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Circulation of Knowledge and the Production of Scientific Facts: Proposing an Analytical Trajectory for Texts in Science Education

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Ludwik Fleck; Mikhail Bakhtin; Epistemology; Language; Texts.

Abstract In this study, considering the interrelationship between epistemology and language, based on the theories of Ludwik Fleck and Mikhail Bakhtin, we propose an analytical trajectory for texts that circulate scientific knowledge. For this, we first give visibility to the way Fleck intertwines the social, the language (and the text) and the epistemological. Then, we present elements of Bakhtin's philosophy of language that can analytically and theoretically deepen the social-linguistic dimension of textual productions in science. This theoretical articulation, among such authors, is systematized through questions that may enable researchers and Higher Education professors or Basic Education teachers to reflect on the role of the various texts that circulate scientific knowledge. Studying the materiality of the texts that circulate science can contribute to the process of production, incorporation and mediation of readings of such materials in the different teaching-learning contexts of the disciplines of Science Education. It also contributes to the construction of knowledge in the field of research in Science Education.

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Introduction

The reading of different types of texts also constitutes Science Education, including Physics, in Basic Education (Almeida & Ricon, 1993; Setlik & Higa 2019; Silva, 1997) and in Higher Education (Lima & Almeida, 2012; Rodrigues, 2015). Currently, the literature on reading, using and operating texts in Science Education is quite diverse and extensive (Silva, 2013). However, few studies integrate the analysis of the materiality of texts that circulate scientific knowledge to the perspective of reading in teaching. Understanding the forms of several texts of Science can contribute to their production, incorporation, practices and mediations of the readings in different teaching and learning contexts of Science Education disciplines. As Silva (2013) states, based on Orlandi, the forms of the texts are not indifferent

to the meanings that can be generated in reading, so the reader training needs to be thought also for such forms (also related to contexts). In addition to the reader as a *historical-social subject*, the text can be thought of in its *form-content-context* and, therefore, seen as the result of a process (Silva, 2013).

In the case of Science, studies indicate that textual production can be understood as constituting knowledge and not just a means of communicating Science products. Several thinkers in the field of epistemology and *Science Studies*, including Bruno Latour, Thomas Kuhn and Ludwik Fleck, emphasize relations between language and knowledge construction. Hence the importance of thinking about texts in Science and Science Education in the interplay of theories of the fields of epistemology and language. In this study, based on the theories of Ludwik Fleck and Mikhail Bakhtin, we propose an *analytical trajectory* for texts that circulate scientific knowledge.

Some works in literature on Science Education discuss articulations between discourse and epistemology (Barros, 2011; Nascimento, 2005; Lima, 2018; Silva, 2017). Silva (2017), for example, articulates Foucault's theory of discourse with Kuhn's epistemology, involving the notion of textualization. The aforementioned study proposes textualization as a central analytical category for the articulation between discursive and epistemological approach, since it "shifts the analyses of the 'contents' of the texts, to the relationships between textual form, content and socio-historical determinations" (Silva, 2017, p. 3547). Other studies approach discourse — mainly from the French Discourse Analysis — and Fleck's epistemology (Barros, 2011; Nascimento, 2005). Others use Fleck's and Bakhtin's theories together to carry out analyses of symbolic materials (Sangiogo, & Marques, 2015) — here it is about the images analysis, and the relations between the theories of these two fields are not developed. Bakhtin is also taken as a reference in dialogue with other epistemology authors, such as Bruno Latour (Lima, 2018).

Although the number of studies in the area of teaching has grown, regarding different objectives and discussions, which are based on Fleck's epistemological theory (Lorenzetti et al., 2018), we consider that his epistemology highlights the knowledge-language relationship, and, in literature in general, this relationship with textual productions is still not widespread. We understand that this epistemologist discusses the genesis of scientific facts, highlighting the role of language in the constitution, stabilization and transformation of scientific concepts — for him, the movement of ideas in *intra* and *inter* collective traffic is essential to the construction of scientific facts. Therefore, when discussing the genesis of a scientific fact, from a sociological perspective with evidently discursive aspects, Fleck (1981) brings reflections that directly involve language, which emphasizes its inseparability with the knowable. The existence of relations between thought and language is also pointed out by scholars in the field of language (Bakhtin & Volochinov, 2014; Vigotski, 2008). As proposed by Vigotski (2008), thought and language are interrelated: all thought is structured, above all, through words. Bakhtin & Volochinov (2014) also indicate that the word is the material of the individual's inner language and consciousness.

In his works, Ludwik Fleck presents a contrast to the so-called "Vienna Circle", a

group of scholars who were in favor of logical empiricism and, therefore, of the concept of unhistorical science. Biographical aspects[1] and the various publications by Ludwik Fleck can be found in several studies of the literature (Da Ros, 2000; Sady, 2012; Schäfer, & Schnelle, 2010), yet we do not intend to develop these aspects in this study. Fleck's epistemological historical theory has as its central reference, in the construction of his argument, the development of the concept of syphilis and the establishment of the Wassermann test as a scientific fact.

It is difficult to ascertain systematic influences on Fleck's thinking (Schäfer, & Schnelle, 2010), even though some scholars have made efforts to do so. Although Fleck has no specific training in philosophy, Löwy (2008), for example, argues that the idea of scientific observation as a cultural and social process culminates in the existence of a confrontation of Fleck's ideas with other Polish thinkers, who are presented and developed in detail by such author. According to research by Da Ros (2000), Fleck has a strong ideological link to the tradition of the Polish School of Philosophy of Medicine (EPFM) of his time and previous generations.

His main work, the book "*Genesis and Development of a Scientific Fact*", was written between 1925 and 1935 (Sady, 2012) and translated into Portuguese only in 2010. This book is one of the main bases of this study. In the first two chapters of such book, Fleck starts from a historical analysis of a scientific concept to indicate that these concepts of science have histories, which are related to thought styles. The thought style is never individual, therefore, knowledge is not an individual production (or the simple sum of several), in fact, knowledge is a collective production that necessarily implies a sociological approach to knowledge.

The last two chapters of his book, in turn, focus on the empirical part of science and the importance of traffic (circulation)[2] of ideas between different circles of individuals. Important concepts of his epistemological theory are taken up and developed, such as "thought collective" and its relation to reality, and finally, the structure of scientific production, with its circles, traffic and the corresponding textual productions. Lorenzetti, et al. (2018) point out that the circles and traffics concepts have been explored in the literature in the area of Science Education, however we consider that the relationship of these concepts with the textual productions — as pointed out by Fleck (1981) — are still little evidenced.

Considering the reading in Science Education, these still little considered relations from the theory of Fleck (1981) allow the vision of the existence of an epistemological

1 In short, Fleck was a Polish physician and biologist, who worked on the construction of an epistemological theory based mainly on his readings of philosophy and sociology and his practice with patients and as a teacher in bacteriology, microbiology and immunology laboratories (Da Ros, 2000). Unlike other epistemologists of the time, Fleck had no training as a physicist, mathematician, or philosopher, which may have favored his differentiated approach, as we see it, about scientific knowledge.

2 In the Brazilian translation of Fleck's work, it is common to use the word traffic, although circulation also appears. The latter is mostly used in teaching research and is consistent with Fleck's ideas. According to Jarnicki (2016), Denkverkehr (as it appears in German) and Krqzenie (as it appears in Polish) approach the idea of a type of movement, flow without necessarily having a defined direction.

role of texts in the construction of scientific facts. However, we understand that, although Fleck (1981) approaches textual productions in science, his theory is not a theory of language and, therefore, other theories on the field of language can dialogue and contribute to the construction of an *analytical trajectory* to study the materiality of these texts.

Bakhtin's language theory has been taken as basis for analytical trajectories proposals in research in Science Education, for the analysis of texts and interactions in the classroom (Lima et al., 2019; Veneu et al., 2015). These analytical trajectories can also incorporate elements of epistemological theories to better understand the specific form of the texts that constitute Science Education. Lima et al. (2019), for example, seek to advance the development of an analytical trajectory from Bakhtin, and, when they perform an example analysis of the scientific dissemination material, they relate to ideas of the epistemological field, mainly from Latour and Feyerabend - who are mobilized during the interpretation of the textual material.

Between the 1920s and 1930s, Mikhail Mikhálovich Bakhtin[3] composed his main studies on language in opposition to two mainstream currents of philosophical-linguistic thought at the time: idealistic subjectivism (Humboldt and Vossler) and abstract objectivism (Ferdinand de Saussure) (Yaguello, 2014). The various members of the so-called "Bakhtin Circle" contributed to the articulations of the bakhtinian thought. In "Marxism and Philosophy of Language", for example, which was initially signed by Volochínov, and which has his contributions, criticisms of these two main currents are made, arguing in favor of a Marxist approach to language, that is, they undertake the search for an application of the sociological method in linguistics (Yaguello, 2014).

Although several Bakhtin Circle's writings approach issues related to language, in this investigation, we mainly resorted to the essay "*The Genres of Speech*", written between 1951 and 1953 (Bakhtin, 2011), to "*Marxism and Philosophy of Language*" (Bakhtin Volochínov, 2014, Volochínov, 1973) and some elements of "*Toward a Philosophy of the Act*" (Bakhtin, 2010), which are the basis of all concepts in the bakhtinian theory.

Considering the relevance of texts, practices and mediations of readings in Science Education, in this study, we propose an *analytical trajectory* from the articulation between theoretical elements of Ludwik Fleck's epistemological theory and Mikhail Bakhtin's language theory. Our methodological path was initially to deepen the understanding of textual productions in Fleck (1981), with its meanings within his theory of knowledge, to later seek in Bakhtin's language philosophy — such sources have been previously mentioned — theoretical elements that can deepen the understanding of the linguistic social dimension of texts in science. It was possible to identify several points of dialogue between the authors and to develop a sequence of questions to be asked in the face of the materiality of texts that circulate science; to reflect, build knowledge or even better

3 Biographical and diverse works of Bakhtin aspects can be found in several studies of the literature (Todorov, 2011; Yaguello, 2014). In short, Mikhail Mikhálovich Bakhtin was a Russian philosopher, theorist and historian of literature who, from the Circle of Discussions with other thinkers (Bakhtin Circle), produced several writings on language, especially before the 1930s and after the 1960s.

understand the functioning of these materials in reading practices in Science Education.

We present this study in two sections. In the first, we give visibility to our reading about the way Fleck (1981) intertwines the social, the language (and the text) and the epistemological. This section on Fleck's theory discusses his general and basic concepts aimed at thinking about texts in science, with a sub-item on the circulation of knowledge, approaching the *intra* and *inter* collective circulations. In the second section, we articulate elements of Bakhtin's language theory (1973, 2010, 2011, 2014) that contribute analytically and theoretically to the social-linguistic dimension of Fleck's theory. In a sub-item, we derive the analytical trajectory, as a set of questions, for analyzing texts that circulate knowledge of Science.

Ludwik Fleck's epistemology: circulation and texts as constitutive of knowledge production

Fleck (1981) understands the production of scientific facts from a triadic relationship among object, subject and state of knowledge — social, historical and cultural relations that characterize the thought style of a collective — with reciprocal relations between knowledge and these three factors. Among the pillars of Fleck's epistemology (1981) are two interrelated categories: the "thought style" and "thought collective". It is not possible to isolate the object of observation from the thought style (a way of perceiving) from a given context, that is, the scientific fact is built within a historical context, so it should not be understood as absolute or immutable.

It is not trivial to elaborate a precise definition of all the characteristics of the thought style, Fleck (1981) affirms that he does not intend, in his work, to exhaust all understanding about this category. His intention is to demonstrate the functionality of this category in order to understand the construction of scientific knowledge. In the fourth chapter, the last of his book, after presenting several aspects of the thought style, Fleck seeks to introduce a definition for this category:

> Like any style, the thought style also consists of a certain mood and of the performance by which it is realized. A mood has two closely connected aspects: readiness both for selective feeling and for correspondingly directed action. It creates the expressions appropriate to it, such as religion, science, art, customs, or war, depending in each case on the prevalence of certain collective motives and the collective means applied. We can therefore define *thought style as [the readiness for] directed perception, with corresponding mental and objective assimilation of what has been so perceived.* (Fleck, 1981, p. 99, emphasis in original)

In this definition, it is clear that the thought style is not limited to the mental level, since the way of doing, or rather, its realization on the objective level, is also involved in this category. The thought style is not only about perception of reality, but also about action: perceiving and acting. Style exerts a coercive force on the individuals' thinking and action (especially in an unconscious way). It is the sharing of a way of seeing that

guarantees the so-called "*harmony of illusions*" (Fleck, 1981, p. 28) within science: a closed system, with reciprocal effects between the known, the things to be known and the actors of the knowledge.

Among the various features and meanings attributed to the thought style, due to the interest of our study we highlight two: 1) there is no individual thought style, this category is closely linked to the other, namely, the thought collective that shares this "way of perceiving" and acting; and 2) the thought style is also related to a specific language, to the "delicate shading of the meaning of a word" (Fleck, 1981, p. 53) that occurs through the historical or didactic introduction in a field of knowledge. From these two characteristics, we understand the need of the circulation of knowledge between different circles and collectives, so that the individuals are carriers of thought style.

Therefore, from the category of thought style, it is essential to understand what constitutes the thought collective, since it is a category interrelated to the thought style and the basis of this epistemological theory. In Fleck (1981), the thought collective is defined as

> [...] *a community of persons mutually exchanging ideas or maintaining intellectual interaction, we will find by implication that it also provides the special "carrier" for the historical development of any field of thought, as well as for the given stock of knowledge and level of culture. This we have designated thought style.* (Fleck, 1981, p. 39, emphasis in original)

From this definition, it is clear that in order to belong to a thought collective, the individual must necessarily be a carrier of the thought style. Somehow, the individual is coerced into a certain collective form of thinking. The exchange of thoughts within a community is only possible through communication between individuals, that is, through texts, whether oral, imagery or written. It is from such a conception that Fleck (1981) developed other concepts to understand the construction of scientific facts, such as the different "*sciences*" and the traffic of ideas and practices, which we will approach in the sub item of this section.

When thinking of the thought collective as a means of analyzing the social conditioning of thought, it is not appropriate to conceive of it as a fixed group or a social class (Fleck, 1981), as the collective is defined by the sharing of a thought style. Therefore, it is not possible to substantially demarcate the thought collective (Fleck, 1981). Indeed, the thought community does not always coincide with the official community, sometimes it is possible to belong to a thought collective even without a formal introduction. Likewise, formal members of the community may not share the traits of their thought style.

When carrying out the analysis of the formation of thought collectives, Fleck (1981) points out the existence of different forms of collectives, such as casual and momentary and relatively stable. As the names of the classifications suggest, the first appears and disappears every time people exchange ideas, while the second is formed mainly around socially organized groups. The latter make it possible to analyze the

thought style, because they need relatively stabilized texts.

> Such stable (or comparatively stable) thought communities, like other organized communes [Gemeinden], cultivate a certain exclusiveness both formally and in content. A thought commune becomes isolated formally, but also absolutely bonded together, through statutory and customary arrangements, sometimes a separate language, or at least special terminology. (Fleck, 1981, p. 103)

In the preceding excerpt, the link between the categories thought style and collective with specificities of the language that constitutes a given community reappears. The thought collective can also be understood as a discursive space where interactions nurture certain specificities in their forms, due to the coercions of a certain thought style.

There is a relationship between institutions and thought collectives, as institutions organize groups in a certain way, stabilizing (amid tensions) thought styles. Each thought collective, according to its thought style, is closed in its way of structuring knowledge. However, even though the collective is stable, there is no absolute closure on the traits shared between individuals in the community; at some point, during the movement of information, or due to internal complications, there may occur transformations in the form and in the shared knowledge.

Individuals belong to more than one thought collective, which in itself implies circulation of ideas and practices. The circulating thought is a collective thought, which does not belong to an individual in isolation (Fleck, 1981), but, at the same time, "thoughts pass from one individual to another, each time a little transformed, for each individual can attach to them somewhat different associations" (Fleck, 1981, p. 42). Each subject with their history and participating in different collectives will establish specific meanings (deviations of meaning may appear) for the ideas and practices that are circulating.

Fleck (1981), moreover, discusses the structural characteristics common to all thought collectives. The author states that the development of knowledge is not only due to the circulation of thoughts among the specialists of that knowledge, but, in addition to this circulation, there is a strong influence of other subjects (not specialists in specific knowledge - belonging to different collectives) in the process of knowledge development.

> The general structure of a thought collective consists of both a small esoteric circle and a larger exoteric circle, each consisting of members belonging to the thought collective and forming around any work of the mind [Denkgebilde], such as a dogma of faith, a scientific idea, or an artistic musing. A thought collective consists of many such intersecting circles. Any individual may belong to several exoteric circles but probably only to a few, if any, esoteric circles. There is a graduated hierarchy of initiates, and many threads connecting the various grades as well as the various circles. No direct relation exists between the exoteric circle and that creation of thought [Denkgebilde] but only one mediated esoterically. Thus most

> of the members of the thought collective are related to the works produced by the thought style [Gebilde des Denkstiles] only through trusting the initiated. But the initiated are by no means independent. They are more or less dependent, whether consciously or subconsciously, upon "public opinion", that is, upon the opinion of the exoteric circle. This is generally how the intrinsic self-containment of the thought style with its inherent tenacity arises. (Fleck, 1981, p. 105)

The "public opinion", which is located in the larger exoteric circle of the thought collective, is not isolated and only dependent on specialists; on the contrary, Fleck (1981) emphasizes a relationship between public opinion and the esoteric circle of knowledge, which is also dependent on that. The thought collective can also be understood as a certain space of asymmetry, due to the hierarchy of the participating individuals, which shapes the discursive form between different subjects (typical of social interactions). The link between these different circles, made up of individuals with different levels of knowledge initiation, makes possible the development of the thought collective, through the circulation of knowledge. Therefore, the social division within the collective is also a division of forms of communication, and of ways in which knowledge is materially invested in text, with specific forms.

The thought collective, while relatively stable, and general category, can take different forms, depending on the type and stage of development of the knowledge with which it is associated. Authors like Bensaude-Vincent (2001) indicate that in other times, such as the eighteenth century, there was no clear demarcation between scientists and amateurs, since in that period there was not a strong consolidated international scientific academy, therefore, the configuration of circles around knowledge was different from the current form. Fleck (1981) argues that the collective of Modern Science is made up of different "*sciences*", and esoteric circles (experts) can still be divided between "specialized expert" and "general experts". This is because with modern science a new gradation of instruction has emerged in the collective.

In modern science, according to Fleck's theory (1981), at the center of the esoteric circle, there are the "specialized experts" and outside this small central specialized circle, there are the so-called "general experts". Meanwhile, in the exoteric circle, there are "the more or less educated amateurs" (Fleck, 1981, p. 111), also presenting a gradation between different individuals. Fleck's epistemology (1981) highlights the role of both circles (eso and exoteric) in the establishment and persistence of a thought style. Among individuals from different circles, due to the "relation of definite mental superordination" (Fleck, 1981, p. 106) of the public in relation to the experts, on the one hand there is confidence in the initiates (experts in knowledge), and on the other hand the dependence on public opinion. Therefore, although there is a hierarchy among the individuals that make up the collective of science, all the positions described are necessary for the functioning of the structure of production of scientific facts, in a movement of interdependence. Among collective participants with mentally equal positions, there is a "certain solidarity of thought in the service of a superindividual idea" (Fleck, 1981, p. 106), that is, a

dependence between peers with a mental plane. Because of these interactions between individuals in the collective, the thought formations strengthen.

The circles of different knowledge have spatial and temporal extension, the more the esoteric circle extends in these different dimensions, mediating the thought within the collective, the more stable the way of thinking of the community becomes (Fleck, 1981). The more immersed in a collective of knowledge, and the longer this insertion — the process of education and experience — lasts, the more the habits and rules of such community are perceived as indisputable. The resistance that opposes the free thinking of individuals is what Fleck calls "fact" (Fleck, 1981, p. 99). Therefore, the "scientific fact" appears as a sign of resistance to the thought, within a thought style. This resistance makes it difficult to see arbitrarily and without definite form; the perception of form is directly related to the thought style.

The traffic of ideas and thoughts, between different collectives and within the same thought collective are fundamental and constitutive mechanisms of the production of scientific facts, which are materialized in texts, in ways that are also social and coercive.

> Cognition is the most socially-conditioned activity of man, and knowledge is the paramount social creation [Gebilde]. The very structure of language presents a compelling philosophy characteristic of that community, and even a single word can represent a complex theory. To whom do these philosophies and theories belong? (Fleck, 1981, p. 42)

Scientific fact is not an individual product, which does not mean that individuals do not participate in the process. "Cognition is therefore not an individual process […] rather it is the result of a social activity, since the existing stock of knowledge exceeds the range available to any one individual" (Fleck, 1981, p. 38). For Fleck (1981), a scientific fact is a social event that comes from coercion of thought — the circulation of ideas and cultural practices between individuals who are coerced into a form of perceiving, thinking and acting.

Education has a fundamental role in coercing individuals to a way of perceiving. According to Pfuetzenreiter (2003), for Fleck, the thought style can be passed on to generations through education, initially in the general education system, in several domains, and later through an education directed in a specific area. For Fleck (1981), "every didactic introduction is therefore literally a 'leading into' or a gentle constraint" (p. 104) to a thought collective. The didactic introduction to a collective can be considered more of an indoctrination than an incentive to critical-scientific thought (Schäfer & Schnelle, 2010).

Coercion is associated with a discourse of authority, which can be present in the teaching of Science Education, especially in the textualization of knowledge in textbooks. Science Education, mainly at the Basic Education level, can be problematized in this sense, so that it ceases to be a space for the exclusion of other meanings to be a space for dialogue and negotiation of meanings. We believe that the forms of the texts regulate the forms of exchanges, the discursive space formed. The entry of other texts

and reading mediation practices become essential for a less indoctrinating and more inclusive education.

Nevertheless, in order to participate in a thought collective, it is necessary, in addition to a direct formative view (which can be learned), the experience (as a practical action) within the field in question, since to be a carrier of a thought style implies having specific habits, in a way of doing. The notion of experience, which appears in more than one chapter of Fleck's work (1981), relates to the subject's position in regard to knowledge: the experience of the specialist is different from the experience of the "the more or less educated amateurs", and texts play a role in this experience. The greater the knowledge and experience within a community of knowledge, the greater the mastery of its languages and methods, and the greater the level of specialization of the individual. Culture/tradition and experience are conditioning factors in establishing scientific facts.

When sharing a thought style, it becomes costly for an individual to perceive the world in ways other than the collective gaze. The realizing execution comes to dominate over the creative predisposition (which can appear in the encounter and deviations of meanings between different ways of thinking and acting). Knowledge is a field of experience and it is in this field that words acquire meaning. In the case of Physics, Kuhn (1978) points out that this experience is "transmitted" by the "exemplars", whether of an experimental nature, in didactic laboratories, or of a mathematical nature, through problem solving. Problem solving embodies a way of thinking, connects language and reality in a certain way, other than by correspondence, and can be understood as a form of experience.

As we pointed out, the more one enters an area of knowledge, the greater the link with the thought collective (Fleck, 1981). In addition, the more elaborated an area of knowledge, the smaller the divergences of opinions (Fleck, 1981). The process of insertion and living within a thought style alters the subject of knowledge — conditioning their gaze — and this is what creates harmony within the system, which Fleck (1981) calls "*harmony of illusions*". Thus, in modern science, first, one must learn to see and ask questions through education, tradition and habit, in such a way that, many times, the answer is pre-formatted in the question itself. The thought style becomes coercion for individuals and defines "what cannot be thought of in any other way" (Fleck, 1981, p. 123). For Fleck (1981), the idea that a scientist wished to know something and through neutral observation and experimentation he discovers it, is a "fairy tale".

In the tangled modern society, different thought collectives intertwine and relate to each other in space and time (Fleck, 1981), moving thoughts. Fleck (1981) calls intercollective traffic the movement of information that occurs between different collectives and, therefore thought styles. Meanwhile, intracollective traffic is related to the circulation of knowledge within the collective itself. Both types of traffic are essential for the construction of scientific facts, as we will elaborate below in the sub item of this section.

The circulation of knowledge as essential for the constitution, stabilization and transformation of thought styles

Complementing, expanding or transforming the thought style requires the circulation of scientific knowledge. As previously presented, the thought collective is formed by different individuals who, in a specific discursive space, interact seeking the stability of a certain collective thought. Through circulation "(...) knowledge (...) becoming polished, transformed, reinforced, or attenuated, while influencing other findings, concept formation, opinions, and habits of thought" (Fleck, 1981, p. 42). Fleck (1981) advances in the understanding of the flow of information between different individuals, perceiving reciprocal influences on the circulation of knowledge, and circulations do not always have an intention. Next, we will start by deepening the intracollective circulation of knowledge and, later, the intercollective circulation.

The *intracollective* circulation of knowledge: Internal to the thought collective

This type of circulation can happen between peers or between different individuals belonging to the same thought collective. Through a historical analysis of the development of syphilis and the Wassermann test, Fleck (1981) shows that the establishment of this test as a scientific fact is not the result of an expert individually (it was not Wassermann who "discovered" it), there were several circulations of ideas and practices between individuals and, therefore, the scientific fact appears as a result of a collective process of science. "The communication of thoughts within a collective, irrespective of content or logical justification, should lead for sociological reasons to the corroboration of the thought structure" (Fleck, 1981, p. 106).

Fleck (1981) points out several ways to circulate scientific knowledge within the collective, depending on whom it is intended for. Through the analysis of different texts related to science, he identifies what he calls different "*sciences*": *popular science*, *textbook science*, *vademecum science* and *journals science*. Thus, Fleck (1981), describing the circles that make up modern science, coincides with a description of the textual forms that characterize them. This description, therefore, is simultaneously linguistic (or discursive), social and epistemological.

Each of these "*sciences*" has specificities, that is, main characteristics in their textual materiality. When circulating, knowledge is textualized in different ways according to the individuals involved in the interactions. Although Fleck (1981) points out four social forms of thought, the "*textbook science*" (used in the didactic introduction) is not detailed in his study, so we will not cover it here. The other "*sciences*" are discussed below.

The so-called *journals science*, the closest to scientific praxis, does not hide the internal conflicts and uncertainties of science: it has a provisional character, in addition to being characterized by personal aspects. Experts of the esoteric circle of knowledge

can be considered as "creative", as they end up personifying new ideas from their experiences and from the intersection of different thought collectives (it is in the history of individuals that there is dialogue with different thought styles). In addition, the point of view and the work method acquire a more personal character (Fleck, 1981). This science, therefore, is characterized in its form by the provisional, uncertain and personal aspects (the community must approve the scientist's ideas, thus the modesty in the way of expressing, as well as the personal caution about his interpretations), in addition to being non-addictive (however, the scientist wants his ideas to be incorporated into the community's thought style).

The knowledge that circulates in the texts of the *journals* becomes a pre-disposition of the scientific fact. Thus, in order to become a fact within the collective it still needs to acquire resistance as an idea, and for this reason the knowledge of the journals is textualized in dialogue (in the introduction or conclusion) with the knowledge of the *vademecum*, in which such knowledge exists as scientific facts. The knowledge of the experts in the *journals science* seeks to adapt to the scientific facts accepted in their context, an acceptance within a thought style.

Through the evaluation and dissemination of knowledge in the communications of the *journals*, the scientist submits his knowledge to a verification by the thought collective about the adequacy of that knowledge to the style — there is no neutrality. Thus, due to the adaptation to the thought style, and the intracollective circulation among members of the community who evaluate knowledge regarding this style, it is possible that the specialist's knowledge leaves the cautious insecurity (*journals science*) to certainty (*vademecum science*) and resistance, as a scientific fact (Fleck, 1981). The less the scientist's "creative" thinking adapts to the science's thought style, the longer the collectivization process of results will take (Fleck, 1981).

Between *journals science* and *vademecum science* there is a relationship of tension, which shows the very dynamism of science: the journals science seeks its acceptance in vademecum science, which means to be approved by a certain thought style and to have a certain objectivity (Fleck, 1981). Based on this circulation among experts, which, we emphasize, occurs through specific forms of texts, knowledge can be recognized as belonging to or incorporated into the thought style, and it can also be structured by other specific forms of texts; these with the objective of extending knowledge to the other, more external subjects, of the thought collective.

The *vademecum science* arises from a selection plan, also formed in the esoteric traffic, in the discussions of experts based on mutual understandings and disagreements. From the *journals science* to the *vademecum science*, there is a certain process of selection and simplification of knowledge. The *vademecum* moves away, to a certain extent, from scientific practice, with an impersonal language and a certain security, that is, with a more fixed character, since the changes of ideas occur with a certain slowness in this science. Specialized science in the form of a *vademecum* seeks a critical summary of knowledge in an orderly system (Fleck, 1981). The knowledge in the *vademecum* is transformed

into coercion of thoughts, thus being taught and used, becoming the central column of the scientific community (Fleck, 1981).

The *popular science*, in turn, is characterized mainly by the greater plasticity of knowledge, compared to other forms of circulation of knowledge. According to Oliveira (2012), popular science is intended for "broad circles of lay adults with general education" (p. 125, *our translation*), which must be understood at the time of Fleck's writings. In an analysis of Fleck's work, Oliveira (2012, p. 132, *our translation*) considers the layperson's "general formation" to what we now call "higher level", or something more restricted, since the "amateurs" would not be so far from the circle of experts.

Popular science, therefore, is aimed at non-experts in the knowledge in question, which is why its main characteristics are the absence of details and controversies. Fleck (1981) summarizes that popular science is simplified, illustrative and apoditic science (these are the main characteristics of exoteric knowledge). The specialized knowledge exhaustive for the amateurs is confusing and of no practical use (Fleck, 1981). The further we move away from the esoteric center of knowledge towards the exoteric periphery, the more plastic the thought becomes. Emotional plasticity gives knowledge clarity, which can be materialized by images (which supply the role of evidence) or metaphors. For Fleck (1981), these characteristics of popular science are also justified by their epistemological role, "certainty, simplicity, vividness originate in popular knowledge. That is where the expert obtains his faith in this triad as the ideal of knowledge. Therein lies the general epistemological significance of popular science" (Fleck, 1981, p. 115).

Fleck also points out other epistemological aspects of popular science: "Truth is thus made into an objectively existing quality" (Fleck, 1981, p. 116). Such a characteristic "was also created by the demands of the intracollective communication of thought and subsequently reacts upon expert knowledge" (Fleck, 1981, p. 116). The requirements of the described intracollective traffic reside in a set of anonymous rules for the production of interlocution, constituted socially and historically, which result in discursive forms.

Fleck (1981) does not detail the form of popular science, which he calls special and complex structure. He only mentions its epistemological importance and its main characteristic as textualization. It is clear, in his theory, the importance of popular science in spreading a worldview and for the development of science, which intertwines with different fields of knowledge.

> […] This furnishes the major portion of every person's knowledge. Even the most specialized expert owes to it many concepts, many comparisons, and even his general viewpoint. It thus constitutes the general operative factor in cognition and must accordingly rank as an epistemological problem. (Fleck, 1981, p. 112)

Fleck (1981) emphasizes the importance of popular science, with its form, for the construction of scientific fact. It is in popular science that knowledge becomes "incarnated" (Fleck, 1981, p. 125). Popular science with its characteristics disseminates a worldview (*Weltanschauung*) and, thus, has a fundamental role in the circulation and construction of scientific facts, since it has a retroactive effect on the experts. Although

this worldview (*Weltanschauung*) may seem insignificant to the claims of an expert, "it does provide the background that determines the general traits of the thought style of an expert" (Fleck, 1981, p. 113), it is "an exalted feeling about the solidarity of all human knowledge. Or it may be a belief either in the possibility of a universal science or in the albeit limited potential for further development in science" (Fleck, 1981, p. 113). This is the epistemological function of popular science in the production of scientific facts, and, thus, the circle of intracollective dependence on knowledge is closed. His argument, in his book, goes on to a true comparative textual and epistemological analysis between a report of a bacteriological examination with a textual component of the specialized esoteric circle and a clinical physician in his relationship, communicatively textualized, with a patient.

When Fleck (1981) distinguishes these three forms of knowledge within the thought collective, he sees different ways of structuring knowledge within the same thought style. However, given the richness of the current empirical reality, one must pay attention to the limitations of Fleck's reading, especially in relation to the characteristics of the texts. Oliveira (2012), for example, suggests that it is more appropriate to think of the different "*sciences*" in terms of emphases or in levels, because scientific articles and manuals can also incorporate characteristics attributed to popular science, such as the use of images and simplification, to some degree, of knowledge.

The *intercollective* circulation of knowledge: Between different thought collectives

Now we begin to discuss the *inter*collective circulation of knowledge. For Fleck (1981), the knowledge of a thought collective can circulate to other collectives, which results in a dynamism of science. As previously discussed, intracollective circulation promotes the tendency to stabilize the thought style by strengthening it in the collective. However, despite the tendency for the thought style to persist, Fleck (1981) argues that the style can undergo mutations or transformations; and this is closely related to intercollective movements.

Schäfer and Schnelle (2010) clarify that the expert not only belongs to his specific thought collective, but also to a "universal exoteric collective of the everyday world of life" (p. 27, *our translation*) and hence the role of "public opinion" that we have described. Fleck (1981) points out that one of the circumstances that escape the collective's logical-formal control is the expert's ability for plastic adaptations of concepts. With this, the role of popular science in the construction of scientific facts is again emphasized, since through the movement of bringing specialized knowledge closer to everyday life (an exoteric universal collective), knowledge becomes accessible to specialists from different thought collectives, and can move in an intercollective traffic in different fields of society - popular science is part of specialized science (Schäfer & Schnelle, 2010). Individuals can participate in more than one thought collective, scientific or non-scientific, participating in few collectives in esoteric circles and in many collectives in the exoteric

circle (Fleck, 1981). It is at the intersection between the different thought collectives that the subjects, in the different collectives, promote changes in their thought styles. This circulation reduces the style's coercion force, since, through these exchanges, it is not possible to control all forms of meaning over knowledge that may arise. Thus, language, which promotes circulation among different collectives, has an epistemological role in the establishment and transformation of thought styles.

> He [Fleck] recognizes the importance of language as an institution that not only enables, through its understanding, the communicability and, thus, the reproducibility of scientific knowledge, but also assumed, through "misunderstanding" (= shift in meaning), present in any communication, a positive function for the development of the sciences. The ideal language of logical empiricists should precisely avoid shift in meaning. One of the postulates of logical empiricism is the "invariability of meaning" (Bedeutungsinvarianz). For Fleck, hurting this postulate is not only part of everyday language, but it is also a necessary part of scientific language. The shifts in meaning of the concepts that occur in the intercollective exchange of thoughts can be so severe that an understanding between members of different collectives, which have also been historically divided, is no longer possible. (Schäfer & Schnelle, 2010, p. 28, *our translation*)

The word is a special medium of intercollective communication and its circulation among collectives brings a shift in the meaning of the word, "in a shift or a change in the currency of thought" (Fleck, 1981, p. 109). The word energy can have different meanings between different collectives, that is, a certain meaning in the physics collective and another meaning in the collective of an athlete, or religious, among others.

Different thought collectives are linked to different thought styles, and in some cases, depending on the differences, there is no possibility of dialogue between them (incommensurability). Thus, intercollective circulation occurs, above all, between thought styles that have common features. This is because, "the greater the difference between two thought styles, the more inhibited will be the communication of ideas" (Fleck, 1981, p. 109), the more incommensurable they are. For Fleck,

> Words as such constitute a special medium of intercollective communication. Since all words bear a more or less distinctive coloring conforming to a given thought style, a character which changes during their passage from one collective to the next, they always undergo a certain change in their meaning as they circulate intercollectively. One could compare the meaning of the words "force", "energy", or "experiment" for a 'physicist', a philologist, or a sportsman; the word "explain" for a philosopher and a chemist, "ray" for an artist and a physicist, or "law" for a jurist and a scientist. (Fleck, 1981, p. 109)

As we pointed out in this study, language can be considered one of the main traits that characterize the thought style. For Fleck (1981), the circulation of thought between

individuals leads to changes in the forms of thought, as each individual makes different associations, the receiver understands in another sense what the sender wants to be understood. These different associations transform language and, therefore, thought, since they are interrelated.

The knowledge of the collectives is built by the clash of different forces and ideas that are found internally and externally to these collectives. Fleck (1981) highlights the role of factors external to science. The scientific thought collective has a constant relationship with the general society; with its political instances and general demands that, when met by science, also legitimize and strengthen the "elite" of researchers.

Possible dialogues between elements of Fleck's and Bakhtin's theories

Fleck and Bakhtin theorize in different fields of knowledge: the former thinks of the construction of scientific knowledge, while the latter of the dynamism of verbal creation. We understand that the two theories involve different epistemological, anthropological, ethical, aesthetic aspects. Fleck (1981) brings language into his theory, with explicit passages on the dynamics of words. Bakhtin (2010) thinks of the apprehension of the world by the subject, the theory of the ethical act, although his emphasis is on knowledge of the human sciences, his theory also permeates the discussion in relation to the natural sciences. In addition, both explicitly seek an approach with a sociological bias for their object of study, in such a way that several intersections of concepts between the two theories become possible. Although no references are established between them, it is interesting to note that their writings date from a close period (1920s and 1930s), thus, both were permeated by discussions and theories that emerged at that time. It is possible to find Marxist influences in Fleck's (1981) writing, as well as in the Bakhtin's Circle theory.

Bakhtin's studies have an interactive/relational focus, that is, he thinks the language as conceived in its concrete and living integrity and not as a specific object of linguistics (Castro, 2010). For Bakhtin, language is essentially dialogical - life for him is dialogical in nature - thus, alterity defines the human being, who is essentially connected to the others (Barros, 2005). Discourse is never individual, as it is constructed between social beings (Bakhtin/Volochínov, 2014). This is because every utterance is always in a context of communication and related to other utterances (previous and successors) and, therefore, it is full of others voices (words of others), even coming from different social spheres, which merge forming a "new" utterance. Understanding an utterance requires examining the context in which it is inserted, since its existence is linked to concrete communication situations (Bakhtin, 2011).

Bakhtin (2010) makes an effort to seek a synthesis between the ontology of the existing and the epistemological processes of apprehension. He builds the theory of the ethical act, as a reinterpretation of Kant's works. This philosophical theory, exposed, above all, in the work "*Toward a Philosophy of the Act*", will support several other

bakhtinian concepts related to language (Sobral, 2008).

In Bakhtin's (2010) philosophy, the act can be thought of in two planes. In one of them, there are the concrete acts that are unrepeatable, related to concretely defined subjects; and in the other, there are the acts as activity, related to what there is in common between the acts of individuals, therefore, repeatable, as an example to be followed (Sobral, 2008). It is as if the acts could be divided into singularities and generalities, or variety and fixity (Sobral, 2008). In a way, it seeks to explain the transformations in the abstract world (repeatable) by the singular acts of different individuals (unrepeatable) that occur in the plane of experience.

From an ontology of subject as socio-historical, one of the bases of the bakhtinian thought is the idea that existence forms consciousness (Sobral, 2008). For Bakhtin, life consists of an uninterrupted sequence of acts. It is through the actions of individuals that creation, novelty and transformation arise. When thinking about verbal creation, the act gains a central aspect in Bakhtin's theory and defines the existence of a dynamism in the representation of life, resulting from individual action.

> In Bakhtin, act/activity and event are not to be mistaken for the physical action *per se,* although they encompass it, being always understood as human action, that is, physical action practiced by human subjects, an action to which is actively attributed a meaning at the moment it is performed. Bakhtin approaches this difference in terms of the distinction between the data (physical) and the postulate (the one proposed by the subject), to which it is added, to account for the aesthetic activity, the created [...] (Sobral, 2008, p. 13–14, *our translation*)

To be understood as an act, physical action must necessarily be endowed with meaning, involving, especially, the thought. Each thought, with its content, is a singular and responsible act of individuals. Bakhtin (2010) emphasizes, throughout his work, the value of considering participatory thought, which transcends theoreticism, since only through participative-responsiveness it is possible to explain the dynamism of life.

These bakhtinian philosophical concepts, to a certain extent, can dialogue with the fleckian conception of the scientific knowledge construction. Both theories take the conception of evolution of concepts through transformations that create new systems; Bakhtin thinking explicitly of the language, and Fleck of our scientific beliefs. Both authors point out that there can be incommensurability between systems when they undergo transformations, and these also come from the individuals' acts.

Fleck sees in the construction of knowledge a classical period, where there is a certain accumulation of knowledge that only reinforces the current thought style, however the slips and internal complications can manifest the period of complications (in which the exceptions to the thought style are seen) (Fleck, 1981). From the complications, ruptures with the classical era can occur, that is, transformations in the belief system. Even with the link to past ideas (such as "proto-ideas" or "pre-ideas" that may persist) a new system is created, which does not get along well with the previous one.

Bakhtin also perceives the changes in the language system. The creation of new

words, which can even result from errors and deviations when they find a favorable analogy, which maintain a relationship with the history of the language at the same time that they create a new system, because the new system does not get along well with the previous one. The systems become essentially different (Volochínov, 1973).

> A rough analogy can be used here that will adequately portray the attitude of the second trend of thought in the philosophy of language toward the history of language. Let us liken the system of language to Newton's formula for the solution of binomials. Within this formula reigns a strict set of regulations under which each term of the formula is subsumed and given its fixed function. Now let us suppose that a student using this formula has misconstrued it (for instance, has mixed up the exponents or the plus and minus signs). In this way, a new formula with its own inner regulatory principles is obtained (of course the new formula does not work for the solution of binomials, but that is beside the point of the analogy). Between the first and the second formulas there is no mathematical connection analogous to that which holds for the terms within each formula. The situation is exactly the same in language. (Volochínov, 1973, p. 55)

It is not a simple process of accumulating meanings of language systems, it is another system. Each period of time has its linguistic norm, if the transgression of the norm is not perceived as such this transgression will not be corrected, and in a favorable ground the deviation can become generalized, that is, a new linguistic norm (Volochínov, 1973). For Bakhtin, the present of the language is not understood with its history, since its laws are different.

Fleck and Bakhtin emphasize the moments of aesthetic creation and the composition of novelties and singularities in our way of perceiving and acting in the world. However, both, each in their own way, also recognize stabilizing and shaping forces of discourse. Thus, Bakhtin speaks of centripetal and centrifugal forces in the composition of discursive genres, that is, in the uses of language as a transforming force and, at the same time, of its stabilization in types of utterance on which we operate in different contexts of social life. The emphasis is on the acts of transformation, but the stabilization is there, placing the subject in ways of speaking accepted in certain spheres of communication. Fleck, likewise, emphasizes the stabilizing force of "thought styles" that enhance certain ways of perceiving and acting, but blind us to other possibilities. His focus is directed to movements of permanence and changes in thought styles (or opening to new styles, recognized by collectives that are constituted based on other premises). For Bakhtin (2010), in turn, the existence-event, while unique, encourages the entry of new elements in the concrete historical plan. However, the existence-event is not a fact, "the unity of the social milieu and the unity of the immediate social event of communication" (Volochínov, 1973, p. 47) is essential for a language fact to exist, that is, it is essential to exist a well-defined ground and interaction between people integrated into an immediate social unit. While the fact tends to remain in time and space, the existence-event is situated in the temporality of a space-time.

The characteristics described by Fleck (1981) for the several texts that circulate science structure knowledge, through exchanges there is a process of transformation of knowledge inside and outside the collective. Bakhtin can still complement this perspective about the texts with the different roles in the collective, related to its characteristics.

With regard to popular science texts, Bakhtin does not use the term "thought collective", but when thinking about discursive genres, he points out the existence of two types of "spheres": the sphere of everyday life (of fast and everyday exchanges) and the ideological sphere, which can be of art, science, morals, religion, etc. Hence, Bakhtin (2011) develops the idea of primary (simple) and secondary (complex) speech genres, in such a way that the latter absorb and digest the primary speech genres. The ideological sphere needs the sphere of everyday life to crystallize its concepts, at the same time that the sphere of everyday life is influenced by ideological spheres (Volochínov, 1973).

> The established ideological systems of social ethics, science, art, and religion are crystallizations of behavioral ideology, and these crystallizations, in turn, exert a powerful influence back upon behavioral ideology, normally setting its tone. At the same time, however, these already formalized ideological products constantly maintain the most vital organic contact with behavioral ideology and draw sustenance from it; otherwise, without that contact, they would be dead, just as any literary work or cognitive idea is dead without living, evaluative perception of it (Volochínov, 1973, p. 91).

It is through the sphere of primary genres, with "real" dialogue between different individuals that slips and new developments are more likely to occur.

> The upper strata of behavioral ideology the ones directly linked with ideological systems, are more vital, more serious and bear a creative character. Compared to an established ideology, they are a great deal more mobile and sensitive: they convey changes in the socioeconomic basis more quickly and more vividly. Here, precisely, is where those creative energies build up through whose agency partial or radical restructuring of ideological systems comes about. Newly emerging social forces find ideological expression and take shape first in these upper strata of behavioral ideology before they can succeed in dominating the arena of some organized, official ideology. Of course, in the process of this struggle, in the process of their gradual infiltration into ideological organizations (the press, literature, and science), these new currents in behavioral ideology, no matter how revolutionary they may be, undergo the influence of the established ideological systems and, to some extent) incorporate forms, ideological practices, and approaches already in stock (Volochínov, 1973, p. 92).

From the preceding excerpt, it can be seen that everyday genres (behavioral ideology) play a role in the construction and establishment of ideological systems; indeed, it is a flow in both directions. While the everyday life speech genres, for the most part, are inserted in real alternations of subjects, in real dialogue, in the various secondary

speech genres there is no real/immediate alternation of the subjects of the discourses — this is closer to an abstraction. Secondary speech genres, especially rhetorical ones, may even incorporate aspects of everyday life genres, and this happens in some modalities of scientific popularization: the author often asks questions in his utterance, which he then answers, "raise objections to his own ideas and responds to his own objections, etc." (Bakhtin, 2011, p. 276, *our translation*).

Grillo (2008) articulates Bakhtin's studies in the understanding of scientific popularization, thinking about these two discursive modalities: genres of everyday life and those elaborated in social organizations (ideologicals).

> In this process of externalization, scientific and technological knowledge come into dialogue with that of other spheres, especially with the ideology of everyday life, but also with the artistic, political, religious spheres, etc. This dialogue [...] brings together different spheres of knowledge production, composed of their own valuation centers, by their genres, by their images. This contact allows not only an increase in the state of knowledge of the presumed recipient, but also promotes the submission of scientific and technological knowledge to a living critical evaluation. (Grillo, 2008, p. 69, our translation)

Next, we bring other elements of dialogue between these two theories that can help to understand the role of texts in science, for the analysis of texts by research in Science Education and for mediation of readings in teaching situations.

Thinking of an analytical trajectory for texts that circulate science

Thinking about the analysis and understanding of the forms of the texts that circulate knowledge of science, we consider that the bakhtinian theory, in addition to the dialogues previously presented, can provide an analytical and theoretical complementation on the social-linguistic dimension. In this sub-item, we present our reading of theoretical elements, in dialogue with the fleckian ideas, which can be considered in an *analytical trajectory*.

In Fleck's epistemological theory (1981), the texts are part of the scientific knowledge production process and their forms are related to the positions of subjects and functions in the thought collective — the thought style (which has social, historical and cultural elements) will also determine choices and qualify text meanings. Bakhtin's theory of language can provide a deeper understanding of the texts. For Bakhtin (2011, 2014), the utterances are always immersed in extraverbal contexts, related to the [1] object-meaning of the text, [2] an axiological position of a subject who talks about such an object-meaning to an [3] interlocutor who determines the choices (even unconscious) about the forms of the utterance [4] within a social organization - which determine the [5] speech genre and [6] the utterance style. The utterances are constituted by [7] dialogical tones and, in the specific case of science, by speech genres with [8] specific characteristics that [9] determine the form and meanings of the scientific knowledge

that is circulating. All these aspects, in the event-existence of the utterance, generate a speech about a fact from science, that is, a scientific fact. Next, we seek to better clarify our reading of these concepts by building a sequence of questions for reflection on the texts, as a possibility of an *analytical trajectory*.

1. What is the object-meaning of the text?

The different texts have different objects-meanings, and here a first relation with textual form/materiality appears. The object of the text must be thought along with its meaning, that is, in a first relation of valuation in relation to the object: what, how and why somebody talks about it. For example, there is an infinity of texts that circulate Quantum Physics, and, in a textual analysis, it is not enough to identify that such scientific concepts are circulating, but also other aspects related to the movement of the text, which is the movement of knowledge itself, if we think from the dynamic conception of Fleck (1981). Quantum Physics can circulate as a basis for a new concept, as scientific popularization, as self-help (Lima, 2017), as a justification for a religious idea, as entertainment, as fiction, as educational material, among other possibilities; this is related to choices, cuts, omissions and emphases on the object in the text.

2. What is the axiological position of those who speak about the object-meaning, that is, who is the author-creator?

In the bakhtinian theory, the author-creator is different from the author-person because whenever an individual "talks" about something, they need to assume an axiological position within a field. Briefly resuming the issue of words, present in the theories of Bakhtin/Volochínov (2014) and Fleck (1981), from heteroglossia, being in an axiological position allows to shift the meaning of words, within the context of use. Thus, at other times, in other fields, an individual can use the same word with other meanings (in Fleck's theory (1981), the individual can carry more than one thought style). Taking an axiological position at the moment of creation necessarily implies an active principle on the way of seeing, which guides both the construction of the concrete utterance and directs the interlocutor's reading.

3. Who is the author-creator's interlocutor? 4. And what is the social organization to which the utterance is linked?

The subject of an axiological position 3) speaks to someone, who can be considered the representative of a 4) social group. The speaker of an enunciation always has an active responsive attitude, which the speaker anticipates, and it determines the constitution of the utterance. Therefore, "an essential (constitutive) feature of the utterance is its address to someone, its addressing" (Bakhtin, 2011, p. 301, *our translation*). The fact that it is addressed to someone, that it is aimed at a recipient, appears as a substantial index of the utterance. An imaginary interlocutor can be created, which in the real interaction does not coincide with the subject who participates in the interaction. That is, there may be a

presumed interlocutor, and another real one that installs itself from the circulation of the utterance (Brait, & Melo, 2008). In any case, presumed later utterances (active responses) determine the utterances. Hence the link in a speech communication chain (which links the past and the future). Fleck (1981) when distinguishing the different "*sciences*" within the thought collective, relates these to the direction of different positions and levels of experience in the collective, that is, it is about different interlocutors. However, the bakhtinian theory (Bakhtin, 2011) provides more elements for understanding this interlocutor's determination (also as a social audience) about the forms of the utterances.

The existence of spheres of communication and social activity stems from the fact that different subjects, involved in speech interactions and different social practices, can share systems of meanings. For Volochínov (1973), signs exist only in an inter-individual ground, through the social organization of individuals. Each social organization has its own signs and meanings. The social organization of which one speaks and for which one speaks determines the adoption of a speech genre.

5. From the previous elements: what is the speech genre adopted for the text?

Speech genres are relatively stable types of utterance associated with a sphere of communication or activity. Despite the stable form shared in a social organization, in everyday life use with the slips, the uniqueness of human acts, or even with new means and supports, can culminate in the transformation of these shared stable forms. However, speech genres always correspond to manifestations of culture; they are always linked to cultural spheres. Without the form of speech genres, which we use in an unconscious way, interactions between subjects would be practically impossible.

Bakhtin conceptualizes that genres are made up of three elements that are inextricably linked: thematic content, style and compositional construction. Such elements reflect the specific conditions and purpose of each sphere. For Bakhtin (2011), all fields of human activity make use of language and, therefore, its character and use is multiform, as much as the fields of human activity. In these fields of human activity, the relatively stable forms of utterance can be better characterized and studied. Similarly, Fleck (1981) points out that the study of the thought style is more conducive to *relatively stable thought collectives*, in which the "*different sciences*" also circulate.

6. Still about social organization: what is the style in which the text takes place (dogmatic, personal, what position on the object-meaning the author assumes, incorporates everyday life dialogue, etc.)? What are the particularities/feelings/judgments of the author-creator in the style (elements of expression in writing)? What are the characteristics related to the tradition of a sphere of activity (shading of words, specific vocabularies)?

Speech genres imply language styles. An axiological position characterizes the text in a style. Contrary to the common sense that gives style individual aspect, in Bakhtin, it is linked to a social group in a context/tradition. It is for this reason that Bakhtin (2011) emphasizes that the style is, above all, collective; each social organization seeks

to preserve some "traditional" forms of utterance. For this reason, each era has its own language style and elaboration of utterance, which are transformed by the individuals' acts (through dialogues with other styles that occur in their history, in the subjects' real experience). In the unique existence of creation, it is possible to exist a "*messy style*", which later can even be incorporated into the traditional style, by a certain community at a certain time. Some genres are more favorable than others for the individuality of the style (Bakhtin, 2011). Above all, a style represents a worldview, therefore, it corresponds to a unity, which takes place in the creation of textual material. Bakhtin says that,

> We call style the unit of forming and finishing procedures of the character and their world and procedures, determined by them, of elaboration and adaptation (immanent overcoming) of the material. [...] Great style encompasses all fields of art or does not exist, as it is, above all, the style of the worldview itself and only later is it the style of material elaboration. It is clear that style excludes novelty in the creation of content for it relies on the solid unity of the axiological ethical-cognitive context of life. (Bakhtin, 2011, p. 186–187, *our translation*)

If every utterance necessarily has an author, content and interlocutor, the style, despite being able to incorporate individualities, maintains a close link with the social. The style is linked to a tradition in the form of structuring utterance within a social organization — related to an axiological position, that is, a way of perceiving the world. The fleckian concept of thought style is also related to specific vocabularies and the shading of words in each field.

The understanding of words proposed by Fleck (1981) is also close to Bakhtin's conception, who understands that there is an asymmetry between the subjects[4] and, therefore, the understanding is essentially active, responsible, since it always implies a counter-word (interpretation) to the sender's word. For Bakhtin the words are neutral. This is because the meaning only appears if there is a specific orientation of a field (Bakhtin & Volochínov, 2014).

7. Is it possible to identify dialogical overtones in the text? What are the analogies and metaphors used, and for what purposes?

Fleck (1981), in his epistemological theory, emphasizes the historical and social aspect of scientific knowledge. The thought style shared by a community in a context necessarily arises from the encounter of various styles, forms of thought. For Fleck (1981) the analysis of the thought styles is possible in relatively stable collectives, in which the texts have also relatively stable forms, and in a historical, social and cultural analysis, it may be possible to perceive historical overtones (related to different contexts) that have constituted that form of knowledge.

4 The subject is determined by their socio-historical experiences, however these experiences place them in a unique place and this gives the subject a unique understanding and action. Faraco (2017) emphasizes that the basis of Bakhtin's philosophy does not lie in ontology (being as a being), but in the axiology of the subject (since one is defined by the relationship, one needs the other to constitute oneself).

Bakhtin (2011) can provide more elements to think about the constitution of the various texts that circulate science. His theory seeks to advance on the studies of stylistics, which until then considered in his analysis of styles, first, the object-meaning and, later, the expression of the author on the latter. For this, the bakhtinian theory brings the perspective of the importance, in addition to these two aspects already considered by stylistics, to add the "*other*", which is essential in the constitution of the subjects, and the style of our creation on the world. Every utterance maintains dialogic overtones with previous utterances, to which they reply, while being determined by their interlocutor (Bakhtin, 2011).

We consider that analyzing the dialogue with previous utterances is essential to understand the texts that circulate science. Each text, utterance of science, is part of a historical-social process, and, therefore, is constituted by dialogue, in the encounter of different voices.

> The utterance is full of dialogical overtones, and without considering them, it is impossible to fully understand the style of an utterance. Because our own idea — be it philosophical, scientific, or artistic — is born and forms in the process of interaction and struggles with the thoughts of others, and this cannot fail to find its reflection also in the forms of verbalized expression of our thought. (Bakhtin, 2011, p. 298, *our translation*)

When creating a thought about the world, it is not possible to talk only about an object, it is always necessary to establish dialogue, to talk with other people, whether they are peers of the community with their established forms of thought, or they belong to the external community, in a way that dialogical overtones are always incorporated into any utterance about the world.

8. Thinking specifically about the characteristics described by Fleck for each of the "sciences": what is the level of simplification, certainty, illustration, plasticity of the knowledge conveyed in the text? 9. How do the previously stated characteristics structure the scientific knowledge that is textualized? What are the differences in comparison with other types of texts that present the same scientific concepts?

On the one hand, Fleck (1981) exemplifies four forms of text constitution — *popular science*, *textbook science*, *vademecum science* and *journals science* — within the thought collective, which are determined by a certain hierarchy of initiates. Bakhtin (2011), on the other hand, explicitly cites the example of genres in science when he says that the interlocutor's apprehensive background can shape the utterance: genres of popular scientific literature, special educational literature and special research work that have interlocutors with different levels of knowledge and experience.

These textual forms have specific characteristics that we explored in detail, based on Fleck (1981), in the previous section of this study and, therefore, will not be discussed again here. We only emphasize that these characteristics are also important elements when we think of the meanings that can be generated from a text that circulates science.

For example, the level of simplification and illustration of textualized knowledge, at the same time that it can favor reading and different senses, it also distances knowledge from the expert's esoteric circle. In popular science, for example, "distortions" or "erasures" of the history and concepts of science can be identified, which can be potential or limiting in relation to approaching science for another public. Hence the need for Science Education teachers and researchers to know such texts, reflect on their characteristics and roles in order to better mediate and bring the general public closer to science texts.

From Bakhtin (2011) we can consider other theoretical elements. The texts of special research work (or "*journals science*") are closer to the scientific practice, in general, and materialize by specific style and speech genre. While the special educational literature (or "*vademecum science*") is in a circle of professional training in the area, here there is no questioning about the contents, dominating a dogmatic, doctrinal style, perhaps close to what Bakhtin calls neutral or objective styles of exposure.

> However, also the so-called neutral or objective styles of exhibition, concentrated as much as possible on their object and, it would seem, foreign to any repeated look at the other, involve, nevertheless, a certain conception of their recipient. Such objective-neutral styles produce a selection of linguistic means not only from the point of view of their suitability for the object of the speech but also from the point of view of the proposed discernible background of the addressee of the speech, but this background is taken into account in an extremely generic way and is abstracted from its expressive aspect (the speaker's expression in the objective style is also minimal). Neutral-objective styles presuppose a kind of triumph of the recipient over the speaker, a unit of their points of view, but that identity and that unit cost almost the complete refusal to expression. It should be noted that the character of neutral-objective styles (and, consequently, of the conception that serves as a basis for them) is quite diverse due to the difference in fields of speech communication. (Bakhtin, 2011, p. 305, *our translation*)

The utterance in special educational literature of science, in general, are monovocal, even for their purposes of forming a directed gaze at objects. The practice of reading this speech genre in Science Education also needs attention, in order not to become a mechanism for excluding interpretations and participants in science. Although incorporating individualities, the genres of educational literature are less suitable for the author's individual style, especially when compared to popular scientific literature, or special research work.

Thought coercion can be thought of based on both authors. For Fleck (1981) the coercion of individuals to a way of thinking, through the didactic introduction in a field of knowledge, is part of the process of stabilizing and maintaining the structure of the thought collective, formative view guarantees the "*harmony of illusions*". In Bakhtin's philosophy of language, coercion aligns with the speech of authority, practiced by the military, religious as well as in science. Speech genres within the thought collective play a role in coercing individuals to a way of perceiving, acting and thinking.

Brait and Pistori (2012) highlight the importance, when analyzing a speech genre, of considering the tradition in which it is inserted; in the specific case of science, there is a tradition of this social organization that confers specificities in its utterance, such as the monological character of the manuals, among other characteristics. No matter how changes in form and style occur, there are always dialogical overtones with the tradition of the field to which it is inserted. The comparison between different textualizations of the same knowledge can be a way to better understand the construction of textual forms in science.

Final considerations

Based on Bakhtin's theory of language, there are several studies (Lima et al. 2019; Veneu et al., 2015) with perspectives on the construction of analytical trajectories for texts related to the teaching of Sciences. However, even if issues related to epistemology are raised in the interpretations during the application of such trajectories in the analysis of texts that circulate scientific knowledge, such epistemological relations are not explained in the general proposal of analytical trajectory itself. As we pointed out in the introduction, there are studies that already articulate epistemology and discourse (Barros, 2011; Nascimento, 2005), from specific authors, and those that, within this perspective of articulation, argue about the constitutive relationships between circulation and textualization (Silva, 2017; 2019). However, the focus of this study was on strengthening relationships between two specific theories little explored jointly in the literature, Fleck and Bakhtin. When articulating elements of theories in the language and epistemology fields for the construction of a possible *analytical trajectory*, we aim to emphasize that elements of epistemology are intrinsic in the analysis of texts that circulate scientific knowledge.

There are several possible approximations between these two theories, however each one has its details and particularities related to its field of study, so that one can complement (or dialogue with) the other, aiming at a broader theoretical framework on the texts and science. Fleck (1981) specifically conceptualizes the construction of scientific knowledge and does not detail concepts related to the field of language that can contribute to analytical trajectories for the analysis of speech in texts that circulate science. Ideas such as genres, speeches, interlocutor, dialogical overtones, etc., are developed and detailed in the bakhtinian theory, which has a more extensive theoretical framework in relation to the fleckian theory, and can enrich an analysis of the textualizations of science, especially with the similarities in approach between such theories. However, Fleck (1981) describes the epistemological role of textual productions within science, which seems indispensable for thinking about any text that circulates this knowledge. Therefore, we propose an *analytical trajectory* that uses elements from both theories together to understand the role of different texts in the construction and teaching of science knowledge. The answer to each of the questions proposed in the analytical trajectory requires careful analysis and helps to answer the next question; one must seek

a total look at the set of textual construction, with verbal and extraverbal elements.

This *analytical trajectory* was applied, although not explicitly, in the analysis of a text of scientific popularization on Quantum Physics (Setlik, 2019), in addition to being part of the development of a didactic activity proposal for the initial training of Physics teachers (Setlik & Silva, 2021, to be published). In Setlik (2019), it was possible to perceive, by applying the questions of the trajectory, several limitations and potentialities of a chapter of a book of scientific popularization, analyzed in relation to the knowledge of quantum physics, from distortions, metaphors, meanings and relations with other textualizations that permeate the intention of the author of the text in the defense of a specific theory (as part of the movement for the constitution of the knowledge of science). In this case, the trajectory proved to be an engine to reflect on the text and the knowledge that is circulating. In Setlik and Silva (2021, to be published), the discussion of the trajectory with undergraduate students, within a context of training that already addressed reading issues in the teaching of Natural Sciences, provided the development of other perspectives of future teachers about texts in science, including with the appropriation of some of the concepts of such authors.

In general, the *analytical trajectory* presented in this study can be considered for the training of teachers, for analysis of texts by research in Science Education, for mediation of readings in teaching situations, among other possibilities. The perspective on the texts presented can help teachers and researchers from Higher Education or Basic Education to better understand the ways in which the texts can mobilize senses and meanings related to scientific concepts. As well as recognizing the constitutive character of the text in the construction/production of scientific knowledge, which must be problematized in Education in an approach that does not dichotomize language and epistemology, form, content and context, thus allowing working the potentials, limitations and the role of the different textual materials in relation to scientific knowledge.

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The authors declare this study was conducted following ethical principles.