in High School about the implementation of Transversality in the two decades of validity of the National Curriculum Parameters are configured. To achieve our objective, we grounded ourselves on the theoretical-methodological assumptions of French Discourse Analysis, based on the works of Michel Pechêux and Eni Orlandi.

We focused our analysis on two questions: (1) What do you understand by Transdisciplinarity? and (2) What do you understand by Transversality in Science Education? The analysis of the *corpus* of the answers evidences a discursive functioning that reveals effects of meanings that help to understand what Transversality means in the discourses of these teachers, considering the socio-historical context from which they speak.

On the one hand, regarding the concept of Transdisciplinarity, the teachers' discourses reveal meanings of cooperation, dialogue, and interaction between different areas of knowledge and subjects in the approach of contents and themes. In this way, they show a convergence with the meanings found in the national curriculum documents published from the 1990s onwards, since there is a centrality in the methodological aspects to the detriment of the epistemological dimension. Consequently, the discourses on Transdisciplinarity present the need for cooperation between the areas in the approach of the contents, from a perspective of pedagogical practice, but not of the unification or integration of knowledge, as opposed to its reductionism or simplification.

On the other hand, from the descriptive and interpretative movement, from the answers of teachers in the area of Natural Sciences, related to the concept of Transversality, the following meanings emerged: (i) approach to knowledge/subjects/contents/themes from the reality/daily life of students; (ii) relate/interconnect/integrate knowledge/subjects/science for meaningful learning; and (iii) possibility of contextualization and articulation between theory and practice. The statements express meanings of connection/integration and the need to contextualize or address everyday issues. It is evident, once again, that the teachers' discourses are intertwined with the discursive formations present in official documents from the 1990s onwards, which assume citizenship as the guiding axis of education and highlight current social issues as urgent and necessary themes in the process of curriculum organization.

Thus, as occurs in the analysis of the discourses on Transdisciplinarity, we observed meanings based on the centrality of curricular contents, so that social themes, although seen as important, remain supporting and not as integrating axes of the various areas.

From the analytical movement carried out, we found that, after 20 years of implementation, the discursive marks that characterize the perceptions of Transversality and Transdisciplinarity denote a crossing of the discourses by the terms present in the official national and state curriculum documents. These paraphrastic processes reflect, if

we consider the conditions of these teachers' statements production, the imposing form and the little representativeness of the class in the construction of curriculum policies in the country.

In addition, we warn that the understanding of Transdisciplinarity and, consequently, of Transversality, based on a procedural methodological dimension, to the detriment of the epistemological view of unification of knowledge, may have contributed, over the years, on the one hand, to the maintenance of the traditionally disciplinary and fragmenting logic of the curriculum and, on the other hand, to a lack of responsibility concerning the consideration of themes in the planning of pedagogical practices and teaching and learning processes. This lack of responsibility occurs in the sense that, by being displaced from the domain of a subject and the responsibility of all the curricular components of High School, considering the complexity of the Transversal Themes, these themes may have suffered a silencing movement, since by being everyone's responsibility, they may also have become nobody's domain.

In other words, we see that from this contradiction between the intention to integrate knowledge, through the Transversality of some themes, and the formal structuring of the curriculum, topics of great relevance — such as health, sexuality, and the environment — which before the PCN were treated as disciplinary contents, started, after the implementation of the Transversal Themes, to be treated in a secondary way, and not as protagonists of the processes. Therefore, it is not enough to insert new terms in the guiding documents; there must be an in-depth understanding of these concepts and the guarantee of the structural and formative conditions for their implementation.

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