REVISTA ENSINAR (RENSIN)
DOI: https://www.doi.org/10.52832/rensin.v4.748
Home page: https://bio10publicacao.com.br/ensinar
e-ISSN: 2965-4823

ARGUMENTATION AND SOCIOSCIENTIFIC ISSUES IN NATURAL SCIENCE EDUCATION: A CRITICAL ANALYSIS IN LIGHT OF FAIRCLOUGH AND THE FREIREAN PERSPECTIVE

ARGUMENTAÇÃO E QUESTÕES SOCIOCIENTÍFICAS NO ENSINO DE CIÊNCIAS DA NATUREZA: UMA ANÁLISE CRÍTICA À LUZ DE FAIRCLOUGH E DA PERSPECTIVA FREIRIANA

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Recebido: 01/09/2026| **Aprovado**: 09/09/2026| **Publicado**: 16/09/2026

Abstract: Argumentation constitutes a significant dimension of science education, especially when linked to socioscientific issues (SSIs), as it enables the mobilization of scientific knowledge in the face of problems involving social, ethical, environmental, economic, and political dimensions. This study aimed to critically analyze how argumentation is discursively constructed and mobilized in research on SSIs in science education, drawing on Fairclough's Critical Discourse Analysis and the Freirean perspective on education. This is a qualitative, bibliographic study conducted via searches on the CAPES Journal Portal, using the descriptors "socioscientific issue," "teaching," and "argumentation", combined with the boolean operator *AND*, covering the period from 2021 to 2025. Following the application of selection criteria, six scientific articles related to the fields of Biology, Chemistry, and Physics were analyzed. The analysis considered the textual, discursive practice, and social practice dimensions proposed by Fairclough, linked to Freirean categories such as dialogue, problematization, autonomy, and critical reading of reality. The results highlight a prevailing view of argumentation as an epistemological practice and a resource for critical development, alongside the use of SSIs as pedagogical tools to foster the confrontation of perspectives and the formulation of stances. However, a tension was identified between using SSIs to develop argumentative skills and their potential to problematize social, ideological, and power relations. The study concludes that this integration broadens the understanding of science education as a space for dialogue, meaning-making, and critical development.

Keywords: Argumentation. Socioscientific Issues. Science Education. Critical Discourse Analysis.

Resumo: A argumentação constitui uma dimensão relevante do ensino de Ciências, especialmente quando articulada às Questões Sociocientíficas (QSC), por possibilitar a mobilização de conhecimentos científicos diante de problemas que envolvem dimensões sociais, éticas, ambientais, econômicas e políticas. Este estudo teve como objetivo analisar criticamente como a argumentação é discursivamente construída e mobilizada em pesquisas sobre QSC no Ensino de Ciências, considerando as contribuições da Análise Crítica do Discurso de Fairclough e da perspectiva freiriana de educação. Trata-se de uma pesquisa qualitativa, de caráter bibliográfico, realizada a partir de buscas no Portal de Periódicos da CAPES, utilizando os descritores "questão sociocientífica", "ensino" e "argumentação", combinados pelo operador booleano AND, no período de 2021 a 2025. Após a aplicação dos critérios de seleção, foram analisados seis artigos científicos relacionados aos campos da Biologia, Química e Física. A análise considerou as dimensões textual, da prática discursiva e da prática social propostas por Fairclough, articuladas a categorias freirianas, como diálogo, problematização, autonomia e leitura crítica da realidade. Os resultados evidenciam a predominância da compreensão da argumentação como prática epistemológica e recurso para a formação crítica, além do uso das QSC como dispositivos pedagógicos para promover a confrontação de perspectivas e a construção de posicionamentos. Entretanto, identificou-se uma tensão entre o uso das QSC para desenvolver competências argumentativas e seu potencial para problematizar relações sociais, ideológicas e de poder. Conclui-se que essa articulação amplia a compreensão do ensino de Ciências como espaço de diálogo, produção de sentidos e formação crítica.

Palavras-chave: Argumentação. Questões sociocientíficas. Ensino de Ciências. Análise Crítica do Discurso.

1 INTRODUCTION

Natural Sciences education, encompassing the curricular subjects of Biology, Physics, and Chemistry, faces challenges driven by social demands that extend beyond the mere acquisition of scientific concepts. Issues related to health, the environment, energy, food, technology, and social change involve scientific knowledge intertwined with ethical, political, economic, and cultural dimensions; this necessitates educational processes that help students understand diverse perspectives and engage critically in debates of collective interest (Silva ; Gehlen, 2017). In this context, socioscientific issues (SSI) represent an approach that bridges scientific knowledge and controversial societal problems, thereby fostering discussion, argumentation, and decision-making processes (Krupczak *et al.*, 2021).

The use of socioscientific issues (SSIs) in natural science education has been discussed across various educational proposals and contexts, highlighting the potential to link scientific knowledge with socially relevant situations. These issues can help shape pedagogical practices that move beyond an approach focused solely on content transmission, instead fostering critical inquiry, student participation, and consideration of the various dimensions inherent in the problems being analyzed (Batistoni *et al.*, 2021). In Brazil, research has examined various characteristics of SSIs in science education, as well as instructional approaches developed based on this framework (Silva ; Gehlen, 2017; Maciel ; Alves, 2025).

In this context, argumentation plays a crucial role, given that SSIs involve situations where different individuals may offer distinct interpretations, justifications, and stances. Constructing arguments requires mobilizing knowledge, analyzing evidence, formulating justifications, and considering divergent perspectives; it is a practice linked to both scientific learning and participation in discussions on issues of social interest (Silva *et al.*, 2024). However, in socioscientific discussions, argumentation is not limited to conceptual aspects, as it also encompasses values, moral dimensions, and diverse ways of understanding controversial issues (Silva ; Santos, 2015). Accordingly, studies focusing on argumentation regarding SSIs have investigated the various ways these practices emerge and are structured within science education (Barbosa ; Batinga, 2021; Martins do Vale *et al.*, 2023).

The complexity of socioscientific issues (SSIs) is also linked to the challenges teachers face regarding their pedagogical approach. Discussing controversial topics can involve value conflicts, differing stances, and difficulties in mediating debates and guiding argumentative processes (Zhang *et al.*, 2021). Consequently, incorporating SSIs into natural science education requires not only selecting socially relevant topics but also understanding the pedagogical and discursive conditions that enable them to be problematized. It is therefore important to analyze how argumentation is conceived and employed in these proposals, as well as the meanings attributed to student participation, scientific knowledge, and dialogue.

The Freirean perspective provides a foundation for understanding these dimensions of educational practice. For Freire (2019a), dialogue is a fundamental element of education, linked to the capacity for a critical reading of reality and the collective construction of knowledge. Problem-posing education stands in

contrast to the "banking" model of education by recognizing individuals as active participants in the educational process and by taking concrete reality as a fundamental element of pedagogical action (Freire, 2019b). From this perspective, knowledge is not reduced to the transmission of information; rather, it involves dialogue, critical reflection, and the potential to intervene in reality. Fostering autonomy, in turn, presupposes the exercise of speaking, listening, reflecting, and taking responsibility, dimensions that become particularly significant in educational processes grounded in participation and the development of stances (Freire, 2021).

Bridging the Freirean perspective with SSIs allows us to view socioscientific issues as opportunities to problematize concrete situations where scientific knowledge intersects with contradictions, values, and diverse social standpoints. In this light, argumentation can be understood as more than just a discursive skill or a teaching strategy; it also takes on a formative dimension, enabling individuals to express their understandings, engage with differing perspectives, and form stances regarding reality. Thus, dialogue and problematization become important elements for analyzing the potential of socio-scientific issues (SSIs) for fostering critical awareness in Natural Sciences education.

This discursive dimension can be deepened using Critical Discourse Analysis (CDA) proposed by Norman Fairclough. For the author, discourse must be understood as a social practice, establishing relationships with the social contexts in which it is produced and being able to participate in both the reproduction and transformation of social relations (Fairclough, 1992). Language, from this perspective, is not a neutral element, as discourses participate in the construction of representations, identities and social relations and may be related to power relations and ideological processes (Fairclough, 1992). Critical discourse analysis therefore makes it possible to investigate how certain meanings are produced and how different forms of representation of reality can be constructed, legitimized or questioned.

The articulation between the Freirean perspective and Fairclough's Critical Discourse Analysis allows us to construct a critical reading of the relationships between QSC and argumentation in the teaching of Natural Sciences. The Freirean perspective contributes to understanding the pedagogical dimensions related to dialogue, problematization, autonomy and critical formation, while CDA offers support for analyzing how meanings and positions are constructed discursively and how discourses relate to the social conditions in which they are produced. These are, therefore, references that perform distinct and complementary functions in the investigation, allowing the articulation of the political-pedagogical dimension of education with the discursive dimension of the practices analyzed.

Although scientific production on QSC has advanced in the discussion of its possibilities for teaching Science, it remains pertinent to investigate how argumentation is understood and related to socio-scientific issues and what meanings are attributed to dialogue, problematization and critical formation in academic productions in the area. This gap is especially relevant when considering the need to understand not only the presence of QSC and argumentative practices in educational proposals, but also the meanings and positions discursively constructed around these practices. The critical analysis of scientific production can, in this sense,

contribute to identifying approximations, tensions and limits in the ways in which QSC and argumentation are conceived in the teaching of Natural Sciences.

Given this context, the present study aims to analyze, in the selected scientific production on the teaching of Natural Sciences, involving Biology, Physics and Chemistry, how socio-scientific issues are related to argumentation, identifying meanings attributed to dialogue, problematization, participation and critical formation, in light of the Freirean perspective and Fairclough's Critical Discourse Analysis.

2 METHODOLOGICAL APPROACH

This study is a qualitative, bibliographic research project developed through a literature review integrated with Critical Discourse Analysis (CDA), drawing on Fairclough's (1992) perspective. The choice of a qualitative approach stems from the interpretive nature of the object of study; the research interest lies not merely in identifying the frequency of specific concepts within scientific literature, but rather in understanding the meanings, stances, and discursive relationships constructed around socioscientific issues (SSIs) and argumentation in Natural Sciences education. From this perspective, scientific literature is understood as a socially and historically situated discursive practice, wherein specific ways of assigning meaning to science, teaching, argumentation, participation, and the development of individuals are produced and mobilized.

The methodological approach was guided by the following research question: How has recent scientific literature discursively constructed the link between socioscientific issues and argumentation in Natural Sciences education in Brazil between 2021 and 2025? This question guided the definition of search and corpus selection criteria, as well as the organization of analysis procedures. Defining the problem in this way also allowed the investigation to shift from a purely descriptive perspective of the scientific literature toward a critical reading of the meanings attributed to SSIs, argumentation, and the educational aims of Science teaching.

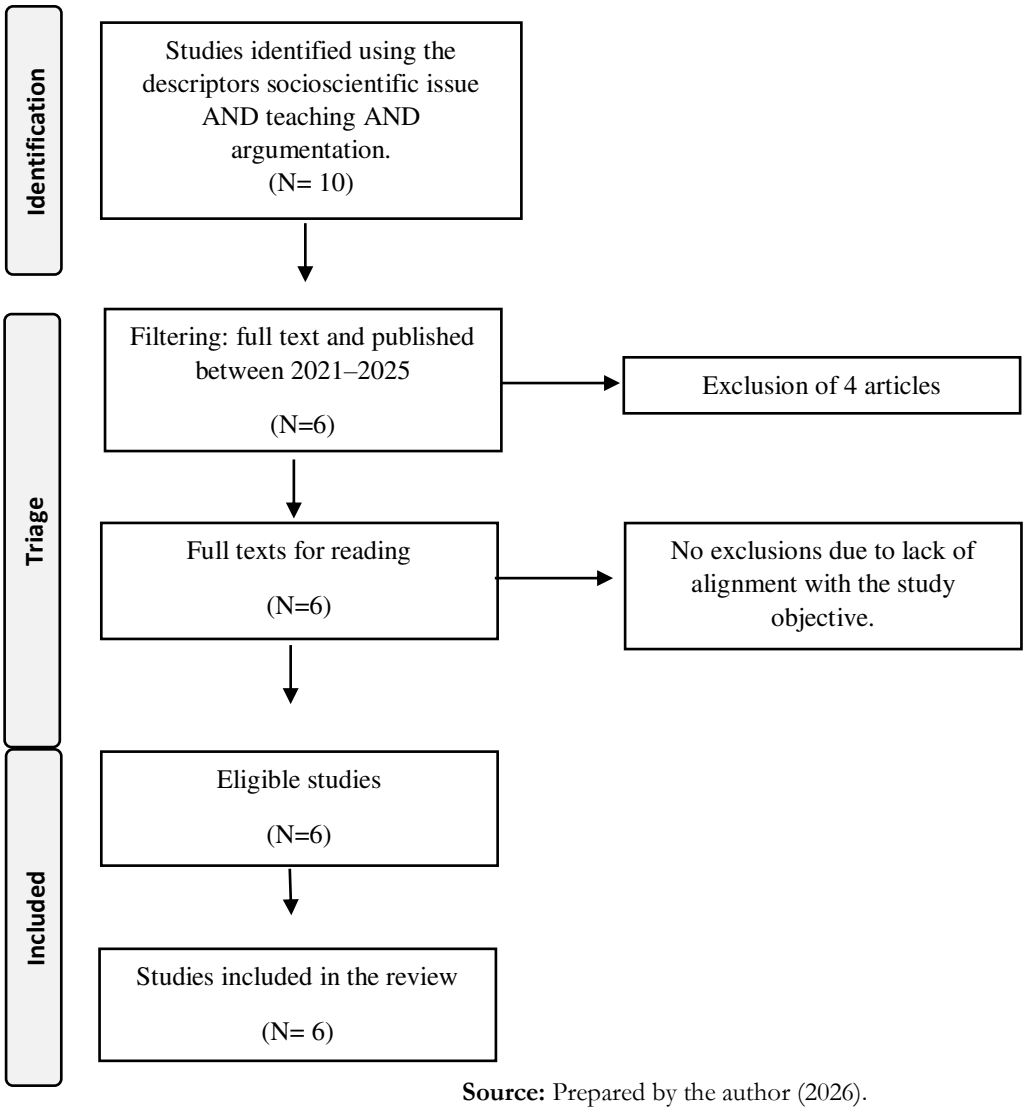
The literature review was conducted based on the principles of bibliographic research outlined by Gil (2008) understood as a systematic process of surveying, selecting, and analyzing previously published materials. Complementarily, Severino (2016) emphasizes the need for an analytical and interpretive reading of the selected works to move beyond a merely enumerative approach to the literature. These premises guided the organization of the corpus and the reading of the selected studies, establishing a distinction between the stage of systematizing bibliographic information and the actual interpretive phase of the investigation.

The corpus was compiled using the Journal Portal of the Coordination for the Improvement of Higher Education Personnel (CAPES). This database was selected as a methodological boundary for the study, given its role as a gateway to national and international scientific output available within the journal system. The search employed the descriptors "socio-scientific issue," "teaching," and "argumentation," combined using the Boolean operator AND, to identify studies where these three conceptual axes were interrelated within the field of science education. The timeframe covered the period from 2021 to 2025, intentionally chosen to focus on contemporary scientific output regarding the topic under investigation.

This five-year timeframe serves to delimit the scope of the study rather than to provide an exhaustive historical account of the literature on socio-scientific issues (SSIs) and argumentation. Selecting this interval allows the analysis to focus on recent formulations, taking into account contemporary shifts in science education and approaches to socio-scientific controversies. However, it is acknowledged that this timeframe limits the survey's temporal scope; consequently, the results are interpreted as representative of the selected corpus rather than an exhaustive synthesis of the entire body of knowledge on the subject.

The initial search yielded ten publications. The inclusion criteria were as follows: scientific articles published in peer-reviewed journals within the specified timeframe, with full text available, and demonstrating a substantive link between socio-scientific issues and argumentation within the context of natural science education. Studies were excluded if they were duplicates, addressed the topic only tangentially, or lacked a consistent discussion regarding the argumentative dimension of SSIs. Following the application of these selection criteria, four publications were excluded, leaving six articles for full analysis. The process of identification, screening, eligibility assessment, and inclusion of publications is presented in Figure 1; the flowchart has been retained as a record of the corpus construction process.

Figure 1. Flowchart explaining the selection of publications from the CAPES Journal Portal.



Source: Prepared by the author (2026).

The analysis of the corpus was carried out in two interconnected stages. The first involved the systematic organization and characterization of the selected publications. Initially, an exploratory reading of the six articles was conducted in their entirety to grasp their objectives, theoretical assumptions, methodological designs, approaches to socioscientific issues (SSIs), and the connections established with argumentation. This stage provided a broad overview of the corpus and facilitated the identification of conceptual and discursive elements relevant to the interpretive phase.

Subsequently, an in-depth analytical reading was performed, guided by a summary matrix developed for this research. This instrument systematized information regarding the title and journal, authorship, objective, methodological design, main results, and publication year of each study. The summary matrix served to organize and characterize the corpus, enabling comparisons between the works and the identification of similarities, differences, and recurring patterns in the research objects and approaches. However, this stage was not treated as the final data analysis but rather as a preparatory step for the discursive interpretation.

The second stage consisted of the analysis itself, grounded in Norman Fairclough's (1992) Critical Discourse Analysis (CDA). This perspective was chosen based on the understanding of discourse as a social practice, which allows for the investigation not only of what texts explicitly state but also of the ways in which specific meanings are produced, legitimized, reiterated, or challenged within specific social contexts. From Fairclough's (1992) perspective, discourse analysis links text, discursive practice, and social practice, making it possible to understand the relationship between linguistic choices, the processes of discourse production and circulation, and the broader social conditions in which these discourses are constituted.

The operationalization of CDA began with the definition of the units of analysis. Excerpts were selected from the articles in which the authors articulated conceptions of argumentation, definitions or characterizations of socioscientific issues, pedagogical justifications, forms of teacher mediation, assessment criteria, educational aims, or stances regarding participation and problematization in science education. The selection of these units took into account their relevance to the research question and their capacity to highlight the conceptions, relationships, and stances present in the analyzed texts.

The selected units were organized into a specific analytical chart, distinct from the summary chart used for bibliographic characterization. This analytical chart was structured into four fields: provisional category, representative excerpt, source article identification (using the author-date system), and preliminary interpretive observation. This procedure ensured traceability between the selected excerpts and their respective source texts, allowing the interpretations developed to remain grounded in the documentary corpus.

The analysis was guided by the three interconnected dimensions proposed by Fairclough (1992). At the textual dimension, the study examined lexical choices, forms of evaluation, modalities of assertion, ways of naming Socioscientific Issues (SSIs), argumentation, the subjects involved, and educational purposes. At

the discursive practice dimension, the study examined how the research produces, mobilizes, and articulates scientific, pedagogical, and social discourses regarding SSIs and argumentation, considering the convergences, shifts, and relationships among the different discourses present in the publications. At the social practice dimension, the aim was to interpret how the meanings constructed in the texts relate to issues of power, ideology, participation, critical education, and the potential for reproducing or transforming educational practices.

This procedure was linked to the Freirean perspective, specifically the concepts of dialogue, problematization, concrete reality, critical education, and práxis, which served as frameworks for interpreting the meanings attributed to the educational purposes of SSIs. Integrating Fairclough and Freire does not imply equating the two theoretical perspectives but rather using them complementarily: while Critical Discourse Analysis (CDA) offers tools to understand discourse in its relationship with social practices, power, and ideology, the Freirean perspective contributes to interpreting the pedagogical and political-educational dimensions related to dialogue, the problematization of reality, and the construction of possibilities for transformation.

During the analysis, the discursive units were initially grouped based on conceptual affinity and semantic recurrence. The preliminary categories were subsequently cross-referenced across the six articles, allowing for their refinement and reorganization based on their relevance to the research question and the adopted theoretical frameworks. This process made it possible to move beyond merely identifying the presence or absence of specific concepts and to examine the meanings attributed to them in the various texts, as well as the relationships and tensions between them.

In the next stage, a cross-cutting, comparative interpretation of the corpus was conducted, seeking to identify regularities, shifts, contradictions, and discursive silences. The analysis focused particularly on how the publications conceptualize SSI (Socio-Scientific Issues), which conceptions of argumentation are mobilized, the roles assigned to dialogue and problematization, and the educational aims associated with Natural Sciences teaching. Thus, the analysis was not limited to term frequency or the thematic classification of the studies; rather, it sought to understand the discursively produced meanings and their pedagogical and social implications.

The analytical framework thus served as a tool for organizing, tracking, and systematizing the interpretation, while CDA (Critical Discourse Analysis) provided the theoretical-methodological basis for understanding the discourses present in the corpus. The established approach aimed to ensure coherence among the research question, corpus composition, units of analysis, interpretive categories, and the frameworks of Fairclough and Freire. Based on this procedure, the results are presented through representative excerpts from the analyzed articles, accompanied by critical interpretation, to elucidate how meanings regarding SSI and argumentation are discursively constructed within the selected body of scientific literature.

3 RESULTS AND DISCUSSION

Analysis of the six selected articles, published between 2021 and 2025, reveals a corpus consisting of studies that link Socioscientific Issues (SSIs) with argumentation in the field of Natural Sciences education. Although they feature different subjects, teaching strategies, and theoretical frameworks, the publications converge on an interest in understanding or fostering argumentative processes associated with addressing socioscientifically controversial issues.

All six articles were published in Portuguese. This result specifically characterizes the corpus identified and selected via the CAPES Journal Portal; thus, it does not allow for the inference, based on this finding alone, of a predominance of Brazilian output across the entire field of research. Similarly, the identification of the journals reveals the presence of outlets specializing in Science Education, Chemistry Education, Physics Education, and Science Education, indicating that the link between SSIs and argumentation spans various areas of the Natural Sciences.

Regarding methodological design, four of the six studies present proposals for intervention or classroom application involving SSIs, representing 66.7% of the corpus. One study is characterized as qualitative research focused on analyzing argumentative output, while another is theoretical-methodological in nature, aimed at developing evaluative criteria for mock trial activities. Thus, the corpus shows a strong presence of research oriented toward the pedagogical operationalization of argumentation, whether through teaching sequences, mock trials, or the analysis of student work.

Regarding the materials analyzed, various forms of data generation are identified, including argumentative texts, discursive interactions, classroom activities, and assessment instruments. This diversity demonstrates that argumentation is investigated both as a form of student discourse and as a pedagogical phenomenon organized and mediated by specific teaching strategies.

Details regarding the publications, including their objectives, methodological procedures, main conclusions, and years of publication, are summarized in Table 1.

Table 1. Identification of publications regarding title, journal, author(s), objective, method, conclusion, and year of publication.

Study / Journal	Author(s)	Objective	Method	Conclusion	Year
Considerations on the development and validation of a simulated jury in the classroom based on a socioscientific issue with high school students. *Observatório de la Economía Latinoamericana*	Oliveira *et al.*	To develop and validate a simulated jury proposal involving a socioscientific issue in high school education.	Didactic intervention study involving the implementation of a simulated jury and qualitative analysis of student interactions and productions.	The simulated jury proved to be an effective strategy for promoting scientific argumentation, critical positioning, and student engagement.	2024
Analysis of argumentative texts produced by undergraduate chemistry students on the socioscientific issue of pesticide use in Brazilian	Martins do Vale *et al.*	To analyze the argumentative structure of texts produced by undergraduate students in response to a socioscientific issue.	Qualitative documentary analysis of written productions based on theoretical frameworks of argumentation.	Advances were identified in the construction of arguments, although weaknesses remained in the articulation	2023

crops. *Investigações em Ensino de Ciências*				among data, justifications, and conclusions.	
A proposal for assessment criteria for simulated jury activities in science education. *Caderno Brasileiro de Ensino de Física*	Melo and Vieira	To develop assessment criteria for simulated jury activities in science education.	Theoretical-methodological study involving the development and validation of an assessment rubric.	The systematization of criteria supports formative assessment of argumentation and provides greater clarity in assessment processes.	2022
Socioscientific issue and the emergence of argumentation in chemistry teaching. *Química Nova na Escola*	Batinga and Barbosa	To investigate how socioscientific issues foster the emergence of argumentation in chemistry classes.	Qualitative research involving the analysis of classroom discursive interactions.	The incorporation of socioscientific issues enhances argumentation and expands conceptual problematization in chemistry education.	2021
Socioscientific issue: A strategy for developing argumentation in chemistry classes. *Góndola, Enseñanza y Aprendizaje de las Ciencias*	Barbosa and Batinga	To analyze the use of socioscientific issues as a strategy for developing argumentation in chemistry classes.	Didactic intervention involving qualitative analysis of student productions and interactions.	Improvement in argumentative quality was observed when the socioscientific issue structured the didactic organization.	2021
Socioscientific issue on the medicinal use of *Cannabis sativa*: A didactic proposal based on Critical-Historical Pedagogy. *Revista Brasileira de Ensino de Ciências e Matemática*	Peixoto and Genovese	To propose a teaching sequence on the medicinal use of *Cannabis sativa* based on Critical-Historical Pedagogy.	Development and implementation of a didactic proposal with qualitative analysis of the activities conducted.	The articulation between the socioscientific issue and Critical-Historical Pedagogy promotes conceptual understanding and students' critical development.	2021

Source: Prepared by the author (2026).

Characterizing the corpus constitutes an initial stage of the analysis. Beyond merely establishing a quantitative distribution of the studies' characteristics, this systematization enabled the identification of conceptual and discursive regularities, subsequently examined through the lens of CDA (Fairclough, 1992) in conjunction with a Freirean perspective.

An analytical and comparative reading of the six articles made it possible to identify regularities in how SSI (Socio-Scientific Issues) and argumentation are signified and operationalized. The categories were not defined solely by the frequency of words or concepts but were constructed based on recurring meanings, stances, and forms of discursive organization related to the research object. This analytical process led to the systematization of categories expressing the primary meanings attributed to argumentation, SSI, critical education, and the pedagogical relationships found in the analyzed studies. Table 2 presents a summary of these categories, their respective operational definitions, the discursive units considered in the analysis, their frequency within the corpus, and the specific studies in which they were identified.

Table 2. Emerging discursive categories identified in the analysis of the selected studies.

Discursive Category	Operational Definition	Observed Discursive Units	*Incidence in the Corpus (%)	Author(s)
Conceptualization of argumentation as an epistemic practice	Argumentation understood as a process of constructing, justifying, and evaluating knowledge and well-founded positions.	Evidence, justifications, arguments, counterargumentation, decision-making, argumentative quality.	100%	Oliveira *et al.* (2024); Martins do Vale *et al.* (2023); Melo and Vieira (2022); Batinga and Barbosa (2021); Barbosa and Batinga (2021); Peixoto and Genovese (2021)
Critical education as a formative purpose	Association between argumentation, well-founded positioning, intellectual autonomy, and participation in addressing socially relevant issues.	Critical education, critical thinking, positioning, participation, decision-making.	100%	Oliveira *et al.* (2024); Martins do Vale *et al.* (2023); Melo and Vieira (2022); Batinga and Barbosa (2021); Barbosa and Batinga (2021); Peixoto and Genovese (2021)
Socioscientific issues as a pedagogical device	SSI used to articulate scientific knowledge with social, ethical, political, and controversial dimensions.	Controversy, social context, social, ethical, and political implications of science.	83.3%	Oliveira *et al.* (2024); Martins do Vale *et al.* (2023); Batinga and Barbosa (2021); Barbosa and Batinga (2021); Peixoto and Genovese (2021)
Controversy as a structuring element	Controversy mobilized as a condition for confronting perspectives, engaging in debate, and constructing positions.	Debate, positioning, conflict of perspectives, deliberation, defense of arguments.	83.3%	Oliveira *et al.* (2024); Melo and Vieira (2022); Batinga and Barbosa (2021); Barbosa and Batinga (2021); Peixoto and Genovese (2021)
Teacher mediation as a component of argumentative construction	Teacher action in organizing, guiding, problematizing, and deepening argumentative interactions.	Mediation, pedagogical intervention, questioning, guidance, problematization.	83.3%	Oliveira *et al.* (2024); Melo and Vieira (2022); Batinga and Barbosa (2021); Barbosa and Batinga (2021); Peixoto and Genovese (2021)

Note. The percentages were calculated based on the presence of each category across the six articles comprising the corpus. Incidence indicates the presence of the category in the study analyzed and does not represent the degree of theoretical depth or intensity of occurrence.

Source: Prepared by the author (2026).

In this process, five main categories were identified: the conception of argumentation as an epistemological practice; critical education as an educational goal; Socio-Scientific Issues (SSI) as a pedagogical tool; controversy as a structuring element; and teacher mediation as a component of argumentative construction. The assessment of argumentation was considered a cross-cutting dimension related to the ways in which argumentative outputs are monitored and enhanced.

The first category, the conception of argumentation as an epistemological practice, was present in all six studies analyzed. Despite differences in the theoretical frameworks and procedures adopted, argumentation appears associated with the formulation of justifications, the mobilization of knowledge, the presentation of evidence, and the construction of well-founded positions. In Oliveira *et al.* (2024), this

dimension manifests in the organization of a mock trial; in Martins do Vale *et al.* (2023), it focuses on the analysis of argumentative outputs; in Melo and Vieira (2022), it relates to defining criteria for assessing argumentation; and in Barbosa and Batinga (2021), Batinga and Barbosa (2021), and Peixoto and Genovese (2021), it is integrated into instructional proposals guided by controversial issues.

This consistency allows us to observe that argumentation is discursively legitimized within the corpus as a practice associated with the production and mobilization of scientific knowledge. However, the meanings attributed to this practice are not entirely equivalent. In some studies, argumentation is primarily presented as a strategy to foster conceptual learning and organize instructional activities; in others, it takes on greater centrality as an object of analysis or as a competency to be developed and assessed.

The second category, critical education as an educational goal, also runs through all six studies. Argumentation is linked to opportunities for developing critical thinking, forming well-founded positions, and engaging with issues that extend beyond strictly scientific content. This recurrence is particularly significant when interpreted in light of Freire (2019a; 2019b; 2021), for whom education is not reduced to the transmission of information but involves the construction of subjects capable of understanding and critically intervening in reality.

However, the discursive presence of critical education does not, in itself, signify the realization of an emancipatory perspective. The analysis allows for a distinction between the declaration of an educational aim and its actual incorporation into the pedagogical organization. When expressions such as critical thinking, citizenship, or autonomy appear merely as expected outcomes of argumentative activity, without being accompanied by a problematization of reality, dialogue, and reflection on the social conditions constituting the controversy, critical education may take on a predominantly declaratory character.

The third category, SSCI (Socio-Scientific Controversial Issues) as a pedagogical tool, was present in five of the six articles. SSCIs are constructed as situations capable of bridging scientific knowledge and socially relevant problems, thereby mobilizing ethical, political, and social dimensions. In the studies by Oliveira *et al.* (2024), Barbosa and Batinga (2021), Batinga and Barbosa (2021), Martins do Vale *et al.* (2023), and Peixoto and Genovese (2021), the controversial issue organizes or underpins various forms of argumentative activity.

This discursive construction of SSCIs is significant because it shifts scientific knowledge from a purely conceptual presentation to a situation where differing positions must be confronted. However, the analysis also raises the question of the extent to which this contextualization effectively fosters problematization. From a Freirean perspective, problematizing does not merely mean introducing a social theme into the classroom; rather, it involves relating that theme to concrete reality, its contradictions, and the subjects' possibilities for action.

The fourth category, controversy as a structuring elemento, also appears in five studies. Controversy is utilized as a condition for presenting, confronting, and justifying diverse perspectives. Mock trials, debates, and proposals involving socially controversial issues constitute recurring ways of organizing this process.

From Fairclough's (1992) perspective, this aspect allows us to understand argumentation not merely as the formal structure of a discourse, but as a social practice in which different positions are produced, legitimized, and confronted. The debate, therefore, is not discursively neutral: it involves forms of positioning, the selection of arguments, the legitimation of specific types of knowledge, and the construction of relationships among the participating subjects.

The fifth category, teacher mediation as a component of argumentative construction, appears in five studies, albeit with varying degrees of explicitness. The teacher is portrayed as responsible for organizing discussion situations, encouraging the presentation of justifications, soliciting evidence, challenging positions, and fostering conceptual deepening. In this sense, argumentation does not appear as a spontaneous phenomenon, but rather as a pedagogically mediated practice.

This dimension aligns with the Freirean perspective by attributing a formative function to dialogue. The teacher does not merely occupy the role of knowledge transmitter but participates in creating conditions that allow individuals to question, argue, and reconstruct their understandings. At the same time, CDA (Critical Discourse Analysis) makes it possible to problematize which discourses are legitimized during the mediation process and how certain positions may be favored or silenced.

Finally, the assessment of argumentation appeared in 50% of the corpus. This dimension emerges most systematically in studies that employ specific criteria, categories, or instruments to analyze the quality of arguments. Its more limited presence indicates that, although argumentation is frequently presented as a pedagogical goal or strategy, its systematic assessment does not constitute a similarly consolidated dimension across the analyzed studies.

Taken together, the categories highlight a body of research that assigns a significant role to SSI (Socio-Scientific Issues) and argumentation in Natural Sciences education, particularly due to the potential to integrate scientific knowledge, controversy, stance-taking, and critical development. However, the discourse analysis reveals that the application of these concepts is not uniform. The same terms can take on different meanings depending on the theoretical frameworks and pedagogical objectives employed in each study.

Analysis of the corpus reveals that the link between SSI and argumentation is discursively constructed as a potential avenue for pedagogical innovation in Natural Sciences education. The studies analyzed employ various strategies, such as mock trials, debates, teaching sequences, writing tasks, and assessment tools, yet they share the understanding that controversial situations can foster the construction and articulation of well-founded positions.

From Fairclough's (1992) perspective, however, understanding this dynamic requires going beyond a mere description of pedagogical strategies to examine discourse as a social practice. Argumentation does not occur in a neutral discursive space. When arguing about an SSI, individuals draw upon knowledge, values, perspectives, and socially constructed ways of interpreting a given problem. Thus, the choice of specific arguments, evidence, and ways of representing a controversy plays a part in the discursive construction of social reality itself.

This perspective allows for a reinterpretation of the previously presented results. The recurrence of argumentation as an epistemological practice indicates that the studies attribute legitimacy to argumentative discourse as a means of producing and validating knowledge. However, critical analysis draws attention to an additional issue: which forms of knowledge are considered legitimate, which positions are recognized as acceptable, and which dimensions of the controversy remain less visible? These questions shift the analysis from the formal structure of the argument to the relationships between discourse, knowledge, and power.

Connecting this to Freire (2019a; 2019b; 2021) broadens this interpretation by allowing us to understand problematization as a central element of critical education. From the Freirean perspective, dialogue does not simply equate to the existence of differing opinions within a school activity. Dialogue presupposes subjects engaged in a critical reading of reality, in knowledge production, and in the possibility of transformation. Thus, an argumentative activity only approaches a problematizing perspective when the controversy is linked to concrete reality and the contradictions that constitute it.

In this sense, Socio-Scientific Controversies (SSCs) have the potential to create problematizing situations, as they introduce issues into education where science, society, ethics, and politics intersect. Studies dealing with pesticides, the medicinal use of *Cannabis sativa*, and other scientific controversies demonstrate this potential by linking scientific concepts to socially relevant situations. However, the mere presence of a controversy does not automatically guarantee a problematizing educational practice. It is necessary to observe how the controversy is discursively constructed, which questions are formulated, which positions are set in opposition, and what possibilities for understanding and action are generated.

It is at this point that the convergence of Fairclough and Freire proves productive for interpreting the corpus. Critical Discourse Analysis (CDA) allows for an examination of how discourses are produced and linked to social relations, while the Freirean perspective enables a critical examination of their pedagogical and formative implications. The former contributes to an understanding of the relationships between discourse, power, and ideology; The second allows us to examine the extent to which the educational process fosters dialogue, problematization, autonomy, and praxis.

In this context, teacher mediation constitutes a particularly relevant dimension. The studies analyzed attribute various roles to the teacher in organizing argumentation, including questioning, guidance, requests for evidence, and conceptual deepening. This role highlights that the quality of the argumentative process depends on the discursive conditions created within the educational setting. While the teacher can expand opportunities for participation and problematization, they can also curtail discussion when the activity is conducted solely to reach a predetermined answer.

Drawing on Fairclough (1992), this dimension can be interpreted by considering the power relations inherent in the organization of discourse. Determining who speaks, which arguments are accorded greater legitimacy, which forms of knowledge are deemed valid, and how positions are evaluated are decisions that shape the construction of discursive practice. From a Freirean perspective, these same conditions can be analyzed in terms of the possibilities for dialogue and the active participation of the individuals involved.

Another aspect identified in the corpus concerns the assessment of argumentation. Although half of the studies explicitly address assessment criteria or tools, this dimension does not appear with the same prominence in the remaining research. This finding suggests a tension between valuing argumentation as a discursive educational goal and the difficulty of establishing systematic procedures to monitor its development.

This tension is significant because argumentation can be presented as an element linked to critical development without assessment processes necessarily incorporating the dimensions that underpin such development. An assessment focused exclusively on the formal structure of an argument may prioritize evidence, justifications, and conclusions, yet fail to address the social conditions of discourse production, the various standpoints involved, and the capacity to critically problematize reality.

The prevalence of studies conducted within specific didactic intervention contexts also warrants attention. While this does not imply that argumentation is absent from other educational levels or contexts, it highlights a characteristic of the selected corpus: the concentration of research on delimited pedagogical situations. Thus, the results point to a need to understand how argumentative practices related to SSI (Socio-Scientific Issues) can be more systematically integrated into Natural Sciences education, without reducing controversy to a mere one-off or purely instrumental tool.

The analysis therefore reveals a central tension: while SSI are discursively framed as instruments for fostering critical awareness, their potential for emancipation depends on how they are problematized, mediated, and assessed. When controversy is used solely to enliven a lesson or generate formally structured arguments, its critical potential may be diminished. Conversely, when a controversial situation is linked to concrete reality, dialogue, critical reflection, and the capacity to take an informed stance, it aligns more closely with a problem-posing approach to education.

In this way, the analyzed corpus reveals the relationship between SSI and argumentation as a field characterized by both convergences and tensions. Convergences are found in the emphasis placed on argumentation, the use of socially relevant issues, and the link between these practices and critical development. Tensions arise primarily from the gap between stated emancipatory goals and their actual pedagogical implementation, the varying depth of critical frameworks applied, and the relative scarcity of systematic procedures for assessing argumentation. In light of Fairclough (1992) and Freire (2019a; 2019b; 2021), the results suggest that the educational potential of socioscientific issues (SSIs) does not lie simply in the presence of controversial topics in the curriculum. It depends on the discursive relations established around these topics and the opportunities afforded to individuals to critically interpret reality, confront perspectives, construct arguments, and take a stance regarding the social contradictions that permeate science.

Thus, within the analyzed corpus, argumentation can be understood as a discursive practice that transcends the formal organization of arguments and relates to the ways in which individuals make sense of scientific and social problems. SSIs, in turn, constitute privileged spaces for this discursive production when linked to the problematization of reality. Bringing together Critical Discourse Analysis (CDA) and the

Freirean perspective thus highlights that the contribution of SSIs to Natural Sciences education depends less on their use as a didactic technique and more on the discursive and pedagogical conditions under which they are mobilized.

4 FINAL CONSIDERATIONS

This study aimed to analyze how recent scientific literature has discursively constructed the link between socioscientific issues and argumentation in Natural Sciences education, covering the period from 2021 to 2025. Based on an analysis of six articles selected from the CAPES (Coordination for the Improvement of Higher Education Personnel) Journal Portal, it was possible to identify that argumentation plays a central role in the proposals investigated. It is understood not merely as a communicative resource but as a practice linked to knowledge construction, student participation, and the adoption of stances regarding socially controversial issues.

The results highlighted the recurrence of six analytical dimensions within the corpus: the understanding of argumentation as an epistemological practice; critical development as an educational goal; socioscientific issues as pedagogical tools; controversy as a structural element of activities; teacher mediation as a component of argumentative construction; and the assessment of argumentation. Together, these dimensions indicate that socioscientific issues are utilized to shift away from practices centered on content transmission toward situations where students are invited to interpret problems, mobilize knowledge, confront perspectives, and justify their positions.

An analysis guided by Critical Discourse Analysis, specifically Fairclough's (1992) perspective, revealed that this connection is not limited to the methodological strategies described in the studies. The discourses present in the corpus also reflect conceptions regarding scientific knowledge, the individuals involved in the educational process, and the forms of participation and meaning-making considered legitimate in Science education. In this context, argumentation takes on a discursive and social dimension, as it involves stances, choices, power relations, and disputes over the meanings attributed to socioscientific issues.

Engaging with the Freirean perspective broadened this interpretation by highlighting that the mere presence of controversy and argumentation does not guarantee a critical educational practice. For socioscientific issues (SSIs) to effectively contribute to critical education, they must be linked to the problematization of concrete reality, dialogue, the participation of the subjects involved, and the construction of possibilities for action and transformation. From this perspective, argumentation can move beyond the goal of producing answers deemed "correct" and instead become a practice of critically reading reality, one in which diverse forms of knowledge and experience can be contrasted and reinterpreted. Thus, integrating the perspectives of Fairclough and Freire proved productive for understanding various dimensions of the phenomenon under investigation. While the Faircloughian perspective allows for the critical examination of discourses, stances, and power relations involved in the production and circulation of meaning, the Freirean

perspective helps interpret the pedagogical and political conditions necessary for dialogue and problematization to foster processes of critical education. These are, therefore, complementary perspectives, drawn upon in light of their respective theoretical specificities.

Although the analyzed corpus is limited to six articles found on the CAPES Journal Portal and to a specific timeframe, the results help highlight trends and tensions within recent scholarship on SSIs and argumentation in Natural Sciences education. While this scope does not allow for generalizations regarding the entirety of Brazilian scientific output, it does enable a critical reading of how specific practices, goals, and conceptions are discursively constructed across the selected studies.

In conclusion, the integration of socioscientific issues and argumentation holds the potential to strengthen science teaching practices committed to participation, reflection, and critical education. However, realizing this potential depends on how controversial situations are pedagogically structured, the actual spaces for dialogue created, and the students' ability to move beyond merely expressing opinions toward processes of problematization, argument construction, the contrasting of perspectives, and reflection on reality. In this sense, working with QSC does not merely mean introducing controversial topics into instruction, but rather creating conditions for scientific knowledge, discourse, and social reality to engage in dialogue, thereby fostering a science education that contributes not only to understanding the world but also to questioning it and participating in its transformation.

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