Speech analysis under a Bakhtinian approach: Contributions to research on physics education

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[This paper is part of the Focused Collection on Qualitative Methods in PER: A Critical Examination.] Since the beginning of the 21st century, the appropriation of the sociocultural perspective by the physics education research community has represented a linguistic turn in the field, pointing out a promising path to overcome the dominance of the "individual paradigm," both in terms of student learning and initial and continuing teacher training. This approach views science, science education, and research as human social activities embedded in larger sociocultural and institutional contexts, implying a significant theoretical importance to the role of social interaction and the context in which these interactions occur, viewing them as critical to a better understanding of the learning process rather than merely as a secondary role. In this theoretical framework, language plays a fundamental role as a mediator of human action, notably, it is the main system of signs used by humankind. Hence, we recognize the origin of sociocultural perspectives in Lev Vygotsky's sociohistorical psychology. The neo-Vygotskian James Wertsch proposes a "continuity" of Vygotsky's theory by emphasizing one of its unexplored assumptions: the characterization of human action as an activity mediated by signs and instruments. In this theoretical construction of a sociocultural approach to human action, the philosophy of language of Mikhail Bakhtin Circle becomes crucial. Data of discursive nature (oral and written speech of the instructor and their pupils, textbooks, or official documents) may be analyzed in physics education research, particularly those focusing on classroom situations (typically didactic interventions). We employed Bakhtinian analysis to avoid the text's objectivist (positivist) stance and the structural deterministic idea of ideological interpellation suggested by Althusser and endorsed by Pêcheux's discourse analysis. In order to contribute to a qualitative research technique for discursive data analysis, we explain the Circle's theory and translate it into possible methodologies for research in physics education. We suggest an "analytical trajectory" based on this as a possible arrangement of the interpretation of discursive data under Bakhtin's metalinguistic. Finally, we exemplify the use of this analytical trajectory in our research group's works.

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I. INTRODUCTION

In science education research, we have witnessed a significant break with Piaget's vision of the student as a mini-scientist who would develop a Kantian epistemology from direct experience and logical frameworks in the last two decades. Science historians, sociologists, and anthropologists [1–3] have challenged the notion that science is the only valid approach, divorced from social institutions, politics, cultural beliefs, and values, in favor of a perspective that understands this enterprise as a (very) human activity whose focus of interest and theoretical framework is part (and not apart) of the dominant culture and political context of its time [4].

Following the footsteps of Vygotsky's (1896–1934) perspective, the so-called sociocultural turn in research on teaching physics reinterpreted its objects of investigation as human social activities embedded in a cultural and institutional system, implying attributing significant theoretical weight to the role of social interaction [5,6], viewing it as necessary to the learning process rather than just as an aide. The smallest scale of social interaction considered is interpersonal interaction, since human social activities, such as science, science teaching, and research on science teaching, are only possible because we grow up and live within institutions and communities that give us tools to attribute meaning to the world around us: language, pictorial conventions, systems of beliefs, systems of values, and specialized discourses and their practices. Collectively, such tools for our life—our social systems of semiotic resources and our socially significant forms of use of these resources—constitute the culture of a community [4].

Recognizing that thought is a type of material action performed with the use of material and psychological tools provided by a society's culture, with a focus on our most important system of signs or psychological tool—language—research on science teaching has also taken a linguistic turn in the last two decades. The growing interest in the role of language in science education [7–9] stems from research conducted within sociocultural theories and the recognition of the links between language, culture, and cognition [10–12]. The language was viewed not only as a culturally transmitted resource but also as a phenomenon central to the processes of appropriation of scientific discourses in the classroom [13].

The centrality of the phenomenon of language has required traditionally better-trained researchers in psychology, especially in cognitive psychology and canonical science philosophers, to turn their attention to the human, social, and applied social sciences (sociology, anthropology, applied linguistics, metalinguistics, political economy, cultural studies). Such a sociocultural turn has enabled an expansion of the objects of study (beyond the science classroom) and the theoretical frameworks hitherto employed. The training of researchers has come to demand new theoretical possibilities that can cope with studies on how people learn to speak and write the languages of science and how they engage cooperatively and significantly in a wide variety of activities and how they mean their practices [4].

A landmark in the sociocultural turn of research in science education was the creation of the journal Cultural Studies of Science Education (CSSE), which published its first issue in 2006, in a process of recognizing qualitative research as a viable form of investigation and accepting social and cultural theories as the foundations of research in science education. Another highlight was the theoretical construction of Wertsch, an American psychologist, who is very referenced in science education works based on Bakhtin's thought (1895–1975) [14].

Based on the assertion that the central fact of psychology is the phenomenon of mediation [5,6,12], he argues that typically human actions employ mediating instruments, such as tools or language and that these mediating instruments shape action in an essential way. The relationship between action and mediating instruments turns out to be so fundamental that it is more appropriate to speak of "individuals who act with mediating instruments" than simply of "individuals". His theoretical construction is called sociocultural because it seeks to understand how mental action occurs in cultural, historical, and institutional scenarios. This term is also a way of recognizing the contributions of various disciplines and schools of thought in the study of mediated action, as well as Vygotsky's original construction. Vygotsky's psychological theory, considered a precursor of the sociocultural approach, is concerned with understanding how the domain of socioculturally situated forms of mediated action, i.e., in the interpsychological plane, can lead to more particular forms of the same in the intrapsychological plane [12].

Wertsch [12] considers that Vygotsky was not successful in providing a genuinely sociocultural approach to the problem of the mind, in particular, he did not manage to investigate how historical, cultural, and institutional scenarios are linked to various forms of mediated action. In order to extend Vygotsky's ideas and bring to the forefront the sociocultural nature of mediated action, the author proposes the articulation of Vygotsky's theory of mediation with Bakhtin's philosophy of language (metalinguistics). The sociocultural approach to human action, in this articulation, is centered on discursive genres [15] as mediating instruments, adding to this perspective the metaphor of the toolbox to highlight the diversity of cultural tools available to individuals. From this idea, the author develops the notion of *heterogeneity*, according to which in every culture and every individual there is not only a homogeneous form of thought but qualitatively different types of verbal thought. These concepts will allow for questions to be raised about the choice, by a particular subject, of one or another tool to perform an action, establishing a reference from which cultural, historical, and institutional differences in this process can be understood. To complement the theoretical framework necessary for the investigation of human actions, the author proposes the notion of *privileging* [12] (p. 124), which refers to the fact that a mediating instrument, such as a social language, is considered more appropriate or effective in a certain sociocultural scenario. The theoretical construction of Wertsch impacted research in science education, as demonstrated by the work of Kubli [16] who used Bakhtin's and Vygotsky's theories to study how teachers can help their students to be producers of a meaningful vision of the world they live in. The author concludes by stating that Bakhtin provides new insights into theories of teaching processes, as his ideas shed light on our understanding of the space, function, and role of the teacher in the classroom, indicating which aspects should be trained and cultivated in the search for successful, rewarding, and professional teaching.

From the perspective of Bakhtin's thought, van Eijck and Roth [17] are challenged to reflect on cultural and linguistic diversity in the school, in order to value and maintain it in the face of the canonical discourse of science in classrooms. Under the ideas of Bakhtin, the authors articulate the concepts of *epicization* and *novelization* to understand, respectively, the processes of (i) centralization and homogenization of culture and language and (ii) pluralization of culture and language. Based on three analyzed examples, it is shown how the everyday practices of science teaching tend, through epicization, toward a unitary language and cultural centralization. Novelization is proposed as a way of thinking about the opening of science education,

interacting and incorporating alternative forms of knowledge that arise from cultural diversity.

Roth [9] argues that, despite the increasing interest in the role of language in research under the sociocultural approach in the last two decades, the nature of language and its relationship with thought has not changed substantially and, in many aspects, is incompatible with the historical-cultural and dialogical materialist support of Vygotsky and Bakhtin's sociocultural and dialogical approaches and their Circle. For the author, analyses of discursive interactions in science classrooms do not seem to consider the fact that words, utterances, and language are inherently changing phenomena when speaking. Based on the premise that language is a living phenomenon that transforms when used, a theoretical and methodological framework is developed based on the work of Vygotsky and the Bakhtin's Circle (we will explain what is this Circle in Sec. III C). The author concludes that the proposed model has significant implications for theorizing the relationship between classroom talk and formal written expression genres and gives rise to many new research questions.

To understand how Bakhtin's metalinguistics has been appropriated by Brazilian scientific productions, Deconto and Ostermann [14], in state-of-the-art research, found 70 articles from a selection in national magazines classified, by the Brazilian agency that evaluates postgraduate studies, in the highest stratum, without delimiting a specific period. It was possible to perceive that the approach of the reference to the area of science education is a construction that began about 20 years ago, very timidly and that, in the last ten years, began to gain more prominence.

Most of the works (55) developed their propositions based on empirical data extracted from educational products, official documents, course guidelines, scientific dissemination magazines, textbooks, science fiction works, texts written by students, written utterances in response to questionnaires, spoken utterances in semistructured interview situations, utterances by teachers, utterances by students, utterances of discursive interactions between teachers and students. The ideas of the Bakhtin's Circle were mobilized from certain concepts such as utterance, its characteristics, and peculiarities; voice; dialogism; genres of discourse; active/responsive comprehension; extraverbal context; sign, signification and theme; alien discourse. The most cited works were *Marxism and the Philosophy of Language*, referenced in almost 80% of the papers, and *Speech Genres and Other Late Essays* or some text constituting this collection, referenced in almost 85% of the works. Another characteristic of Bakhtinian thought in Brazilian productions is its concomitant approach to a diversity of theoretical frameworks. The presence of theoretical frameworks associated with teacher training, gender issues, argumentation, socioscientific issues, curriculum theories, sociology, psychology (essentially Vygotsky), and linguistics is verified, with a focus on French discourse analysis.

A distinctive characteristic of the analyzed works was the attribution of a purely methodological perspective to the ideas of Bakhtin's Circle. Although most of the productions refer to Bakhtinian thought as a theoretical methodological framework, in the development of their research, its association with a purely data analysis methodology becomes clear. The issue is that assuming it as a purely methodological reference may suggest a conception of a *Bakhtinian method* and, consequently, fall into a positivist view of research inconsistent with Bakhtin's *heteroscientificity.* As we will discuss throughout our text, the Bakhtinian architecture is opposed to mechanistic thinking and closure, in favor of openness, movement, and interactions. In his criticism of mechanism, Bakhtin opposes the mechanical to that which is impregnated by the internal unity of meaning, pointing out that the mechanical is lacking in interactions and is impermeable to influences. As Bakhtin [18] (p. 1) emphasizes

> A whole is called "mechanical" when its constituent elements are united only in space and time by some external connection and are not imbued with the internal unity of meaning. The parts of such a whole are contiguous and touch each other, but in themselves they remain alien to each other.

On the other hand, it seems reasonable to think about *methodological constructions* (and not a method) based on Bakhtinian thought and the analyses developed by members of the Circle.

In this paper, we will initially discuss the philosophical foundations of different schools of discourse analysis in order to contrast them with the perspective of analysis that is based on Bakhtinian thought. In continuation, we will present a synthesis of his thought and concepts that can support analyses of discourse data, as well as examples extracted from the results of our research.

II. QUANTITATIVE *VERSUS* QUALITATIVE PERSPECTIVE IN ACADEMIC RESEARCH: A BRIEF HISTORY OF THIS DISPUTE

A. The *cliche* differentiation between quantitative and qualitative research

In research developed in the area of human and social sciences, in which the field of science education can be said to be included, there are interesting debates about the development of research using two apparently opposing methods, quantitative and qualitative. In the most stereotypical perceptions of these two perspectives, we can describe them as shown in Table I [19] (p. 19).

These four commonly accepted characteristics, put side by side for comparison, suggest a false superiority of

TABLE I. Typical comparison of quantitative and qualitative research.

Quantitative research	Qualitative research
Provides explanations	Provides only descriptions
Is objective	Is subjective
Fundamentally studies causes	Studies experiences
Can test hypotheses	Can only generate hypotheses

so-called quantitative over qualitative research, as if the former could lead to more "scientifically legitimized" results than the latter, resulting in stronger evidence due to their alignment with a hypothesis testing process based on hypothetico-deductive logic. It can be stated that [19] (p. 19):

> The basic idea in this model is that science proceeds by taking two steps. First is the speculative step of proposing a hypothesis. Second is the logical step of testing this hypothesis to see whether its predictions hold up. Science builds knowledge, on this account, by systematically testing hypotheses and eliminating those that are found to be false.

A classic type of quantitative method that aligns with this vision of science is the *randomized controlled trial* (RCT) which, in a simplified way, consists of comparing two or more groups, whose members were randomly assigned to each group. The primary goal is to test the hypothesis that some type of *treatment* (for example, a teaching method or a pedagogical intervention) implemented in one of the groups promotes a statistically significant difference in some characteristics in the group that received this treatment (experimental group) compared to the one that did not (control group). This characteristic is expressed by a relevant dependent variable. This type of research design is very common in the field of health sciences, in which the meaning of *treatment* is more literal, but it has also been widely adopted in educational research [20].

It is generally highlighted by social science researchers that RCT is aligned in its basic principles with logical positivism (see Sec. II B), but this may be a hasty statement and does not take into account how social science researchers who adopt this method actually implement it [21]. The fact that its basic hypothetical-deductive principle aligns with logical positivism does not disqualify it as a method and should not be understood here as a criticism. We just highlight how the history of methods like this brings echoes of the philosophical currents that influenced its genesis. This observation should also be understood carefully in the sense that it does not state that researchers who use RCTs in their research are automatically positivists or sympathetic to logical positivism. We recognize that RCTs are powerful and have been successfully used in educational research. In fact, Connolly, Keenan, and Urbanska [22] show that RCTs are not only being implemented more and more (and successfully) in educational research but it is also possible to counter the criticisms that are usually made against their use in this research area. According to the authors, the main criticisms are (i) RCTs are research projects that ignore context and experience; (ii) RCTs tend to generate simplistic universal laws of "cause and effect," and (iii) they are inherently descriptive and contribute little to theory. In particular, to address criticism (i), the typical complex context of educational environments can be taken into account when the RCT is articulated with a mixed methods framework—in which its results can be dialogically and organically articulated with qualitative methods by means of a completely integrated design, in which the methods are consistently combined throughout the research, producing rich and well-founded results (see Ref. [23], Table III). This research paradigm can help to bridge the apparent gap between quantitative and qualitative perspectives. We agree with this stance, but we will not discuss mixed methods here due to space constraints.

However, we are critical with respect to the idea that RCTs should be characterized as the *gold standard* in educational research (this indeed is a positivist legacy). This can convey an overly idealized perspective of this method, which should be critically considered [24,25]. In addition, logical positivists embrace the idea of a *neutral researcher*, a *tabula rasa*, an equally idealized view that must also be critically addressed—one of the first idealizations to be problematized in discourse analysis theory is precisely the idea of the *neutral subject*. There is no neutral researcher, which in no way means that this researcher cannot conduct reliable research through RCTs. It is, among other things, recognizing this limitation that the researcher becomes proficient in successfully conducting research in diverse methods. We will briefly discuss this point later.

In the next sections, we will detail the underlying view of science in this apparent dichotomy between qualitative and quantitative.

B. Logical positivism

The perspective that scientific research builds knowledge through hypotheses testing, following a hypothetico-deductive logic, largely derives from a view of science and scientific knowledge that approaches the *logical positivism of the Vienna Circle*, a group formed in the early 20th century and comprising philosophers and scientists (from the natural and social sciences and mathematics) among its members. The term *logical positivism* was coined to assert the idea that they agreed with Auguste Comte's positivist philosophy, but this should be articulated with scientific research through formal logic, resolving the dispute between the idea that the basis of knowledge would be

experience (for empiricists like John Locke) or reason (as believed by rationalists like René Descartes). In this way, such a disagreement would be resolved, *because logical positivism defined the roles in science for both experience (in the form of measurements) and reason (in the form of logic)* [19] (p. 21).

At its peak, this movement was ambitious enough to sanction the idea of Unified Science, proposed by one of its most prominent leaders, Otto Neurath. Neurath believed that the sciences should work together, in an articulated way. They should be interconnected through a common structure, a broader physics, through a set of laws that express spatiotemporal relationships between them. Neurath called this *Physicalism*, which consists of a language through which all statements from the most diverse areas of science could be conceived. According to Reisch [26] (p. 157):

> Since the sciences would be linked together by utilizing a common language, a 'physicalist' language, they would each gain a certain continuity with physics. As everyday language, purged of metaphysical, unempirical terms, this language was not that of physics itself. But, since all physicalist statements would 'contain references to the spatio-temporal order, the order that we know from physics they would be transformable into, or replaceable with, the language of physics.

Neurath and the Vienna Circle believed that it would be necessary for the suppression of metaphysics from language to give higher status to statements that could be confronted with empirical and rational procedures. For example, the statement *Jupiter is larger than Earth* can be empirically tested and refuted if it were false. However, the statement *Jupiter's upper clouds are beautiful and colorful like a Van Gogh painting* does not have scientific meaning, it is full of metaphysics—this statement conveys aesthetic sense, value judgment, and other details that are generally assumed to be subjective and transcend direct experience and cannot be directly confronted with empirical and rational procedures to be validated. In other words, this latter statement would be nonscientific. However, this same statement can be reformulated in order to achieve scientific status, that is, to acquire meaning for scientific research: *Jupiter's upper clouds intersect forming a pattern similar to Van Gogh's typical brushstrokes*. In this case, metaphysics has been (at least supposedly) "eliminated" from the statement, and it can be subjected to empirical and rational processes to be refuted or not. This statement is what Neurath called a *protocol sentence*, a short and precise linguistic representation of what is observed at the moment. We stress that, while it may be true that this sentence does not contain *explicit* metaphysical concepts, it is possible that the sentence still carries *implicit* metaphysical assumptions. For example, the use of the term *pattern* may imply a certain metaphysical view of the nature of reality, such as the belief that reality is composed of discernible patterns or structures. Similarly, the reference to Van Gogh's *brushstrokes* may imply a belief in the existence of beauty and aesthetics, which are subjective and cultural concepts that may be considered metaphysical.

Therefore, in the attempt to unify the sciences around a common language, the elimination of metaphysics was a central aspect.

It is not an exaggeration to say that logical positivists were inspired by physics and its technical and methodological procedures, trying to extend them in order to interconnect all sciences. Auguste Comte had already proposed a *social physics* theory in 1856, in order to *include social science in the scientific hierarchy* [27] (p. 434). The main idea would be to describe society and complex social processes in terms of procedures similar to those that physics adopts to explain the natural world. Logical positivists agreed with Comte and one way to materialize this ambitious enterprise would be through the unification of sciences. However, it is necessary to emphasize that Neurath defended a plural science, not the idea of a superior science that governed the others. What he defended was the establishment of connections between the different sciences through a common language, maintaining the unique characteristics of each one [28].

Though Comte intended to unify the sciences, including the social sciences, by defining sets of concepts that could be expressed quantitatively (as in physics), logical positivists did not necessarily limit scientific research to quantitative approaches. The most important thing for them is that the research be objective, free of metaphysics, and free from any particular worldview. While there is no commitment to quantification, it is clear that quantification and measurement of variables are a good way to align this type of research with logical positivism (e.g., these measurements can be shared publicly so that other researchers can verify them, statistical procedures can be employed to make inferences and/or validate a study's results, among other things). Quantitative approaches to scientific research can, however, be framed within the positivist framework. Therefore, the dispute is not necessarily about the quantification or nonquantification of data, but rather about how these data will be analyzed and interpreted epistemologically.

C. Texts and/or speeches: The most classic form of qualitative data

Although scientific research involving RCT as a core method approaches the Vienna Circle's view of science, this does not imply that it is the sole valid research possibility. There are many research situations where RCT (or anything similar) would be insufficient or improper—it all depends on the research challenge. As previously stated, modern statistical methods can be

articulated with qualitative approaches, in a broader perspective known as mixed methods.

The aims of quantitative and qualitative views of scientific study may be very different, which leads to the following consideration: is the comparison provided in Table I not overly simplistic? The answer is yes. A more detailed comparison table may be found in Ref. [23] (p. 126). However, no matter how large and effective the attempts to describe the differences and approximations between quantitative and qualitative research views are, it is a difficult process. According to Aspers and Corte [29], there are numerous ideas for definitions of qualitative research, indicating a possible conciliation between the two views (p. 139):

> We define qualitative research as an iterative process in which improved understanding to the scientific community is achieved by making new significant distinctions resulting from getting closer to the phenomenon studied. This formulation is developed as a tool to help improve research designs while stressing that a qualitative dimension is present in quantitative work as well. Additionally, it can facilitate teaching, communication between researchers, diminish the gap between qualitative and quantitative researchers, help to address critiques of qualitative methods, and be used as a standard of evaluation of qualitative research.

Ten Have [30] proposes a more extensive description, emphasizing that the qualitative approach has the duty of investigating complexity typical of social environments, precisely where educational processes are embedded. According to the author (p. 5), the most important aspect of qualitative research is

> The crucial feature of qualitative research, then, is to 'work up' one's research materials, to search for hidden meanings, nonobvious features, multiple interpretations, implied connotations, unheard voices. While quantitative research is focused on summary characterizations and statistical explanations, qualitative research offers complex descriptions and tries to explicate webs of meaning.

Some features of qualitative research are more or less consensual, regardless of the criteria used. For example, it is well recognized that the most typical method is through *interviews*, which can be open or more constrained [30]. There are other approaches in qualitative research, although the data are mostly focused on vocal language in the form of texts or speeches. Students' and teachers' utterances, text from books or similar sources, educational videos, and other teaching resources are used to mediate interactions between the players in educational environments.

The term text is commonly employed in the sociocultural paradigm that underpins this study to identify any type of speech, whether oral or written [31,32]. Learning about science, according to Lemke [31] (p. 1), includes learning to *talk about science*, that is, learning to utilize its specialized language in reading and writing, reasoning (which is basically a linguistic process) in problem-solving situations, laboratory activities, and daily life. Talking about science, according to the author, means (p. 1)

> […] observing, describing, comparing, classifying, analyzing, discussing, hypothesizing, theorizing, questioning, challenging, arguing, designing experiments, following procedures, judging, evaluating, deciding, concluding, generalizing, reporting, writing, lecturing, and teaching in and through the language of science.

Wertsch [32] (pp. 14–29) adopts this broader concept of text as a discursive embodiment as well but suggests something even more expansive. These texts serve as a conduit for what he refers to as *collective memory* or, more properly, *collective remembering*. Remembering is not a solitary individual's action, but rather an action mediated by socially shared text resources. These semiotic resources may exist within a larger temporal and/or spatial context. That is why the phrase *collective remembering* is employed, emphasizing that this *remembering* is *distributed* rather than located in or entirely owned by a single person and that this process of sharing is mediated through texts. In other words, Wertsch sees collective remembering, as a socially shared broad discursive production context in which participants interact discursively through various texts that may be immersed in a more restricted historical-cultural space-time (for example, a specific didactic context) or a broader one (not restricted to a specific location and covering a long period of time). Whether the sociocultural and historical context is more restricted or larger—depending on the nature of the research questions—the sociocultural and historical context is constitutively incorporated in data analysis in this research perspective.

From a sociocultural standpoint, particularly in Vygotsky and Wertsch's theory, verbal language is the primary form of semiotic mediation, and, assuming that meanings are socially constructed and manifested primarily in discourse interactions [31,33], the analysis of didactic activities is based on textual data—utterances made by students and teachers in their discourse interactions, written texts, and others. The utterances are analyzed moment by moment [34,35], with specific emphasis paid to the discourse strategies people employ to share meanings, grasp concepts, or transmit their own interpretation to others. As a result, under the sociocultural framework, it is customary (and consistent) to place a greater emphasis on the *processual study* of group interactions (particularly discourse interactions) rather than on initial and final

educational achievement (for example, outcomes of pre- and post-tests, widely used in RCTs studies in educational contexts).

Although these premises do not exclude the importance of educational outcomes provided by pretests, post-tests, or similar supplementary data, these outcomes do not effectively capture the discursive learning strategies that occur during teaching interventions that prioritize collaborative work among peers. According to Ref. [36], we presume that learning emerges predominantly as (p. 136)

> […] the coconstruction (or reconstruction) of social meanings from within the parameters of emergent, socially negotiated, and discursive activity.

Consistent with this viewpoint, students' speech is frequently the primary source of data to be evaluated, necessitating a qualitative research approach. In recent years, there has been an increase in the number of studies that address the fundamental role of semiotics (not just verbal language) in learning in the field of physics education [37–41].

As a result, under the sociocultural framework, the text—here defined as oral or written communication—is regarded as the primary form of mediation between actors in educational contexts (and also in others). This explains why qualitative research is preferred in this approach. But how is the text viewed inside this framework? To answer this question, we will compare and contrast two schools of thought on acts of speech: french discourse analysis, by Michel Pêcheux and Bakhtinian analysis, by Mikhail Bakhtin. The goal is to situate these two analyses in relation to more positivist-influenced approaches, such as classical formulations of grounded theory and content analysis.

D. Understanding textual data through the conduit metaphor

The conduit metaphor considers language to be a conduit (or conductor) and words to be containers, implying that language is just a physical conduit (communication channel) of ideas, which are held within words. These concepts would be analogous to real objects passed from one person to another via language [19] (p. 54). In other words, meaning is objectively stored within words, the basic containers that contain all information—the text is objectified, just like a physical object. Thus, communication is defined as the transmission of information between individuals who play the roles of the *speaker*, who speaks and inserts their meanings into the words, and the *listener*, who decodes the sent information and interprets the meanings included in the message. This understanding of textual communication (recalling that text is considered discourse) simply ignores any form of interaction between the speaker and the listener in the production of discourse. In other words, the production of speech is not collaborative, but rather divided into distinct roles of speaker and listener.

Furthermore, speaking individuals are considered unique, independent beings, each playing a role in the communicative process—one is the transmitter, the other the receiver. As a result, the speaker's utterances are self-sufficient, because the listener does not participate in this discursive construction. Any communication failures will be attributed to subjective errors. In this scenario, either the speaker did not know how to use the appropriate words to express their desires or the listener misread those meanings [19] (p. 54). Reddy [42] made the original suggestion for this idea in 1979, which included the following (p. 170):

> (1) language functions like a conduit, transferring thoughts bodily from one person to another; (2) in writing and speaking, people insert their thoughts or feelings in the words; (3) words accomplish the transfer by containing the thoughts or feelings and conveying them to others; and (4) in listening or reading, people extract the thoughts and feelings once again from the words.

When viewed in this mechanical and objective way, this metaphor unquestionably conforms with the core ideas of logical positivism.

III. DISCURSIVE DATA AND RELATED ANALYTICAL METHODS

A. Grounded theory, content analysis, and their positivist orientation

Grounded theory and content analysis are two research methods that are commonly used in the field of text analysis, particularly in the social sciences. Both methods involve the systematic analysis of texts, such as documents, transcripts, or other written materials, in order to identify patterns, themes, and relationships that can help to explain a particular phenomenon or question. It is a qualitative research method that was developed by sociologists Glaser and Strauss [43] in 1967. It is based on the idea that theory should be developed *inductively from data*, rather than *being imposed on the data* by a researcher. In grounded theory, researchers collect and analyze data in an iterative process, continually refining and revising their theories as they go. One key feature of grounded theory is its focus on *developing theories that are grounded in the data*, rather than *relying on preconceived notions or assumptions*. This means that researchers using this method are open to finding patterns and themes that may not have been anticipated at the outset of the study. This positivist orientation, as well as the assumption in the existence of such *neutral researcher*, has been criticized throughout the years (for example, as in Ref. [44]). Because the classical formulation of grounded theory includes the underlying

assumption of a neutral researcher, it has been subjected to problematizations, resulting in proposals for modification that sought to address this controversy, an endeavor in part initiated by Strauss himself in collaboration with Corbin—albeit with linguistic oscillations between positivism and constructionism [45] (p. 28). These problems were addressed by Kathy Charmaz, a Strauss and Glaser student, who proposed the *constructionist grounded theory* as an extension of traditional grounded theory [46,47].

In contrast, content analysis is a process that involves the systematic and objective study of texts in order to identify and classify their content. It is frequently used to find patterns and themes in huge volumes of text, and it may be used to acquire information like the frequency of specific words or themes, the sentiment conveyed in the text, or the links between distinct pieces of text. Unlike grounded theory, which seeks to construct a theory of a social phenomenon from facts, content analysis seeks to systematically *identify the meaning* of a selected textual material considered relevant by the researcher. Instead of connecting these categories to develop a theory, the content analysis focuses on *identifying them* in data [48]. Content analysis, like grounded theory, may be remodeled by questioning the premise that categories develop essentially autonomously from data. The function of the researcher is crucial, according to Braun and Clarke [49,50], who bring this issue to thematic analysis. This has the potential to pave the way for a more reflective version of content analysis. A proposal for combining discourse analysis and a modified form of content analysis is also suggested [51].

Both grounded theory and content analysis have positivist orientations [44,52], meaning that they are based on the assumption that there is an objective reality that can be studied and understood through systematic and empirical investigation (among other things)—is a common claim of both methods the statement *categories emerge from data*. These methods are intended to be objective and reproducible, and they rely on statistical analysis and rigorous coding systems to find patterns and themes in the data. Although these approaches are not strictly committed to the conduit metaphor, certain components may be observed in it: the speaker (emitter) conveys meanings that are independent of the listener (researcher, receptor), who is only considered as the one who will expose these meanings, which may be *discovered* by dissecting the text into categories that *emerge* from it, linking them at the conclusion of the process. This worldview is heavily influenced by logical positivism.

B. Brief comparison: French discourse analysis and Bakhtinian analysis

Discourse analysis is an approach to understanding language and communication that goes beyond traditional positivist research methods like grounded theory and content analysis. It focuses on *how texts and language produce meaning*, rather than simply conveying objective information. The French school of discourse analysis, founded by Michel Pêcheux, and the Bakhtinian school, inspired by Mikhail Bakhtin and the Bakhtin Circle, are two major approaches to discourse analysis. These approaches differ in their views on the role of language and communication in society.

Pêcheux, who is influenced by orthodox Marxist theory, considers language and communication to be more than merely the flow of knowledge between individuals. He defines discourse as the construction of meaning through interactions between persons that are impacted by their social roles and power dynamics [53] (p. 84, 85). Pêcheux proposes the notion of *imaginary formations* [53] (p. 85) to characterize the mental representations that persons have of each other and themselves throughout these interactions, which affect the meanings created in conversation.

Pêcheux considers that the *subject form* is not the owner of their speech since he is *ideologically interpellated*. The subject form is not the concrete subject, but the form of subjection that an individual takes in the incorporation (or emulation of this incorporation) of interdiscourse components in intradiscourse [54] (p. 117). This subject form is defined primarily by ideological interpellation, a key concept in Pêcheux theory that can be defined as a process by which individuals are addressed by specific ideologies, whose responses become a part of their identity—this concept is proposed by Pêcheux revisiting Foucault's idea of *discursive formation* [55] (p. 38) and Althusser's notion of ideology, which, according to him *interpellates individuals as subjects* [54] (p. 101). Pêcheux connects these two concepts in order to link ideology to the discourse itself. This process is facilitated through language and discourse and works to naturalize and normalize certain ways of thinking and acting. Pêcheux's theory has significant implications for how we understand the exercise of power in society and highlights the importance of language and discourse in shaping our thoughts and behaviors. Ideological interpellation is an instance of *structural determinism*, which is the belief that language or another abstract system controls the behavior of those who are subjected to it. Certainly, Bakhtin does not support this or any other sort of determinism in his theory.

Bakhtin, as we will see in further detail in Sec. III C, has a totally different perspective on language. Language, he believes, is a social phenomenon molded by the environment in which it is employed as well as interactions between speakers. He stresses the function of *dialogism* in producing meaning or the ways in which language is affected by the presence of other voices and viewpoints. Bakhtin also introduces the notion of *utterance*, which relates to how language is employed to express meaning in various settings. Unlike Pêcheux's subject form, the subject for Bakhtin is the concrete being. Furthermore, the Bakhtinian subject cannot be completely dominated by

ideology (Bakhtin sees ideology in a completely different way).

Both the French and Bakhtinian approaches to discourse analysis reject the idea that language and texts have a single, objective meaning, and instead focus on the ways in which language produces meaning in social and cultural contexts. They offer important tools for understanding language and communication in a broader, more nuanced way.

Overall, both Bakhtin and Pêcheux acknowledge the importance of ideological interpretation in shaping how we understand and produce discourse, but they understand ideology in completely different ways. While their approaches differ in their emphasis and focus, they both emphasize the importance of analyzing the social and cultural contexts in which language is used, as well as the ways in which it is used to convey meaning and shape our understanding of the world. Both Pêcheux and Bakhtin reject the positivist view of communication.

Pêcheux's discourse theory is also concerned with the social context in which language is used, but he emphasizes the role of ideology in shaping the meaning of language. Pêcheux believes that language is used to reinforce and reproduce a society's *dominant ideologies*, as well as to maintain existing power structures and social hierarchies—is indeed an *althusserian* Marxist-driven theory, embracing a type of structural determinism. Bakhtin sees ideology differently and rejects any sort of determinism, embracing a *pseudo-free* subject that is not ideologically interpellated, but he is also not completely free to be the strict owner of his speech—his utterances are influenced by social and historical context and are always dialogical to other utterances (in texts, speeches, or other forms of discourse).

C. Bakhtinian analysis

The Bakhtin Circle was a Russian school of thought focused on the work of Mikhail Mikhailovich Bakhtin, whose primary members were Matvei Isaevich Kagan (1889–1937); Pavel Nikolaevich Medvedev (1891–1938); Lev Vasilievich Pumpianskii (1891–1940); Ivan Ivanovich Sollertinskii (1902–1944); Valentin Nikolaevich Voloshinov (1895–1936), among others. According to Bakhtin, the subject's thought is socioideological [56] (p. 13):

> Consciousness takes shape and being in the material of signs created by an organized group in the process of its social intercourse. The individual consciousness is nurtured on signs; it derives its growth from them; it reflects their logic and laws. The logic of consciousness is the logic of ideological communication, of the semiotic interaction of a social group. If we deprive consciousness of its semiotic, ideological content, it would have absolutely nothing left. Consciousness can harbor only in the image, the word, the meaningful gesture, and so forth. Outside such material, there remains the sheer physiological act unilluminated by consciousness, i.e., without having light shed on it, without having meaning given to it, by signs.

This socioideological person is not led by the unconscious. According to Pêcheux, as previously said, the subject is motivated by ideology and does not own what they say, even if they are unconscious of it. According to Bakhtin, as will be explained later, the act of speech, or enunciation, does not have a purely individual nature and cannot be explained solely by the psychophysiological conditions of the speaking subject. It is also not susceptible to abstract laws of language, implying that it is not objectively governed by abstract standards of the external world. The production of utterances has a social origin. As a result, the Bakhtinian subject is a real individual, quite distinct from Pêcheux's subject form.

There is also the importance of the sign in Bakhtin's theory. The sign's fundamental function is to describe and explain the world (*signify*), but it also allows for other understandings and perspectives to be raised about it (*resignify*) depending on societal values (ideological). Bakhtin refers to the initial process of signifying the world as *reflect* and the second process of resignifying as *refract* [56] (p. 10):

> Signs also are particular, material things; and, as we have seen, any item of nature, technology, or consumption can become a sign, acquiring in the process a meaning that goes beyond its given particularity. A sign does not simply exist as a part of a reality—it reflects and refracts another reality. Therefore, it may distort that reality or be true to it, or may perceive it from a special point of view, and so forth. Every sign is subject to the criteria of ideological evaluation (i.e., whether it is true, false, correct, fair, good, etc.). The domain of ideology coincides with the domain of signs. They equate with one another. Wherever a sign is present, ideology is present, too. Everything ideological possesses semiotic value.

The sign is therefore socioideological (full of social values) in nature, arising from a given consensus among members of a certain social group, and it originates in the interindividual domain. For a sign to become part of a group's everyday existence, it must gain common meaning; that is, it is not individual will that determines the assimilation of this sign into the group's social horizon (space time of enunciation). According to Bakhtin (p. 22):

> In order for any item, from whatever domain of reality it may come, to enter the social purview of the group and elicit ideological semiotic reaction,

> it must be associated with the vital socioeconomic prerequisites of the particular group's existence; it must somehow, even if only obliquely, make contact with the bases of the group's material life.

In other words, Bakhtin contends that ideology can only take shape and establish itself in society if it has social value (p. 22). As a result, for Bakhtin, sign and ideology are on the same level. However, in their work, Bakhtin and his Circle's understanding of ideology is rather vague. According to Gardiner [57], who did an extensive theoretical investigation on this topic, Bakhtin distances himself from orthodox Marxism in his treatment of ideology (p. 7):

> Rather than interpreting ideology in the usual ways (as a form of "false consciousness," or as a coherent 'belief system'), Bakhtin views ideology as the essential symbolic medium through which all social relations are necessarily constituted. Thus, like Althusser and Gramsci, Bakhtin conceives of ideology not as epiphenomena, or as a distorted representation of the 'real', but as a material force in its own right.

Although not explicitly stated, Bakhtin rejects some orthodox Marxist concepts such as false consciousness (see Ref. [58]). He also rejects the notion of ideology as an *epiphenomenon*, believing that it is organically articulated with social change. Other concepts, such as *class struggle*, are not denied by Bakhtin. Language signification processes, according to Bakhtin, do not occur in a neutral space, but rather reflect social tensions. These sorts of tension processes around meaning cannot be addressed only by linguistics, but rather by a more complete form of theory that takes into consideration the links of language with the social, economic, and political context. This was one of the Circle's aims.

Bakhtin and his group rejected psychological dimensions for ideology, viewing it as an irreducibly social phenomenon. Although they borrowed parts of the terminology of more orthodox Marxism, they diverged from it when developing other concepts. One of these distancing ideas is that the sign *reflects* and *refracts* a specific external reality, despite the fact that traditional Marxism simply suggested the process of *reflection* of such reality [57]. Gardiner advances and demonstrates that members of the Bakhtin Circle conceived of an ideology that was compatible with the concept of a *dialogical subject*, because (p. 13)

> […] ideology basically refers to the process whereby meaning or "value" is conferred on the natural and social worlds. Ideologies are also "material," not only because all possible forms of human action and cognition are embodied in some kind of semiotic sign (e.g., words, gestures, facial expressions, and so on), but because such signs elicit real effects in society. Insofar as ideology is grounded in a myriad of social and cultural practices, it is not epiphenomenal or merely ideational but "an objective fact and a tremendous social force."

The concept of the dialogical subject is important to Bakhtin's theory. A Bakhtinian subject is constituted by the other, the sociocultural environment in which he exists. This concept is defined through the concept of socio-ideological symbols. According to Bakhtin [56] (p. 86), the word is a *two-sided* act that is established in the reciprocal interaction between speaker and listener:

> Orientation of the word toward the addressee has an extremely high significance. In point of fact, word is a two-sided act. It is determined equally by whose word it is and for whom it is meant. As word, it is precisely the product of the reciprocal relationship between speaker and listener, addresser and adressee. Each and every word expresses the "one" in relation to the "other." I give myself verbal shape from another's point of view, ultimately, from the point of view of the community to which I belong. A word is a bridge thrown between myself and another. If one end of the bridge depends on me, then the other depends on my addressee. A word is territory shared by both addresser and addressee, by the speaker and his interlocutor.

Even "isolated" beings' utterances are responses to something that has already been uttered, already said; any utterance, even our thoughts, is filled with dialogic overtones [15] (p. 92):

> After all, our thought itself—philosophical, scientific, and artistic—is born and shaped in the process of interaction and struggle with others' thought, and this cannot but be reflected in the forms that verbally express our thought as well.

The concept of the dialogical subject is also one of the pillars of the sociocultural perspective of learning, with direct implications in education [59–61].

After we have grasped the fundamentals of the subject in Bakhtin, we will concentrate on how he defined the object of study of language. Bakhtin begins his argument by acknowledging that this task is not trivial, and then builds the argument gradually, beginning with language in its physical, physiological, and psychological reality [56] (p. 46):

> With each attempt to delimit the object of investigation, to reduce it to a compact subject-matter complex of definitive and inspectable dimensions, we forfeit the very essence of the thing we are studying—its semiotic and ideological

> nature. If we isolate sound as a purely acoustic phenomenon, we will not have language as our specific object. Sound pertains wholly to the competence of physics. If we add the physiological process of sound production and the process of sound reception, we still come no closer to our object. If we join onto this the experience (inner signs) of the speaker and listener, we obtain two psychophysical processes, taking place in two different psycho-physiological beings, and one physical sound complex whose natural manifestation is governed by the laws of physics.

Bakhtin believes that in order to understand the phenomenon of language, it must be placed in a social context. As a result, Bakhtin's theory is classified as sociolinguistics. This complicates the problem, and it is necessary to assume that the speaker and listener must be members of the same linguistic community (organized society) and must be integrated into the uniqueness of the immediate social situation, i.e., they must share a certain social horizon. Without these conditions, the aforementioned physical-psychological-physiological process cannot be linked to language, to speech, and thus cannot become a linguistic event. Two biological organisms placed in their natural environment will not always produce a speech act [56].

Bakhtin proposes confronting two schools of thought in the idea of limiting language as an object of study, which he terms *abstract objectivism* (represented by Ferdinand de Saussure) and *individualistic subjectivism* (represented by Wilhelm Humboldt, Karl Vossler, and Benedetto Croce). The linguistic system (phonetic, grammatical, and lexical forms of language) is the central axis in the first school of thought, abstract objectivism, which coordinates and organizes all facts of language and makes it the object of study of a well-defined science—its main articulator is Saussure, a swiss linguist, who made the distinction between the language (*langue*), the linguistic system (social creation, as a norm), and speech (*parole*), the concrete act and the manifestation of speech (individual nature, but not free) [62,63]. Saussure argued that linguistics should focus on language rather than speech [63] (pp. 7–17). For him, although language is a *stable set of grammatical norms* shared (and utilized) by members of the same community or society and therefore might be the *object of linguistics*, speech is an individual and creative activity—whereas language is socially established, speech has creative freedom, is chaotic, and inappropriate as an *object of linguistics*. Saussure basically said that [63] (p. 14):

> In separating language from speaking, we are at the same time separating: (1) what is social from what is individual; and (2) what is essential from what is accessory and more or less accidental.

When enunciation acts are examined in the context of a specific group of speakers, Saussure recognizes that various regularities and similarities can be found. These identical traits, according to him, are normative for all utterances—they are phonetic, grammatical, and lexical traits. In other words, they ensure that a given language is unique and that all speakers in the same community understand it. He believes that the act of speech is not possible without the normative rules, proposing a *chess analogy*, in which the rules of the game are for *language*, just as the specific movements executed by each player are for *speech*.

Thus, the fundamental focus of linguistic inquiry must be this abstract, objective, and stable (immutable) system of norms—the linguistic system in question is deemed immutable, predetermined, language is understood as a system whose structure obeys precise laws that do not depend on individual consciousness. The individual finds the linguistic system, and a speech act only becomes a linguistic act when it is articulated to an immutable, preexisting linguistic system at some time in history. This excludes linguistic variants from the scope of research of its linguistic proposition. In this case, the linguistic criterion is analogous to a binary *right or wrong* criterion. There is no room for linguistic taste—no *better or worse*, *uglier or more beautiful*, or other subjective and appreciative criteria. The single criterion is normative—linguistic taste is rejected in favor of linguistic truth. It is easy to see how abstract objectivism corresponds with some logical positivism concepts. In reality, language exists only in the speaker's subjective consciousness as an objective system of inviolable and normative forms. This is one of the most serious flaws of abstract objectivism, according to Bakhtin [56], the separation of language and its ideological content.

For example, value (axiological position) is a factor heavily impacted by the ideology that is completely ignored in abstract objectivism. Furthermore, the language system, the major axis of abstract objectivism, is not directly available to the consciousness of the speaking subject—it is through verbal communication that the subject defines and positions itself. In other words, abstract objectivism, among other issues, fails to connect the presence of language in its abstract dimension (*synchronic* perspective) with its historical evolution (*diachronic* perspective). While language is thought to exist as a system of forms conditioned by norms for the speaker's consciousness, it is only for the historian that it exists as an evolutionary process. It creates a void that *excludes any possibility for the speaker's consciousness to be actively in touch with the process of historical evolution* [56] (p. 81).

Individualistic subjectivism, the second school of thought, is based on an emerging idea at the end of the 19th century—the linguistic phenomenon is conceived as a purely individual act, similar to artistic creation. The Vossler School strongly opposes linguistic positivism; in 1904, he published *Positivismus und Idealismus in der*

Sprachwissenschaft (*Positivism and Idealism in Linguistics*), a book criticizing linguistic positivism. *Linguistic taste*, which Bakhtin refers to as a *special variety of artistic taste* [56] (p. 50), is the main driving force of creation in this perspective. As a result, Vossler's approach to language is fundamentally aesthetic. Stable grammatical forms are irrelevant in any act of speech; what matters is the *stylistic concretization and modification of these abstract forms, which individualize and uniquely characterize any given utterance* (p. 51). This process is unique to each particular utterance.

Vossler's opinions are extremely similar to those of Benedetto Croce. Croce also considers language to be an aesthetic phenomenon, with the word *expression* serving as the fundamental keyword in his understanding of language. In essence, all expressions are creative in nature. It is important to emphasize the meanings of the Greek word *ενέργεια* (*energeia*), which characterize the creative process—expressing language as a constant individual creation and conveying a sense of constant creative activity. Aristotle coined this concept, which is difficult to translate [64]—it is the word that gives rise to the term *energy*. On the other hand, the term *έργον* (*ergon*) is used to describe language as a finished product (referred to as an *inert deposit*), ready to be freely employed as raw material for speech, a free and creative process of an individual nature. The most literal translation of *έργον* is *work*.

The most basic and elementary definition of expression, according to Bakhtin [56] (p. 84), is *something which, having in some way taken shape and definition in the psyche of an individual, is outwardly objectified for others with the help of external signs of some kind*. Expression should thus take into consideration the content (interior) as well as its exterior objectification for others (or for oneself). Individualistic subjectivism, as the name implies, is an idealistic worldview, in *which everything of real importance lies within; the outer element can take on real importance only by becoming a vessel for the inner* (p. 84). The expressive act moves between these two "worlds." The theory of expression must accept that the content to be expressed can exist outside of expression, that it begins in one form and then moves to another. In other words, expression entails taking something preexistent (internal) and expressing it to someone by externalizing it through signs (for example, words) and changing its form. As a result, the expression theory posits a dualism between the internal and the external. There is an obvious priority of internal content—every act of objectification (expression) starts from within and is directed outward. In this sense, the external serves as a passive medium through which the interior origin materializes. In other words, it is merely a medium that passively transmits a translation of the expression produced therein.

Bakhtin criticizes both schools of thought by accusing them of having *proton pseudos* (false premises), taking into account both thesis and antithesis and attempting a dialectical synthesis (seeking a conception that goes beyond, rejecting thesis and antithesis). By asserting that the abstract linguistic system can account for language facts on its own, abstract objectivism rejects enunciation, and speech acts as solely individual events. Individualistic subjectivism goes the other way, ignoring the abstract linguistic system, language, and focusing just on speech, which it defends as a wholly individual act. Both are denied by Bakhtin, who asserts that the speaking act, enunciation, cannot be simply individual; both are social in nature. Furthermore, unlike abstract objectivism advocates, speech acts and enunciation are not rigorously linked to an abstract set of linguistic norms.

As a consequence, the Bakhtinian subject is not a prisoner of linguistic norms, with flexibility and room for unique creativity (subjectivity in enunciation), but this creative freedom has constraints within the sociocultural environment in which this subject is situated. In this way, Bakhtin does not agree with the concept of ideological interpellation, because the speaking subject might be the author of their speech, albeit with limited flexibility, because their speech always interacts with other discourses—the subject is never the only source of an utterance; the act of speech is always dialogical.

D. Subjectivity and some extralinguistic considerations

Two issues must be addressed: (i) the subject in Bakhtin's theory is a subjective subject despite the fact that they are not a prisoner to an external sociolinguistic structure that determines their speech; and (ii) being a subjective subject implies diversity of discourse, but diversity does not imply chaos or something completely indeterminate. In educational settings, for example, students are encouraged to use diverse discursive strategies among themselves in order to grasp and convey scientific topics. Furthermore, the same student may use distinct discursive forms in different situations. This happens because each being is culturally and historically unique, and each circumstance in which there is dialogue is likewise unique. Gee [65], an author who uses Bakhtin's theory in his writings, believes that an utterance has meaning when it conveys a *who* and a *what* (p. 22).

> What I mean by a "who" is a socially situated identity, the "kind of person" one is seeking to be and enact here-and now. What I mean by a "what" is a socially situated activity that the utterance helps to constitute.

The author defines *socially situated identity* or simply *situated identity*, which emphasizes the idea of inherent subjectivity of the subject in discursive production (p. 34).

> Some people dislike the term "situated identity" and prefer, instead, something like "(social)

> position" or "subjectivity" (they tend to reserve the term "identity" for a sense of self that is relatively continuous and "fixed" over time). I use the term "identity" (or, to be specific, "socially situated identity") for the multiple identities we take on in different practices and contexts and would use the term "core identity" for whatever continuous and relatively (but only relatively) "fixed" sense of self underlies our contextually shifting multiple identities.

These premises refer to the core notions of *social language* as well as another related concept known as *speech genres*. Bakhtin argues that in acts of speech, utterances are created in a way that is firmly tied to the social position of the speaking subject and cannot be divorced from their social origin. According to Bakhtin [66], these utterances can represent specific kinds of language, variants that can nearly be considered dialects. Social language may be regarded of as a (p. 356)

> […] system that defines a distinct identity for itself within the boundaries of a language that is unitary only in the abstract. Such a language system frequently does not admit a strict linguistic definition, but it is pregnant with possibilities for further dialectological individuation: it is a potential dialect, its embryo not yet fully formed. Language in its historical life, in its heteroglot development, is full of such potential dialects: they intersect one another in a multitude of ways; some fail to develop, some die off, but others blossom into authentic languages.

Thus, Bakhtin suggests a plausible link between discourse and the identity of the speaking subject (the *who*). At this point, it becomes evident why Bakhtin's theory is a sociolinguistics. Bakhtin [15] introduces the concept of speech genres, which can be interpreted as generally stable forms of discourse in each domain of human activity (p. 60):

> All the diverse areas of human activity involve the use of language. Quite understandably, the nature and forms of this use are just as diverse as are the areas of human activity. This, of course, in no way disaffirms the national unity of language. Language is realized in the form of individual concrete utterances (oral and written) by participants in the various areas of human activity. These utterances reflect the specific conditions and goals of each such area not only through their content (thematic) and linguistic style, that is, the selection of the lexical, phraseological, and grammatical resources of the language, but above all through their compositional structure. All three of these aspectsthematic content, style, and compositional structureare inseparably linked to the whole of the utterance and are equally determined by the specific nature of the particular sphere of communication. Each separate utterance is individual, of course, but each sphere in which language is used develops its own relatively stable types of these utterances. These we may call speech genres.

Bakhtin helps to detail the *who* in his definition of speech genre, tying it not only to social origins, but also to the domain of human activity in which the subject is inserted at the moment of the act of speech. Consider a scientist: he writes adopting a speech genre, closer to the so-called *scientific genre* (used in academic books, papers, and similar texts), but in everyday conversation, he may use a more unconstrained speech genre, depending on the context. This shift is not unintentional; it is part of the (extralinguistic) meaning of discourse. Speech genres are "selected" by speaking individuals based on the environment of discursive creation, although this "selection" is limited to the requirement of adopting a certain genre and which genre is socioculturally necessary for specific fields of human activity. As previously indicated, this illustrates the standard conflict between personal freedom and socioculturally established speech constraints. We emphasize Bakhtin's claim that speech genders are *relatively stable* (and not *strictly fixed* genres) categories of utterances. Subjects adopt specific genders depending on the activity in which they engage to create their utterances, but these genres are not strict paths to be rigorously followed (this could be classified as a kind of deterministic behavior.). As a result, it is not rare for these genders to be somewhat "subverted" at times. An example of this "subversion" can be found in Sec. V.

Bakhtin also helps to define the *what* by indicating aspects such as *thematic content*, *style*, and *compositional structure*, demonstrating what the individual wishes to speak about and how he addresses these subjects through language. All of these aspects are further influenced by their social origin, which is visible in the individual's social language.

Not only the Bakhtinian subject is intrinsically subjective but so is the researcher who analyzes their discourse (analyst). The analysis is also a discursive production, made material through action in the world, carrying social origin, values, expectations, and, most importantly, all the theoretical knowledge of the analyst that enables them to perceive linguistic and extralinguistic details in the analysis of this subject's discourse. In other words, the majority of meanings are produced in the interaction of the analyst with the discourse to be analyzed. This does not mean that any researcher is allowed to produce any imaginable outcome, resulting in naïve relativism.

Every analyst should be anchored in a strong theoretical framework, a set of academic knowledge that guides their analysis in interpreting the meanings that this knowledge allows them to identify in the subject's language and extralinguistic components of speech. Even if two analysts reach similar conclusions, their characteristics are distinct, as are their experiences in the world and their method of articulating and stressing portions of their own theoretical knowledge needed to complete each analysis. Because of this personal character, it is common for discourse analysis to be carried out by more than one individual—complementing and articulating more than one analysis produced by various analysts is a good practice.

It is critical to note that not only should subjectivities of subjects and analysts not be avoided in discourse analysis but they are also an important component of the study. Consideration of the subjectivity of the subject is essential in educational situations because it allows us to study the diversity of ways of thinking and acting of students and/or teachers in didactic contexts. Taking the analyst's subjectivity into account enables the articulation of diverse interpretations by different analysts, which enhances the results and provides a better knowledge of subtle aspects of discourse interactions and how different analysts signify and re-signify these discourses.

We have stressed our distance from logical positivism and methods of text or speech analysis that relegate subjectivity to the level of something always undesirable and that always contaminate results, reducing their reliability, for the mentioned reasons in this and prior sections. Subjectivity does not imply chaos or naive relativism in discourse analysis, especially Bakhtinian analysis; rather, it is an organic and inseparable aspect of the dialogical process of discursive production. The concept of subjectivity as a resource rather than a cause of difficulties is not new, nor is it exclusive to discourse analysis [67].

The philosophical foundations presented here are critical for understanding the Bakhtinian notions employed in discourse interaction studies. Excellent work published in this journal has already made use of Bakhtin's theory's key notions, yielding very fascinating conclusions on a variety of themes [68–71].

IV. BAKHTIN'S METALINGUISTIC

The purpose of this section is to present some of Bakhtin's main considerations on the nature of utterances and speech genres, a fundamental part of his concrete utterance theory [72]. It is necessary, at first, to differentiate the utterance, the analytical unit of Bakhtinian metalinguistics, from other linguistic structures, such as phrases, sentences, prayers, and even from the individual act of speech. The origin of the Bakhtin Circle's main criticism directed to abstract objectivism and individualistic subjectivism lies in this differentiation.

The Circle understands the sentence as a monological utterance, meaning it has no connection to the outside and lacks relational or dialogical character. Linguistics studies phrases by breaking them down into smaller units such as words and phonemes, which are taken from the actual functioning of language. And it is in this sense that the discussions taught by the Bakhtin Circle are different and opposed to linguistic studies, based on the concrete utterance and not the sentence, thus being considered a metalinguistic study. Bakhtin highlights that the philosophical analysis developed by the Circle *is not a linguistic, philological, literary, or any other special kind of analysis (study)* [15] (p. 103). Therefore, Bakhtinian metalinguistics should be treated as a broader analysis than traditional linguistics.

Still in the line of differentiating the sentence from the utterance, Bakhtin states that (p. 75)

> One does not exchange sentences any more than one exchanges words (in the strict linguistic sense) or phrases. One exchanges utterances that are constructed from language units: words, phrases, and sentences. And an utterance can be constructed both from one sentence and from one word, so to speak, from one speech unit (mainly a rejoinder in dialogue), but this does not transform a language unit into a unit of speech communication.

It is clear in this excerpt, therefore, that it is not the language units that define the utterances, despite being fundamental in their constitution. Utterances are social structures that only become effective in real communication between speakers. Whether oral or written, they can be a monosyllabic response in an informal conversation, a lecture, a poem, or a long novel. What characterizes the limits of the discursive unit, the utterance, is the concrete and singular speech of the speaker: the utterance begins when the speaker begins to speak and ends when he finishes speaking. Precisely because they take effect from the real communication between speakers is what we call *concrete utterance*.

To properly analyze an utterance, we need to have a clear comprehension of the social characteristics of the discursive community, including its beliefs, concepts, values, and ideological biases. This sociological conception of the concrete utterance being an act of the material reality of language organically constituted of a verbal part and an extraverbal part, which we can perceive as its distinction from monological utterances. In summary, every utterance consists of both a verbal part and an extraverbal part (or situation), which is integral to the utterance's semantic composition [56].

To perform a discursive analysis using Bakhtin's metalinguistic, it is necessary to take into account both the verbal aspect and the extraverbal context of utterance

production. That is important because the utterance is an organic and unique whole, and all the elements that compose it are inseparable. Although they can be analyzed separately as an exercise in abstraction, the constituent elements must be understood as an integral part of the utterance. The completeness of the utterance reflects not only the will of the individual who speaks but also the individual's relationship with the world. The discourse is directed both to life and to culture, to the subject, and to society (see Sec. III D).

Thus, the utterance is not only bifacial in the sense that it unites culture and life in a single act but it also has a dual nature as it is built in the articulation between the conditions and purposes of the field of action and the emotionally valued individual expression that relates the subject with the theme of his utterance and with his view of the utterances of others on the themes. In particular, on the relationship between the utterance and the field of human action, Bakhtin argues using the concept of *speech genres* (see Sec. III D), stating that *[…] each separate utterance is individual, of course, but each sphere in which language is used develops its own relatively stable types of these utterances*. In other words, an individual's freedom is first demonstrated through their *choice of the speech genre* in which they will express themselves. For example, no one is required to write a scientific article. However, once they have chosen to write a scientific article, their freedom becomes restricted as they must produce an utterance with characteristics that are more or less stable, determined by the rules of the journal or socially accepted by the scientific community.

After choosing the field of human action to communicate and the speech genre to be used, the speaker still has some margin of freedom to express his will. However, this freedom varies according to the speech genres used. For example, a novel book belongs to the literary genre in which the author has more freedom of expression than in a scientific article, which has more autonomy than in an official document. Thus, every discursive act or utterance is unique and singular, but it is always social since it is elaborated in a specific speech genre. It has elements that express the author's freedom and reflect the condition of the communication field in which it is produced.

Therefore, the production of an utterance is not a linear phenomenon. The concrete utterance is not addressed to any random person but to a certain interlocutor. It is addressed to someone: *An essential (constitutive) marker of the utterance is its quality of being directed to someone, its addressivity* [15] (p. 95). That is, understanding an utterance is not a passive process. Comprehension only happens when the interlocutor produces a response (he agrees, disagrees, etc.). When the speaker delivers his utterance, he always does so intentionally; the utterance is not a random product, but an action, an act, the fruit of the will. The speaker, therefore, structures his utterance aiming to produce a specific response in his concrete interlocutor, called the social orientation of the utterance. Bakhtin continues [56] (p. 69):

> Moreover, any speaker is himself a respondent to a greater or lesser degree. He is not, after all, the first speaker, the one who disturbs the eternal silence of the universe. And he presupposes not only the existence of the language system he is using, but also the existence of preceding utterances-his own and others' -with which his given utterance enters into one kind of relation or another (builds on them, polemicizes with them, or simply presumes that they are already known to the listener). Any utterance is a link in a very complexly organized chain of other utterances.

Thus, an utterance is not only determined by what response it will provoke; but he himself is a response to earlier utterances. The responsive quality can be thought of, in the strictest sense, as a response to a dialogue. It can also be thought of, in a broader sense, as the positioning of the utterance in relation to other utterances on the same theme. In this case, an utterance always dialogues with previous utterances and provokes future utterances and is therefore understood as a link in the chain of verbal communication.

But how can utterances be delimited in order to be analyzed? Bakhtin outlines two characteristics that determine the limits of an utterance. The first is the change of speaking subjects: an utterance begins when a speaker speaks and ends when he finishes speaking, initiating a response. The possibility of answering is what Bakhtin calls finalization, which is the second characteristic that can be used to identify the limits of an utterance. This finalization, in turn, can be identified in three ways. In the first place, it is the semantic comprehensiveness of the theme; in the second, the speaker's plan or speech will; and in the third place, it is the typical compositional and generic forms of finalization [15]. The semantic exhaustiveness of the theme means the finalization of the meaning that the author can give about the object that is spoken about. Obviously, this ending is never mandatory, but contingent on the situation. The speech will, in turn, imply the speaker's intention to produce meaning. Finally, each speech genre has a typical way of finishing: scientific articles end with the conclusion section and references; questions in written dialogue end with a question mark, questions in oral dialogue have a typical question intonation, etc.

These two characteristics, the change of speaking subjects and finalization, serve to identify the utterance, which then becomes the unit of analysis. In particular, Bakhtin focuses on three characteristics of utterance: theme, style, and compositional structure (see Sec. III D). The theme is the subject that is spoken about in an utterance; the style is associated with lexical, phraseological, and syntactic choice and the compositional structure with the

composition of the utterance. These three characteristics are directly associated with the speech genres in which a certain utterance is produced and the speaker's desire to express themselves.

For example, the genre of scientific articles published in the journal Physical Review Physics Education Research (PRPER) allows the speaker to talk about a certain set of topics, as long as they are related to editorial requirements; allows for a certain style (the explicit use of citations from other works on the same topic is a stylistic requirement of the contemporary scientific genre, for example) and requires a certain compositional structure (title, abstract, introduction, theoretical-methodological framework, results, conclusions, references). Specifically, the speaker's freedom arises first from deciding to present a scientific utterance and, second, from having internal freedom, within the restrictions imposed by the speech genre.

Furthermore, the speaker's freedom is manifested by the expressiveness he uses, by the subjective, emotionally evaluative tone in which the speaker manifests his relationship to the theme of the utterance. As stated in Secs. III C and III D, these characteristics illustrate the pseudofree subject and the constrained freedom of discursive creation in Bakhtinian theory.

Oral expressions manifest their expressiveness through their tones. When we read an utterance, we can infer and recreate its tone in our imagination. Thus, the same sentence utterance can be uttered with a serious tone or with a tone of irony. The sentence is the same in both cases, but when it becomes a concrete utterance, the tone used completely changes its role in the chain of verbal communication.

In the next section, we will delve into one practical application of Bakhtin's theory of concrete utterance. As part of our research group's efforts to understand the role of language and communication in social interactions, we have conducted a number of studies exploring the use of this theory in various contexts. We will discuss the result of specific studies in some detail, exploring Brazilian didactical books and performing an analysis of utterances on modern physics in contrast with the original texts of quantum mechanics, in dialogue with the *scientific genre*.

V. EXAMPLES OF METALINGUISTIC ANALYSIS

Once the philosophical assumption and main concepts of the Bakhtin Circle's philosophy of language, or its theory of the concrete enunciation, have been discussed, one of the main challenges for those interested in developing a metalinguistic interpretation is to systematize such a discussion so that it can subsidize qualitative research in the field of physics teaching.

Although there is a first methodological orientation in Marxism and philosophy of language, in which it is suggested that cultural productions must be connected with aspects of infrastructure, in subsequent texts, Bakhtin expands this notion so that the analysis of a text goes through its correlation with other texts. That is, when analyzing the extraverbal context of a specific utterance, we are not faced with an objective and concrete material reality that serves as an absolute judge of the meaning of the text; but a series of other texts, which—in turn—have their meaning based on their relationship with other texts.

Thus, there is no recipe, nor a rigid structure, nor a safe path through which a metalinguistic analysis will be followed. The interpreter, when analyzing an utterance, will correlate it with other utterances, investigating their relationships, be they agreement, disagreement, controversy, or indifference. It is from the interpreter's *excess of seeing* [18] (pp. 2227) and the choice of texts that make up the extraverbal context that the meaning of the text will be constructed. Such freedom implies virtually infinite possibilities of meaning for a text, since each interpreter has a unique excess of seeing and, therefore, a unique place in the world, to interpret that text.

This does not mean that any interpretation is valid: the plausibility or relevance of a given interpretation occurs to the extent that the interpreter is able to materialize and concretize the relationships between utterances, evidencing their dialogicality. Thus, even though it is possible to analyze the dialogue in the broad field of culture between texts by authors very distant in time and space, possibly the analysis between closer texts will reveal more concrete and plausible addresses and responsiveness.

Thus, although the analysis process is dynamic, subjective, and unique for each interpreter, we thought of a possible systematization of the process in order to help those who are starting the process of using this methodological theoretical framework [72].

- *Identify the utterance and the immediate context*;
- *Identify the speech genre*;
- *Analyze the direction and social orientation of the utterance*;
- *Analyze responsiveness*;
- *Analyze style*;
- *Integrate the results into a new utterance*.

By proposing these steps, we do not suggest that they be followed rigidly. In fact, depending on the purpose of the analysis, the interpreter has the freedom to continue adapting as needed. Next, we present two research projects that our group has been dedicated to and in which metalinguistic analysis has been used as a methodological theoretical framework.

So, the proposal of a methodological theoretical framework is simply a suggestion of systematization for those who want to start to work with a Bakhtinian approach. As the researcher gets acquainted with the concepts and is confident to interpret the utterances, there is no need to follow the steps. The idea of suggesting this methodological scheme came from the questioning of students and even from other researchers who wanted to work with this

perspective and felt the necessity of starting from an explicit sequence of steps.

A. The presentation of quantum mechanics in the books of the *Plano Nacional do Livro Didático* in Brazil (national textbook plan)

In Brazil, public schools across the country receive textbooks from the so-called *Plano Nacional do Livro Didático* (PNLD), or *Didactical Textbook National Plan* (DTNP). In general terms, the PNLD works as follows: a public notice is opened, and publishers submit collections of disciplines to be approved by the Ministry of Education. The books that are approved are then included in a catalog. Each school can choose the collections they intend to use and then the books are distributed. Regarding the 2017 collection, to which the analyses that will be presented refer, the Brazilian government invested more than one billion reais, which at the time corresponded to approximately 300×10^6 dollars [73].

Recognizing the magnitude of the PNLD and its impact on national education and that the textbook continues to be a popular cultural instrument in the scientific educational context, our research project aimed to analyze the utterances in the textbooks, especially with regard to the teaching of modern physics. With the metalinguistic analysis, we intended to connect such utterances, first, with the Brazilian educational context and discuss which epistemological and political assumptions such texts are aligned [73]. Next, we seek to relate the utterances on modern physics with the original texts of quantum mechanics (the articles written by physicists themselves such as Einstein, de Broglie, Schrödinger, etc.) in dialogue with the scientific genre—also bringing elements from the sociology of science by Latour [74]. Finally, also in dialogue with Latour's studies of sciences, we analyzed the possible ontological stabilization of the wave-particle duality, discussing how the utterances in the books guarantee or not the stability of this concept [75].

It is important to notice that Latour's work is mainly devoted to the analysis of scientific practices. But his metaphysical perspective is much wider and general. The conception of actor-network and ontological stabilization overcomes the walls of the laboratories [76]. Everything that we claim to exist has passed through a long process of ontological stabilization, inside and outside the laboratories. For instance, as Latour himself mentions, how do we know that fermentation exists? Because we eat yogurt, we learn about it in school, in propaganda, and so on [77]. So, his discussion of ontological stabilization can be translated into any context. More specifically, Latour mentions that type 4 utterances (see Table II) should be predominant in textbooks since they are informing the student about something considered to be a fact [77].

Although we will present a general analysis of the results obtained, emphasizing the role of metalinguistics in this process, we will analyze the article by Lima *et al.* [74] in more detail, as the text is in English and can be read in full by the interested reader.

First, the utterances of the books of the *Plano Nacional do Livro Didático* were considered as composing a single discourse genre, as there are stable characteristics running through all texts in terms of thematic content, structure, and style. We discuss this by showing that all the books practically talk about the same topics in modern physics, which practically boils down to approaching the so-called old quantum theory, without going into the conceptual issues of quantum mechanics itself.

In addition, the sequence of topics in the books follows, in general terms, the same structure as the introductory books of higher education physics widely used in Brazil, that is, they present modern physics through a historical proposal, starting from the problems of blackbody radiation—an approach widely problematized in Brazilian national literature–committing historical inaccuracies equal to those of higher education books. This indicates that the authors of the books have a more direct dialogue with higher education books than with physics teaching research papers and with the historical articles on quantum mechanics, committing themselves to the pedagogical conception of these texts.

Perceiving this kind of "didactic colonialism" of the higher education genre over basic education, we also investigated the academic trajectory of the authors of the textbooks. About 56% of the authors did not have a master's degree and 86% did not have a Ph.D. [73]. This result indicates that, in fact, it is likely that the authors start from the books they studied at the undergraduate level to write their books, indicating that there is no deeper pedagogical and epistemological reflexive process in their didactic construction.

Furthermore, the preservice teacher education in Brazil was historically aligned with a $2+2$ undergraduate curriculum, in which students studied 2 years of physics and 2 years of education separately [79]. This perspective reinforces the perspective that science is something completed, ready to be transmitted by someone with "didactic skills." This curriculum, thus, is associated with "traditional teaching," in which a transmissive conception of teaching and learning is reinforced [80]. As it is well discussed by Freire [81], this pedagogical perspective is committed to a capitalist model of organization since it reproduces the structure of a manufacturer, where one conceives the product or curriculum and many others execute the order.

In opposition to this model, a teacher and a textbook writer should be critical scholars who are able to produce their own text from their own reflections and in dialogue with different other texts [82]. This pedagogical perspective is antihegemonic as far as it valorizes the autonomy and criticality of teachers.

TABLE II. Examples of utterance classification [78].

Type	Utterances from textbooks	Comments
1	According to this theory [here Einstein is referring to the theory of energy quantization, proposed by Planck in 1900], if the incident light is composed of energy quanta, the origin of cathode rays… can be interpreted as follows: the energy quanta penetrating the surface of the material and their energy…	In the first type of utterance, one is not speaking about a fact, but about an idea. In the utterance, it is explicit that the concept is part of a theory, and it refers to an interpretation.
2	Photons are like packets of energy (E) proportional to the frequency (f) of the radiation.	In the second type, there are less references to the context of the creation of the concept, but still the expression "are like" implies that one is not speaking about a fact.
3	Maxwell concluded that through this successive chaining, the electric and magnetic fields should propagate through space, as if they were waves, the electromagnetic waves.	In the third type, we have already a conclusion about nature, but still, there is a reference to the human that conceived it.
4	The photoelectric effect is one of the many evidences that emerged throughout the 20th century that light is made up of perfectly identified particles—photons.	In the fourth type, the existence of the photons is sustained by material evidences only. There is no reference to a human creator nor expressions like interpretation or "is like."
5	Thus, when an electromagnetic wave interacts with a material medium—a conductive metal plate, for example—the energy transported by these fields causes the movement of electrons on that plate in the region where the wave strikes.	In the fifth type, there is no reference to any context or explanation about the essence of what is being described. In this case, the undulatory nature of light is simply assumed to be real.

Why does the speech genre of high school textbooks reproduce the undergraduate textbook genre? Because teacher education in Brazil has not been able to produce critical scholars. Universities have invested in a traditional curriculum, which reinforces capitalist and neoliberal premises. This is an example of how the metalinguistic analysis allows one to analyze the relationship between texts and genres and infer possible sociocultural aspects that motivate such relation. As we will discuss, the textbook speech genre does not follow what is expected by Latour, and we find different types of utterances. By analyzing the variation of utterance style along the text, we may evaluate the pedagogical and epistemological commitments of the text.

Likewise, several excerpts from the books reinforce positivist assumptions, an epistemological conception widely criticized in the science teaching literature. It is interesting to note, however, that the PNLD public notice required that the books adopt a contemporary epistemological conception. We found several tables throughout the books discussing philosophy and the nature of science, presenting a conception sometimes contrary to what was presented in the text. This indicates that the authors respond much more to the public notice, seeking to have their collections approved than to the public of students and professors, who should receive a qualified text from an epistemological and pedagogical point of view.

Once this first characterization of the collection has been made, we move on to the discussion of the relationship between these texts and historical articles on quantum mechanics, which allows us to reflect on the didactic creation process [75]. For this purpose, the books were divided into three categories, having as a criterion the explanation that quantum mechanics has several interpretations (p. 379):

1. *The textbook does not explicitly recognize the existence of different interpretations and does not adhere to a specific interpretation. Eleven books were put into this category (…)*
2. *The textbook explicitly recognizes the existence of different interpretations. Two books were put into this category (…).*
3. *The textbook adheres to a specific interpretation and argues it is the only possibility.*

We selected, then, an example from each category and carried out an in-depth analysis mainly with regard to the style of the utterance, investigating how the use of different verb tenses and adjectives was used to reinforce or weaken specific conceptions about the photon. In the present paper, we will highlight the analysis of the book from the first category. We show a small excerpt of analysis to exemplify the type of interpretation that metalinguistic analysis allows [75] (p. 379):

> The story told by Bonjorno *et al.* [a Brazilian book] begins with Planck: "In other words, according to Planck, the vibrating oscillators with frequency f emit energy E in discrete or

> quantized quantities. The minimum amount of energy emitted, that is, the quantum, would be a hf energy package. The "energy packets" could assume values given by $E = nhf$". According to Bakhtin, author's grammatical choices are clues to his worldview, so that an author's style cannot be analyzed separately from the theme. In this passage, the author uses modal sentences ("would be", "could"), giving very subtle evidence that what you are talking about will change later. Namely, even though they reflect Planck's original conception, the verbal form that introduces this conception weakens Planck's voice, working, in this case, as a modulator of the intensity of what is meant. Furthermore, the authors do not explain how Planck arrived at his thoughts; their translation consists of a basic speech describing what Planck obtained. Thus, the translation of the original article by the textbook involves the erasing of Planck's theoretical construction and the propagation of a single idea to the detriment of the whole work. Planck's entire construction is summarized in a few lines—a process Latour calls blackboxing.

Throughout most of the text, the author of this utterance adopts an essentialist corpuscular perspective for the photon and, finally, he changes to an instrumentalist view, presenting Bohr's conception to explain classical phenomena, such as classical interference and diffraction, which is not conceptually accurate. About this, the metalinguistic analysis allowed us to discuss [75] (p. 382):

> "Therefore, we follow the principle of complementarity, enunciated in 1929 by Niels Bohr, which considers the need for two theories to establish double radiation behavior, although it is never necessary to use both models at the same time to describe certain phenomena." The authors, therefore, adopt Einstein's corpuscular view throughout the text and explain the wave behavior of the radiation using the Copenhagen Interpretation (which was not accepted by Einstein) for a problem that is not of Quantum Physics. Thus, the view of the authors is a proper interpretation of the nature of light, which corresponds neither to Einstein's view nor to that of Copenhagen, but is a hybridization of these visions.

So, the textbook presents, first, the corpuscular conception of photons as a fact. In the end, when the book presents Bohr's ideas, the textbook presents the photon perspective as complementary to the undulatory perspective. On the one hand, this weakens the corpuscular conception of the photon since it is recognized as insufficient to describe quantum phenomena. On the other hand, this presentation still attaches the concept of photon only to particle, while it should address that one single photon also engages in undulatory phenomenon such as interference. Furthermore, we may see in Fig. 1(b) that the concept of quantum (considered to be a particle) starts as a level 5 utterance and then it oscillates between 5 and 3 along the text (being 2 in a specific point). Thus, the concept of photons becomes less hedged in later chapters. This result is an example that speech genders are *relatively stable* because it contradicts what one expects from the didactic genders since the more recent conceptions are not presented as "facts" but are still unstable.

This meticulous analysis was extended to the books of the three categories, indicating their relations with the original books, as well as investigating how the stylistic choices reinforce or erase aspects of the scientific constructions. With the exception of the book in the second category, which explained the existence of different interpretations, the other books showed a strong erasure of the internal plurality of science, the last being the book that presented the most authoritarian discourse, insofar as it defended the existence of a corpuscular interpretation as the only possibility—which completely distances itself from the specialized discussion.

In particular, based on this second analysis, we were interested in deepening the investigation into how the nature of radiation is presented throughout the books [75]. Once again, in dialogue with Latour's science studies, we performed sentence style analysis (evaluating verb tense, use of adjectives, and adverbs) to assess how strongly they indicated the existence of an entity, using a classification proposed by Latour, where 1 indicates a very weak existence up to level 5, which would be the maximum level of certainty about existences (a fact). We analyzed the three books of the three categories proposed in the previous article.

In order to exemplify the analysis that we have performed, we show in Table II one example of each type of utterance retrieved from the high school textbooks [78].

With that, we were able to describe the ontological trajectory of the light. For this, we separated the utterances that treated the light as a wave [Fig. 1(a)] and as a quantum [Fig. 1(b)], which in the textbook is associated with particles. Also, we separated the context of the textbook as classical and modern. Next, we classified the utterances based on Latour's classification system and created a graph in which the type of utterance is plotted versus the order of the utterance in the text (utterance 1, utterance 2, utterance 3, …) just for the sake of clarity. For example, we show in Fig. 1(a) the graph obtained from a book we classified in the first category. We see that the undulatory light gains stability in the classical discussions, no longer appearing utterances of type 3. However, in the sequence, we see utterances in the modern context that indicate the

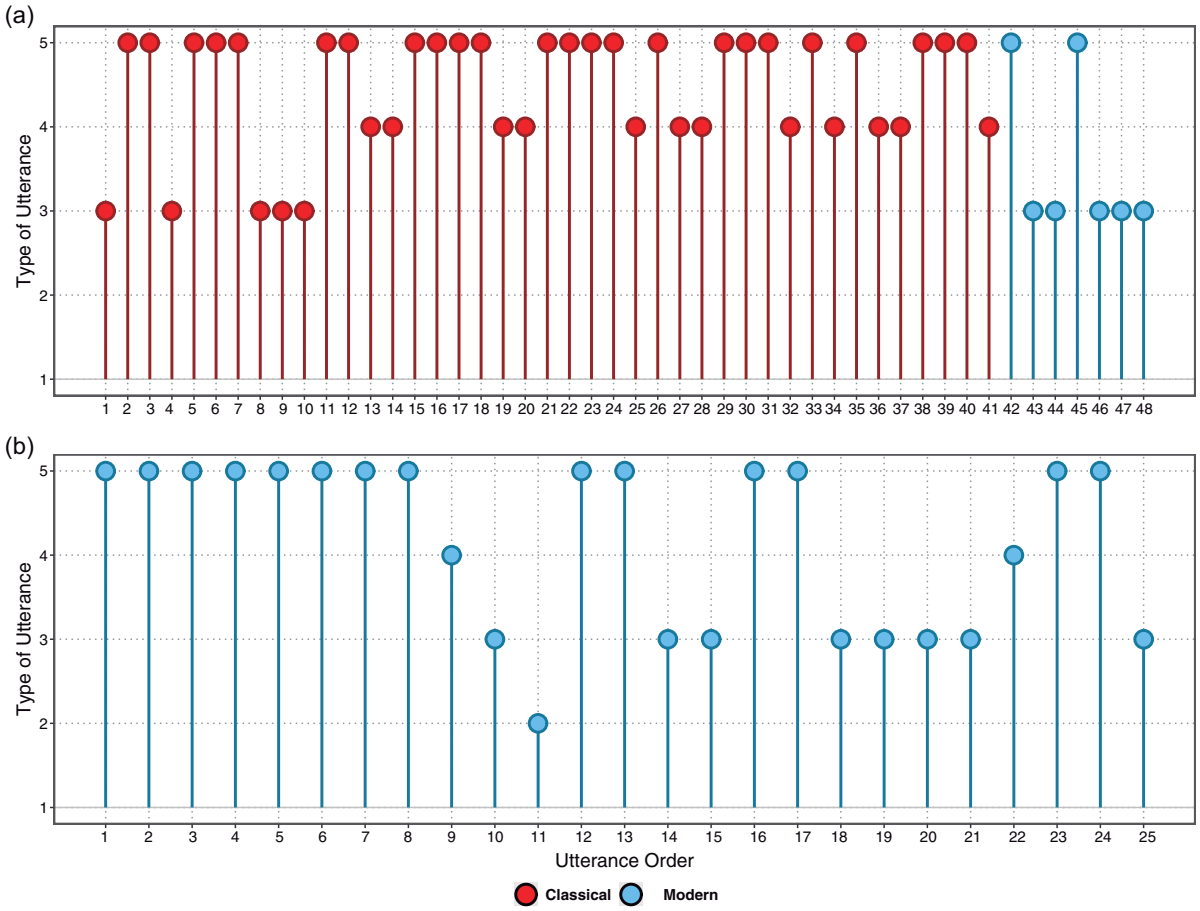

FIG. 1. (a) Plot of discursive pattern obtained from the book of the first category considering an undulatory light. The undulatory nature achieves stability throughout the classical narrative. In the modern context, it oscillates between 3 and 5 (adapted from Ref. [75]); (b) plot of discursive pattern obtained from the book of the first category considering the quantum (which is considered to be a particle in the textbook). The classical nature achieves stability throughout the narrative, reducing utterances of type 3 (adapted from Ref. [75]). In both, the y axis represents the type of the utterance, and the x axis represents the order of appearance of the utterance along the book.

undulatory nature of the light oscillating between 3 and 5. This means that the undulatory light is still presented as a fact in the modern context.

Furthermore, when we do the same analysis for the photon [Fig. 1(b)], we find that it is not mentioned in the classical context (as it was expected). And in the discussion of the modern physics, the photon (which is associated only with a particle) oscillates between utterances 2 and 5. Finally, the last utterance is of the third type.

This indicates two important conclusions. First, we have "contradictory facts" asserted throughout the book: both undulatory classical light and the photon are claimed to be facts. Second, the photon concept itself does not finish as a fact, oscillating between 2 and 5—which is problematic for a text whose objective is to present modern physics.

It is important to compare the results we obtained with what was expected from the textbook speech genre. One expects that a textbook presents stabilized facts (utterances 4 or 5). Another possibility would be to have a historical presentation, then, in this case, the first utterances should reflect the ontological instability (utterances 1–3) and the last ones should present the facts (4 and 5). That is not what we have found. On the one hand, the classical nature of light is presented as a fact in the classical context and sometimes in the modern context too. The photon, otherwise, is presented oscillating from 2 to 5, not seeming to be stable. It implies that the didactic narrative is not consistent along the text and may even create pedagogic obstacles.

We decided to bring this example about textbooks, as we were able to discuss the potential and flexibility of metalinguistic analysis. The theory of the concrete enunciation offers us a fundamental structure to look at the world of discourse and culture, allowing us to focus on utterances from a relational metaphysics and epistemology. While in the first work, the focus was on understanding the epistemological and political commitments of the utterances, connecting such results with the trajectory of the authors and the conditions of the public notices, in subsequent articles, we were able to look at the process of didactic creation and its relationship with historical texts, allowing

new important reflections on the presentation of quantum mechanics in basic education.

VI. CONCLUSION

Pointing out the so-called sociocultural framework, with emphasis on our most important system of signs or psychological tool—language—a linguistic turn was experienced by research on science teaching in the last two decades. Not only was language seen as a culturally transmitted resource, but also a phenomenon considered central in the processes of appropriation of scientific discourses in the classroom. According to Ref. [36], we presume that learning emerges predominantly as (p. 136)

> […] the coconstruction (or reconstruction) of social meanings from within the parameters of emergent, socially negotiated, and discursive activity.

Considering verbal language as the primary form of semiotic mediation, and, assuming that meanings are socially constructed and manifested primarily in discourse interactions, textual data became the empirical source of research on science education analysis, necessitating a qualitative research approach, as utterances made by students and teachers in their discourse interactions, written texts, and others. As a result, under the sociocultural framework, it is consistent to place a greater emphasis on the processual study of group interactions (particularly discourse interactions) rather than on initial and final educational achievement (for example, outcomes of pre- and post-tests, widely used in RCTs studies in educational contexts).

The proposal of the text—defined as oral or written communication—regarded as the primary form of mediation between actors in educational contexts (and also in others) explains why qualitative research is preferred in this approach. Aiming to view the text inside the qualitative framework, we compared and contrasted two discourse analyses: French discourse analysis, by Michel Pêcheux, and Bakhtinian analysis, by Mikhail Bakhtin. The goal was to locate these two theories in opposition to positivist-influenced approaches, such as classical formulations of grounded theory and content analysis. We discussed to what extent both Bakhtin and Pêcheux acknowledge the importance of ideological interpretation in shaping how we understand and produce discourse, recognizing they understand ideology in completely different ways.

Unlike Pêcheux, Bakhtin rejects deterministic worldviews and embraces the concept of a pseudofree subject, in which the subject is not ideologically interpellated, but he is also not completely free to be the strict owner of his speech—his utterances are influenced by social and historical context and are always dialogical to other utterances (in texts, speeches, or other forms of discourse).

As a consequence, we show that the Bakhtinian subject is not a prisoner of linguistic norms, with flexibility and room for unique creativity (subjectivity in enunciation), but this creative freedom has constraints within the sociocultural environment in which this subject is situated. In this way, we highlighted that Bakhtin does not agree with the concept of ideological interpellation, because the speaking subject might be the author of their speech, albeit with limited flexibility, because their speech always interacts with other discourses—the subject is never the only source of an utterance; the act of speech is always dialogical.

After discussing the differences between these two schools, Bakhtin's metalinguistic was presented with the purpose of formulating main considerations on the nature of utterances and speech genres, a fundamental part of his concrete utterance theory [72] and other concepts that can support discourse analysis.

Although the analysis process is dynamic, subjective, and unique for each interpreter, we proposed a possible systematization of the process in order to help those who are starting the process of using Bakhtin's theoretical framework. As practical applications, we discussed two research projects that our group has been dedicated to, as part of our efforts to understand the role of language and communication in social interactions. By examining examples and case studies, we hope to provide a more comprehensive understanding of the role that concrete utterance plays in shaping our interactions with others.

By proposing speech analysis under a Bakhtinian approach and a systematization of the process, we do not suggest it must be followed rigidly. In fact, depending on the purpose of the analysis, the interpreter has the freedom to continue adapting as needed, particularly for investigations carried out in classroom contexts.

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