Argumentation in Physics Classes: Proposal of a Theoretical-Methodological Tool for the Construction and Analysis of Teaching Situations in the School Context

Argumentação em Aulas de Física: Proposta de uma Ferramenta Teórico-Metodológica para Construção e Análise de Situações de Ensino na Realidade Escolar

Argumentación en las Clases de Física: Propuesta de una Herramienta Teórico-Metodológica para la Construcción y Análisis de Situaciones Didácticas en la Realidad Escolar

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Abstract

Considering the potential of argumentative activity in the learning and development of students in science, the objective of this article is to present a proposal for a theoretical-methodological tool for the construction and analysis of argumentative activity in teaching situations. On the one hand, it is based on the pragma-dialectical theory of van Eemeren and Grootendorst (2004), which offers analytical instruments to understand argumentation as a discursive practice structured by speech acts and guided by the critical resolution of differences of opinion. On the other hand, it is based on the perspective of Edwards (1997), when discussing the logics of interaction and content present in everyday school life, understood as ways in which subjects construct and share knowledge in specific contexts — in this case, the school context. Based on the analysis of an example of a school situation, we highlight that the tool allows a deeper understanding of the process of building relationships with school knowledge in Physics classes, demonstrating how argumentative activity enhances this process.

Keywords: Argumentation, school reality, Teaching Physics

Resumo

Considerando as potencialidades da atividade argumentativa na aprendizagem e desenvolvimento dos estudantes em Ciências, o objetivo deste artigo é apresentar uma proposta de ferramenta teórico-metodológica para a construção e análise de atividade argumentativa em situações de ensino. Por um lado, fundamenta-se na teoria pragma-dialética de van Eemeren e Grootendorst (2004), que oferece instrumentos analíticos para compreender a argumentação enquanto prática discursiva estruturada por atos de fala e orientada pela resolução crítica de diferenças de opinião. Por outro lado, apoia-se na perspectiva de Edwards (1997), ao discutir as lógicas de interação e de conteúdo presentes no cotidiano escolar, compreendidas como formas pelas quais os sujeitos constroem e compartilham conhecimentos em contextos específicos — neste caso, o contexto escolar. Tendo por base a análise de um exemplo de uma situação escolar, destacamos que a ferramenta possibilita uma compreensão mais aprofundada do processo de construção de relações com o conhecimento escolar em aulas de Física, demonstrando como a atividade argumentativa potencializa esse processo.

Palavras-chave: Argumentação, realidade escolar, Ensino de Física

Resumen

Considerando el potencial de la actividad argumentativa en el aprendizaje y desarrollo de los estudiantes en ciencias, el objetivo de este artículo es presentar una propuesta de herramienta teórico-metodológica para la construcción y análisis de la actividad argumentativa en situaciones de enseñanza. Por un lado, se basa en la teoría pragma-dialéctica de van Eemeren y Grootendorst (2004), que ofrece herramientas analíticas para entender la argumentación como una práctica discursiva estructurada por actos de habla y guiada por la resolución crítica de las diferencias de opinión. Por otro lado, se parte de la perspectiva de Edwards (1997), al discutir las lógicas de interacción y contenidos presentes en la rutina escolar, entendida como formas en que los sujetos construyen y comparten conocimientos en contextos específicos — en este caso, el contexto escolar. A partir del análisis de un ejemplo de una situación escolar, destacamos que la herramienta permite una comprensión más profunda del proceso de construcción de relaciones con el conocimiento escolar en las clases de Física, demostrando cómo la actividad argumentativa potencia este proceso.

Palabras clave: Argumentación, realidad escolar, Enseñanza de la Física

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Introduction

As a field of research, Physics Teaching covers a wide variety of research themes[1], such as: Physics Teaching and Learning; Physics Training and Teaching Action; Formal, informal and non-formal educational practices in Physics Teaching; Information and Communication Technologies applied to Physics Teaching; Language and Cognition in Physics Teaching; Science, Technology, and Society/Science, Technology, Society, and Environment; Scientific Literacy and Scientific and Technological Literacy in Physics Teaching; Theoretical-Methodological Issues and new demands in research in Physics Teaching; in addition to Equity, Inclusion, Diversity and Cultural Studies in Physics Teaching.

In some cases, according to Megid Neto (2007), cited by Abril and Nardi (2015), these studies seek, in their approaches, mainly, to emphasize methodological issues related to the processes of teaching and learning Physics, often to the detriment of the scientific knowledge traditionally conveyed in school. However, the issue of knowledge is crucial for the understanding and problematization of scientific concepts' appropriation, since this appropriation is influenced by the conditions and the way knowledge is present in this institutional environment. In this sense, the study of teaching and learning processes requires the analysis of pedagogical practices and the context in which they unfold.

Assuming the problem of school knowledge in the investigation means, among other things, understanding the *material existence of knowledge* in school, that is, the concrete ways in which knowledge is manifested in everyday school life. This involves understanding how knowledge is selected, transmitted, and constructed in the interactions between teachers and students, and how these teaching practices are

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1 The themes mentioned are based on the *Encontro Nacional de Pesquisa Ensino de Física* (EPEF). Bortoletto et al. (2007) point out that considering the importance of this event for the consolidation of the research area in Science teaching, it is possible to take it as a reference for themes researched in the field of Physics Teaching.

immersed in cultural contexts. The transmission and construction of this knowledge in the classroom do not neutrally take place; they are permeated by cultural aspects, such as the practices, values, and meanings circulating within the school institution.

From this perspective, Edwards (1997) emphasizes the importance of describing how teachers transmit and present knowledge, and how students actively participate in this construction. According to her, how teachers organize and mediate knowledge directly influences the learning process. Rockwell (1997) also draws attention to the cultural diversity in schools, highlighting the difficulty of speaking in a single *school culture*. In educational contexts, this culture is multifaceted, reflecting the variety and heterogeneity of practices, meanings, and experiences present in school realities, both for teachers and students.

Thus, the relevance of studies that consider the school reality is highlighted because they can contribute to the problematization and coping with educational difficulties.

Argumentation, understood in this context as a process of exchange and construction of points of view through critical discussion and the resolution of conflicts of opinion (van Eemeren & Grootendorst, 2004), plays a fundamental role in the formation of knowledge and in the development of students' critical thinking.

The importance of argumentation is widely discussed in the literature, especially concerning the reflection on knowledge, the construction and reformulation of points of view (Carmo & Carvalho, 2012; Jimenez-Aleixandre & Erduran, 2007; Vieira & Nascimento, 2009), the understanding of the nature of scientific knowledge and scientific practice (Ibraim & Justi, 2018), and the development of the social, affective and cognitive dimensions (Fernandes et al., 2018, 2020). The pragma-dialectic approach (van Eemeren & Grootendorst, 2004), which guides this study, emphasizes argumentation as an essential tool for the teaching-learning process, promoting a critical reflection among the subjects involved.

Regarding the argumentative processes in the school reality, Coraiola (2020) and Coraiola and Higa (2021), based on Edwards' (1997) theory, highlight the existence of logics of interaction and content[2] between students and teachers, peculiar to each context, which is influenced by several factors. In this work, "logic" is understood as an organizational structure underlying school practices, and "interaction" as the forms of relationship and communication established between subjects in the school environment. The logic of interaction, therefore, refers to the relational dynamics constructed in teaching situations, and its understanding is anchored in the perspective proposed by Edwards (1997), taken up by the aforementioned authors. Among the factors that influence this logic, the students' interests, the organization and objectives of the school, the curricular structure, the teaching perspective adopted by the teacher, the subjects' conception of the meaning of learning and teaching Physics at school and the process of signification of the argumentative activity by the participants stand out.

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2 Logic of Content: related to the epistemological assumptions and the formal structure of knowledge, in which students actively participate with the teacher. This aspect, the logic of content, will not be explored in this work.

In teaching situations, these elements can constitute both logics of interaction and content. According to Edwards (1997), both the logic of content and the logic of interaction give rise to the form of school knowledge. Through these logics, it is possible to identify signs of the form of knowledge in circulation and to understand the type of relationship that students establish with school knowledge, whether of interiority or exteriority.

In the relation of exteriority, knowledge seems to the subject to be problematic and/or inaccessible. In this situation, the subjects require clues in the search for the correct answer; they appropriate the lesson mechanically. This process produces a simulation of appropriation of the content and leaves the subject in a position of exteriority. On the other hand, the relationship of interiority with knowledge is developed "when the knowledge that is presented includes and questions the subject. He must then refer to himself, he must seek his point of view. The subject appropriates a content that requires his (the subject's) elaboration" (Edwards, 1997, p. 72, our translation).

In this sense, the objective of this article is to present a theoretical-methodological tool for the construction and analysis of the argumentative activity in teaching situations. To this end, we articulate the pragma-dialectic perspective (van Eemeren & Grootendorst, 2004) and the concept of logic of interaction in the school (Edwards, 1997). As we will discuss below, the theoretical articulation proposed in the tool favors the understanding of the type of relationship established by the subjects with school knowledge, which, in turn, is essential for the teaching and learning of Science mediated by dialogued argumentation.

Therefore, this work articulates two complementary theoretical approaches for the construction and analysis of argumentative processes in school and their implications in the construction of the relationship with knowledge. On the one hand, it is based on the pragma-dialectic theory of van Eemeren and Grootendorst (2004), which offers analytical tools to understand argumentation as a discursive practice structured by speech acts and guided by the critical resolution of differences of opinion. On the other hand, it is based on the perspective of Edwards (1997), when discussing the logics of interaction and content present in the school routine, understood as ways in which subjects construct and share knowledge in specific contexts. From this articulation, it is understood that school argumentative practices, when manifested in the discursive dynamics between students and teachers, express and constitute the relationships that the subjects establish with knowledge, which can be of interiority or exteriority. Thus, the logic of interaction considered in this study is understood as discussed by Edwards (1997), without intending to overlap with the concepts of pragma-dialectics, but as a contribution to a broader understanding of argumentation in the school context.

Argumentation, School Culture, and Science Teaching

The school reality has direct implications on subjects' relationship with knowledge, favoring or limiting their development. Investigating argumentation in this context involves characterizing the group's argumentative activity and identifying the form of knowledge built during this activity.

In this sense, it is essential to understand the specificities of argumentation in Science teaching to recognize important elements of the process of construction of scientific knowledge in the school environment and thus have indications about the form of knowledge in each context.

According to Scarpa (2009), argumentation in Science teaching forms a frontier region that connects school and scientific cultures. This means that participants in school culture, through argumentation, can interact with scientific culture from their own perspectives.

According to Sasseron (2015), considering the school as a space of diverse cultures, emphasizing the influence of school culture in the development of didactic practices, and also considering aspects of scientific culture, enables an in-depth reflection on school scientific culture. Given the relationship between scientific culture and school culture, Valle (2014) points out, based on Mcdonald and Songer (2008) and Mcdonald and Kelly (2012), that it must necessarily be recognized that in Science classes interactions require specific forms of communication that are related to scientific language and that it is important to differentiate the language used in the school context from that used in the broader scientific context.

This discussion reveals the complex interaction between school culture and scientific culture in the context of Science classes. When considering the different ways of speaking, listening, and interacting in the classroom, we observe that the teaching Science process is not only a transmission of scientific knowledge, but also a cultural construction that involves the adaptation of scientific practices and discourses to the school reality. These aspects demonstrate the importance of understanding argumentation as a form of mediation between two cultures, enhancing the construction of relationships of interiority with knowledge.

In this sense, the concept of school culture serves as an essential marker for the analysis of the context in which the argumentation occurs, because learning develops within this culture. Here we will adopt Forquin's (1993) perspective, which defines the school as a specific social and cultural environment, where educational practices have a particular culture. According to this author, school culture can be understood as the set of practices, norms, values, and shared meanings that guide the functioning of educational institutions. This culture not only shapes the way knowledge is imparted but also influences the dynamics of argumentative interactions within the school.

When culture refers to the expectations about students' behavior, the pedagogical practices adopted, and the forms of interaction between teachers and students, what the author calls school culture is characterized. It also reflects the values and norms of the school community.

Thus, understanding the school situation, given the existence of a school culture, helps to reveal how students engage in the construction of their relationship with knowledge during the argumentative activity.

The next section explores how the analysis that takes argumentative interactions as logics of interaction with their own characteristics can favor processes of construction and interpretation of the form of school knowledge and the relationship with knowledge.

Argumentation and the Relationship with School Knowledge

According to Edwards (1997), the forms of knowledge are determined mainly by the way school subjects structure and elaborate knowledge, regardless of the content studied. The author describes three forms of knowledge, each with its own specific characteristics, as presented in Figure1.

Figure 1

Forms of school knowledge

Forms of Knowledge	Description
Topical Knowledge	It refers to the correct naming of isolated terms and their application in specific operations, focusing on accurate transmission and exclusion of elaborate responses.
Knowledge as an operation	It goes beyond topical knowledge, going towards the practical application of scientific concepts in specific situations, such as using physical formulas in exercises.
Situational Knowledge	It involves the subject's signification of the world, mediated by the situation, where knowledge is contextualized in a network of practical and theoretical relationships.

These forms of knowledge can be better understood by analyzing the logic of interaction and the logic of content present in the teaching and learning process.

In this context, Coraiola (2024) proposes some parallels between the forms of knowledge described by Edwards (1997) and the teaching contexts mediated by argumentation. Logic of content becomes especially relevant when considering the different dimensions of argumentative activity. These dimensions are concretized in the classroom through teaching objectives and methodological guidelines, which are closely linked to the way argumentative activity is implemented in Science classes.

The dimensions of argumentation are conceived as constitutive elements of the analysis and characterization of the specific context in which the argumentative activity is developed, in this case, Science teaching in the school. In dialogue with the proposal of Jiménez-Aleixandre and Erduran (2007), who defend the consideration of multiple dimensions to understand the role of argumentation in educational contexts, Coraiola (2024) proposes to complement this analysis by articulating it with the logic of content and the logic of interaction proposed by Edwards (1997).

In this sense, the logic of content is composed of the epistemic, cognitive, and social dimensions of the argumentative activity. The logic of interaction, on the other hand, can be evidenced in activities that involve argumentation, especially when we focus on the development of the discussion based on the phases of critical discussion proposed by van Eemeren and Grootendorst (2004). This articulation allows us to understand how the teaching objectives, the methodological guidelines, and the discursive dynamics in the classroom are interrelated in the construction of the relationship with school knowledge.

To analyze the development of the discussion, which is the focus of this work, Coraiola (2024) suggests the use of the phases of critical discussion (van Eemeren & Grootendorst, 2004). These phases offer a potential path to understand the advancement in argumentation based on the interactions and roles assumed, and contributions during the discussion.

The analysis of the normative and descriptive aspects of argumentation, based on critical discussion, favors the understanding of progress and the search for the resolution of divergences between points of view. Speech acts (van Eemeren & Grootendorst, 2004), for example, can reveal the roles assumed by the subjects during the interaction and the type of contribution that each party presents throughout the process. Therefore, it is essential to analyze these aspects within the daily life of classes.

According to van Eemeren and Grootendorst (2004), speech acts aim (directly or indirectly) to commit to the position/arguments presented and to contribute to the resolution of divergence between points of view. Speech acts can be of the assertive, directive, commissive, expressive, and declarative types (van Eemeren & Grootendorst, 2004), as presented in Figure 2.

Figure 2

Speech Acts

Speech Acts Types	Description	Examples
Assertive	They affirm understanding or relationship with knowledge. They may indicate the defense of a broader and more open argument or evaluation.	"I affirm that", "I understand that", and "I think" can show understanding about the issues under discussion.
Directive	They are intended to get the listener or reader to do something or not do it, such as requests or prohibitions. In critical discussion, they may ask for argumentation, explanations, or definitions.	Requests for explanations or argumentation based on evidence. It contributes to the construction of meanings and generalizations in Science teaching.
Commissive	They relate to the speaker's or writer's commitment to the listener or reader, such as accepting and agreeing. In critical discussion, they involve accepting or not accepting points of view, starting discussions, and assuming roles.	Examples: "I accept" and "I agree". Decide to start or continue the discussion, and accept arguments.

Figure 2

Speech Acts (continuation)

Speech Acts Types	Description	Examples
Expressive	They express feelings, such as thanks, congratulations, or disapproval. They can influence the continuity or withdrawal of critical discussion, although they do not play a direct role in it.	Examples: "Thank you" and "Congratulations". They can influence the progress of the critical discussion, motivating or demotivating the participants.
Declarative	They define, specify, or explain something to broaden the understanding of other speech acts. They can occur at any stage of critical discussion, guiding the resolution of divergences.	Definitions, specifications, or explanations. It facilitates the understanding of other speech acts and favors the resolution of disagreements.

To understand the process of critical discussion, it is useful to analyze the phases that constitute it. The following table describes the four phases according to van Eemeren and Grootendorst (2004): Confrontation, Opening, Argumentation, and Conclusion. Each of these phases plays a role in building an effective debate and resolving disagreements (Figure 3).

Figure 3

Phases of critical discussion

Phase	Description
Confrontation	At this stage, a divergence of views occurs due to the existence of doubt or contradiction. The divergence can be explicit or remain implicit. Without this initial confrontation, real or presumed, there is no need for a critical discussion.
Opening	It seeks to find out how much the participants have in common in relation to the format of the discussion, background knowledge, values, etc. It intends to determine the possibility of an agreement. It includes analysis in the context of discussion, especially with regard to scientific knowledge and argumentation as a method of knowledge construction.
Argumentation	Participants move forward in search of arguments to support their points of view. The goal is to overcome the antagonist's doubts or refute criticism. The argumentation must progress according to the discussion, and there must be a critical evaluation to enable the resolution of the divergence.
Conclusion	In the final phase, the critical discussion seeks to resolve the difference of opinion, determining the outcome of the resolution attempt.

In summary, it is possible to highlight the importance of the constitution of argumentation in the school situation, focusing on both normative and descriptive aspects. Normative aspects refer to the rules and standards that define what constitutes a valid and reasonable argumentation, and can be analyzed based on the phases of critical discussion.

On the other hand, the descriptive aspects focus on the observation of what really happens during the argumentative process. The descriptive perspective is enriched by the analysis of speech acts (van Eemeren & Grootendorst, 2004). This approach analyzes how argumentation occurs in practice, investigating real patterns of discourse, strategies used by the participants, and contexts in which the arguments are presented. The proposed analysis focuses on these aspects of the discussion.

In the next section, a tool is proposed for the construction and analysis of the argumentative process in teaching situations based on the understanding and interpretation of the phases of critical discussion and the speech acts of the participants, and the logic of interaction.

A Tool for the Construction and Analysis of Argumentation in Class

Based on the theoretical articulation presented, a tool is proposed for the construction and analysis of the dialogued argumentative activity composed of two steps (Figures 4 and 5) to contribute to the construction of teaching situations that focus on the development of argumentation and to the development of argumentation and analysis of the procedural aspect of these teaching situations. Aspects that can be explored and analyzed in class are highlighted in order to abstract elements that favor the understanding and development of argumentation in the school reality.

Figure 4

Step 1 of the tool: Analysis of the argumentative activity

Teaching Situation			
1. Characteristics of dialogued argumentation			
Topic of discussion:			
Phases of critical discussion			
Confrontation	**Opening**	**Argumentation**	**Conclusion**
Proposal of themes, questions, and activities that promote argumentation; Identify divergences of views that led to the discussion between the parties.	Characteristics of the points of view presented; Forms of participation in the discussion: • Requests a point of view; • Presents point of view; • Questions point of view.	Characteristics of the argumentation constructed by the parties; Nature of argumentation: • Explore the problem; • Doubt; • Hypothesis raising; • Mediation; • Points of view-justification.	Identify if the discussion has been concluded; Nature of the knowledge mobilized and validated by the group to construct the conclusion.
2. Speech Acts			
Identify types of speech acts (assertive, directive, commissive, expressive, and declarative).			
Contributions of the participants to the discussion and resolution of the divergence between points of view.			

The topics of Step 1 present aspects that can be explored to aim at the development and analysis of argumentation in the school reality. Thus, in the confrontation phase, the themes that should be explored and that make the activity potentially argumentative are analyzed. Also, at this stage, it is interesting to highlight the issue that causes the divergence between points of view. It is important to emphasize that, in the school reality, the divergence between points of view can be implicit and can be presented in the form of conceptual or procedural doubts by the students, a presentation of an opinion different from that presented by the group or the teacher, among others. In this sense, it is important to be aware of the context of the discussion and the parties' contributions in the discursive interactions in the classroom.

In the opening phase, the points of view presented and the forms of participation in the discussion can be analyzed. The particularities of the points of view presented help to characterize which knowledge is being mobilized by the subjects and also their understanding of the topic under discussion. The forms of participation, on the other hand, indicate how the interaction happens and the subjects' contributions to the discussion.

Moving on to the argumentation phase, the characterization of the argumentation and its nature is carried out. In this phase, considering the educational context, it is relevant to analyze which problems are explored in the argumentation, whether doubts are presented, and the justifications for the doubts mobilized. Also, if there is the formulation of hypotheses, whether and how the mediation of the discussion occurs and by which subjects, and whether it is possible to identify, implicitly or explicitly, the point of view-justification.

Finally, in the conclusion phase, in the analysis, it should be observed whether the group reaches a conclusion for the issue under discussion, whether the arguments are accepted by the group, and what knowledge is mobilized and validated for the construction of the conclusion.

Regarding the analysis of speech acts, it is important to observe the characteristics of each act (Figure 2) to identify if and how the school subjects mobilize them during the discussion, as it is possible to follow in the analysis of the teaching situation that will be done later, as an example. In this process, there is the possibility of approximation with the participants' contributions in the discussion to resolve the divergence of points of view, and if the participants reach a conclusion.

Next, Figure 5 demonstrates Step 2 of the proposed tool, in order to identify the indications about the types of relationship (interiority or exteriority) with school knowledge that are being built during the dialogued argumentative activity.

Figure 5

Step 2 of the tool: analysis of the relationship with knowledge
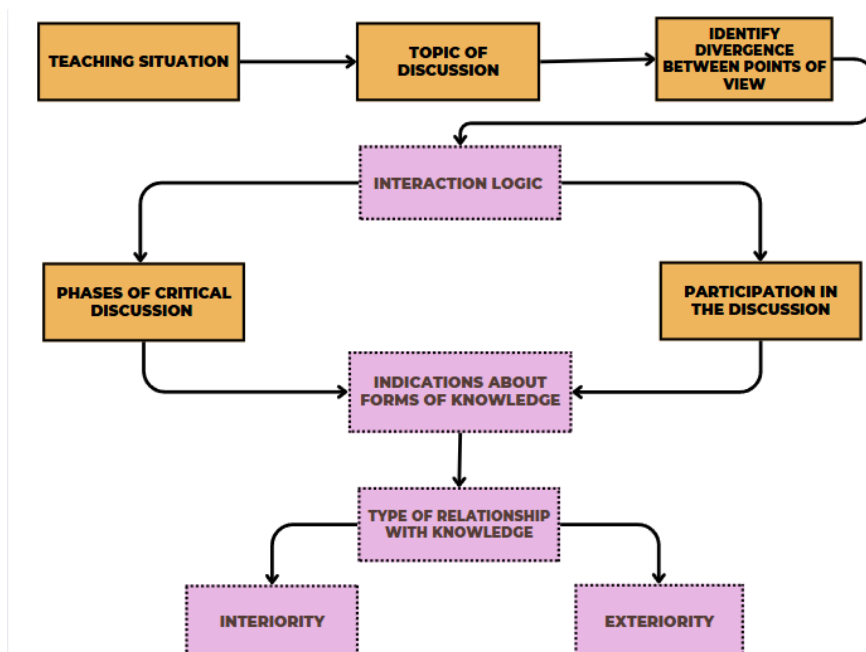
Dialogued argumentation requires participants to engage in specific ways: taking a position on points of view, understanding and evaluating arguments, presenting doubts and justifying opinions, in addition to elaborating on the topic under discussion. The analysis of the phases of critical discussion and the forms of participation reveals the nature of the knowledge being constructed and the type of relationship with knowledge that this construction promotes.

By focusing on the logic of interaction, it is proposed to observe the phases of critical discussion because they allow us to understand whether the participants are engaging in an argumentative process guided by the rational resolution of divergences, in which there is room for the confrontation of points of view, the justification of opinions, the contestation of arguments, and the search for agreements. This analysis shows the extent to which discursive activity is structured by an ideal of rationality that values the exchange of reasons as a path for the joint construction of knowledge.

The observation of speech acts allows the identification of forms of participation, individual contributions to the discussion, mobilized points of view, and significant knowledge for the subjects involved in the school reality. By describing the communicative purposes present in the interactions, such as affirming, asking, contesting, agreeing, explaining, or justifying, speech acts highlight not only the content of what is said, but the way in which the participants relate to knowledge.

This analysis provides concrete indicators about the relationship that is being established with school knowledge, whether of interiority or exteriority. Based on these indicators, it is possible to problematize aspects that favor, hinder, or transform the development of the argumentative activity, especially in its articulation with the school culture and with the culture of the school.

An Example of Argumentation Analysis in the Classroom

As an example, the proposed tool will be used to analyze a teaching situation in a Physics class in High School.

A teaching situation observed and recorded in a study[3] carried out by Coraiola (2024) was selected for analysis. The context of observation was a Physics class of a second-year high school class of a state school in Curitiba, Paraná. The class was recorded through audio recording, with prior authorization from the school and the participants, according to the ethical procedures of the research.

The recordings were transcribed in full, preserving elements of the subjects' orality and anonymity, by replacing the names with pseudonyms. The selection of the analyzed excerpts was guided by the theoretical assumptions of critical discussion (van Eemeren & Grootendorst, 2004), according to which argumentation emerges as a response to a difference of opinion, explicit or potential.

Thus, the examples presented in the article were chosen because they show interactional moments in which there was the presence of a divergence — explicit or implicit — to be resolved through argumentation. These excerpts also reveal strategies of teacher mediation and student participation relevant to the analysis of the logic of interaction and the construction of the relationship with school knowledge in the context of the class.

In this teaching situation, the teacher proposed the evaluation of the following situation: "Consider a lit candle and two balloons, one containing water and the other air". The discussion was around the following question: What will happen to each of the balloons when they come into contact with the candle flame?

Participation in the argumentation was analyzed based on the phases of critical discussion and speech acts. As previously discussed, each of these elements favors the approximation with the form of knowledge being constructed, as they configure a specific interaction logic.

The understanding of this logic in the teaching situation offers elements to interpret the type of relationship with knowledge that is being built during the discussion process. Considering the critical discussion and the contributions of the participants to the resolution of divergences of points of view, we have indications about the type of relationship that is being established with school knowledge during the argumentative activity.

Interaction Between Teacher and Students and Among Students

The interaction between the teacher and the students during the argumentation can be analyzed based on the phases of critical discussion (Figure 3) and the speech acts (Figure 2) described by van Eemeren and Grootendorst (2004), as presented in Figure 6:

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3 This research was approved by the Research Ethics Committee under CAAE 50581921.0.0000.0102.

Figure 6

Speeches in the teaching situation analyzed: teacher-students

Speech	Critical Discussion Phase	Speech Acts	Description
Teacher: I want to see if your imagination is good.	Comparison	Directive	The teacher asks students to use their imagination, suggesting a challenge.
Fábio: In number three?	Comparison	Assertive	Fábio tries to understand the context of the challenge, confirming his assumption.
Teacher: In all of this, I want to see if your imagination is good.	Opening	Directive	The teacher reinforces the request, expanding the context and organizing the activity.
Fábio: To deduce what happens with the balloons, with the air, the water, and the flames, right?	Opening	Assertive	Fábio organizes the variables involved to formulate a hypothesis and predict what will happen.
Eduardo: Teacher, does the balloon melt and then burst?	Argumentation	Comissive	Eduardo suggests a hypothesis and commits to a possible explanation for the experiment.
Teacher: It's a hypothesis, write it down.	Argumentation	Declarative	The teacher validates Eduardo's hypothesis, classifying it as valid, and advises him to register the idea.
Eduardo: Then... Water, ah, teacher...	Argumentation	Expressive	Eduardo expresses uncertainty and frustration when trying to articulate his hypothesis.
Teacher: Write it down, you think it's going to happen. It's an idea, a good deduction.	Argumentation	Directive	The teacher encourages Eduardo to register his hypothesis, validating his participation by offering support.
Bernardo: I don't think it's going to burst, I think it's going to melt and the water will...	Argumentation	Directive	Bernardo expresses his opinion, presenting another hypothesis about what can happen, using a more cautious judgment, as indicated by the expression "I think".
Teacher: I think it will melt and it won't burst.	Conclusion	Assertive	The teacher organizes the hypotheses presented, but without validating the answer, promoting reflection.

The dialogue begins in the confrontation phase, when the teacher provokes the students to reflect on what can happen to a balloon when exposed to the flame of a candle. By saying "I want to see if your imagination is good", she instigates the formulation of hypotheses and opens the space for discussion. The activity is configured, from the beginning, as an invitation to anticipation and the construction of explanations.

In the opening phase, the teacher encourages students' active participation and validates their ideas as legitimate hypotheses. She instructs Eduardo and the other colleagues to record their deductions, as observed in the statements "It's a hypothesis, write it down" and "Write it down, you think it's going to happen. It's an idea, a good deduction". This teaching posture establishes the conditions for collective engagement, opening space for exchanging ideas and mutual listening.

During the argumentation phase, students present different hypotheses about the phenomenon. Eduardo says that the balloon can melt and burst, while Bernardo has the idea that it will only melt and that water will play a role in the reaction. The divergence between the points of view is established, even if the arguments are not fully developed. Students seek to support their hypotheses based on previous knowledge and inferences drawn at the time of discussion.

In the conclusion phase, the teacher synthesizes the ideas debated and proposes a provisional conclusion: "I think it will melt and it won't burst". Her intervention organizes the students' contributions without ending the discussion, reinforcing the procedural and investigative character of the activity.

The analysis of speech acts reveals how the subjects position themselves and build relationships with knowledge during argumentative interaction. The teacher's speech acts, predominantly assertive and declarative, indicate her pedagogical intentionality: to coordinate the debate, legitimize the students' speeches, and mediate the collective construction of explanations. This teaching position creates conditions for students to express themselves and actively participate in the process of knowledge elaboration.

In the interaction with students Fábio, Eduardo, and Bernardo, there is an alternation between assertive and declarative speech acts, on the part of the students, who participate with involvement in the attempt to understand the phenomenon and build explanations. The teacher validates their points of view as important elements in the construction of the answer, which remains open. This dynamic favors a relationship of interiority with school knowledge, to the extent that students get involved in the formulation, evaluation, and re-elaboration of hypotheses based on their own ideas, demonstrating appropriation of the content under discussion.

In parallel, linked to the discussion between the teacher and Fábio, Eduardo, and Bernardo, Elisa starts a discussion in a smaller group, as presented in Figure 7 below:

Figure 7

Speeches in the analyzed teaching situation: student-student

Speech	Critical Discussion Phase	Speech Acts	Description
Elisa: But when the balloon heats up too much, it explodes...	Argumentation	Assertive	Elisa hypothesizes that the balloon bursts due to the heat.
Arthur: With air	Argumentation	Assertive	Arthur specifies that they must consider the air inside the balloon, seeking to understand the causes of the burst.
Elisa: It's with air	Argumentation	Assertive	Elisa agrees with Arthur and reaffirms the importance of air in the heating process.
Heitor: With the flame	Argumentation	Assertive	Heitor suggests that the contact with the flame may cause the burst, offering a new perspective.

Elisa's statement, when she says that "when the balloon heats up too much, it explodes", introduces the hypothesis that heat causes the balloon to burst. This intervention is located in the argumentation phase, as it expresses an attempt to explain the phenomenon based on an idea of its own. By using the conjunction "but", Elisa signals doubt and questions Bernardo's hypothesis that the balloon only melts, which evidences a process of critical evaluation of different points of view. This attitude demonstrates a movement of active elaboration of the answer, in which students not only expose ideas but confront and reevaluate them, signaling the construction of a relationship of interiority with knowledge.

Arthur contributes to the discussion by introducing the variable "air", indicating the search for a more comprehensive understanding of the phenomenon. By mentioning "with air", he suggests that the presence of air inside the balloon is a relevant factor in explaining the burst. This statement is also part of the argumentation phase, as it represents a refinement of the previous hypotheses and expands the elements considered in the explanation of the problem.

Next, Elisa resumes Arthur's speech and reaffirms that the heating of the air inside the balloon is what causes the burst, demonstrating that there was understanding and incorporation of her colleague's idea. This joint construction signals the formation of a provisional consensus between the two, keeping the discussion in the argumentation phase and reinforcing the collaborative character of the knowledge construction process.

Heitor expands the debate by introducing a new variable: the "flame". He proposes that the cause of the burst may be more related to the direct contact with the flame than to the heating of the air. This intervention represents the insertion of a new explanatory perspective and, therefore, also belongs to the argumentation phase. Heitor's proposal not only diversifies the possibilities of explanation but also demonstrates his attempt to intervene in the process of constructing the answer, strengthening his relationship of interiority with knowledge.

The statements evidence an argumentation in development, with the students presenting hypotheses, introducing variables, and constructing justifications sometimes explicitly, like Elisa, sometimes more implicitly, like Arthur and Heitor. The introduction of new elements throughout the discussion points to a growing level of complexity and depth in the analysis of the problem, reflecting the advancement of argumentation and the cognitive engagement of students.

The speech acts produced throughout the interaction are mostly assertive, indicating the students' effort to elaborate and refine justifications for the ideas being discussed. It is observed, however, that communication between students often occurs through short sentences and the isolated mention of variables, without the explicit formulation of complete justifications. Despite this, in the communicative context shared by the group, these statements are understood and effectively contribute to the advancement of the discussion.

This aspect highlights the importance of considering school culture in the analysis of argumentative activity. Even when the logical link between point of view and justification is not verbally explicit, there is a construction of meaning shared among the participants. The analysis of speech acts, in this case, allows us to understand how language circulates in interactions and how students, based on their own forms of expression, construct meanings and establish relationships with school knowledge.

Argumentation and the Relationship With Knowledge in the School Situation

In the previous topic, we explored the analysis of argumentation in a school context, using the phases of critical discussion and the speech acts described by van Eemeren and Grootendorst (2024) as categories. We analyzed two specific interactions — that between teacher and students, and that among students — to identify the argumentative process in its normative and descriptive aspects in the school reality.

In the first analysis, the interaction between the teacher and the students Fábio, Eduardo, and Bernardo demonstrated the phases of confrontation, opening, argumentation, and conclusion. The teacher started the discussion by provoking the students and establishing the problem to be discussed, while the students presented and justified their hypotheses about the behavior of the balloon when heated. The teacher summarized and synthesized the ideas presented, offering a provisional conclusion for the situation under analysis, reflecting the conclusion phase of the critical discussion in this context.

In the second analysis, we focus on the discussion between Elisa, Arthur, and Heitor about the same balloon issue. Observing hypotheses conveyed in the group that interacted with the teacher, especially Bernardo's, Elisa presented an initial hypothesis, while Arthur and Heitor introduced new elements to the discussion. The argumentation phase was evidenced, with students presenting and refining their hypotheses based on possible variables involved, such as air and candle flame. The analysis revealed how different speech acts and students' contributions help to collectively build a deeper understanding of a problem in order to formulate justifications.

In addition, during the observations, it was possible to notice that some students take notes while others discuss or pay attention to the discussion without participating verbally. In some cases, some students seemed distant, showing little involvement with the class dynamics.

It is important to highlight that silence during oral interactions does not always indicate distancing from the collective construction because, within the school culture, there may be traditional forms of participation and also conceptions of the subjects about their roles in the process of knowledge construction that do not necessarily include participation through verbalized argumentation.

These analyses illustrate how the use of the categories of the phases of critical discussion and speech acts can enrich the understanding of argumentation in teaching situations in the school reality. The application of these concepts allows the identification and evaluation of how students formulate, defend, and adjust their hypotheses, contributing to a learning process in which they can establish relationships of interiority with school knowledge.

This type of relationship — of interiority — with knowledge gains prominence from the relationship with the concrete and the students' experiences. In this sense, there is a search to contextualize the content on the part of the teacher and the students, evidencing a form of contextual-empirical knowledge (Coraiola, 2024). This means that the group seeks references and examples of the immediate reality for the construction of knowledge in the classroom. This form of knowledge can be understood as an advance in relation to the form of knowledge as an operation, incorporating some elements of the form of situational knowledge conceptualized by Edwards (1997), but with less emphasis on the abstract-concrete relationship.

Conclusions and Implications

Each moment of interaction in the classroom has its own characteristics, especially concerning the roles assumed by the school subjects and how discursive interactions occur. In the school reality, the acceptance or refusal to participate in class can be expressed in different ways, and as a result of the school and school cultures. In the selected teaching situation, it was possible to evidence, from the proposed tool, that the attempt to elaborate answers and justifications, the search for the colleague's opinion and the questions directed to the teacher are ways of accepting and continuing the proposed discussion, characterizing the phases of confrontation and opening of the critical discussion.

Additionally, the group advances to the argument construction phase. Although complex arguments were not identified, there is a process of elaboration of arguments by the students, and justifications of the points of view and hypotheses formulated. The activity developed highlights the search for the construction of justifications based mainly on previous knowledge.

From the proposed tool, it was possible to highlight these aspects of the participation of school subjects and the characteristics of the activity in this context that evidence the students' learning process about different elements of the argumentation process.

The results of the analysis indicate that the articulation between speech acts, the phases of critical discussion (van Eemeren & Grootendorst, 2004), and the logic of interaction (Edwards, 1997) allows the identification of nuances of the school subjects' participation that go beyond the argumentative structures traditionally analyzed. The tool favors a more relational and situated understanding of the construction of school knowledge. Although there are investigations that analyze structural or epistemic aspects of argumentation, the proposal presented in this article aims to offer a complementary perspective by also considering the interactional and discursive dynamics of the argumentative process. This expands the possibilities of analysis in the field by integrating normative and descriptive aspects of argumentation, allowing a closer look at the forms of engagement of the subjects and the construction of relationships with school knowledge.

These conclusions highlight the importance of understanding the different forms of participation and the steps of argumentation in the classroom reality. The analysis reveals how interactions within the school culture and discursive practices influence the construction of knowledge and the development of students' argumentative skills, offering valuable instruments to improve the analysis and proposal of teaching situations that involve argumentation in the school reality.

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