EPISTEMIC AGENCY AS A CONSTRUCT OF THE SCIENCE EDUCATION FIELD: THEORETICAL ISSUES AND ANALYTICAL PROPOSALS

Agência epistêmica como um construto da área de Educação em Ciências: questões teóricas e proposições analíticas

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Abstract

One of the emerging challenges of science teaching involves the sharing of epistemic responsibilities between teachers and students in the processes of knowledge construction. In this context, the epistemic agency construct has been mobilized as a promising proposal among researchers in the Science Education field. With the purpose of discussing the meanings of the concept for the area, we address the way in which researchers have interpreted and investigated epistemic agency, focusing on the meanings attributed to the two components of the construct: "agency" and "epistemic". To do this, we seek to situate the notion of agency in the broader educational field, considering research that seeks relationships between agency, as a broader and intersectional construct, and learning. In an articulated way, we discuss epistemic aspects commonly considered in the analyses of epistemic agency. Finally, we discuss relationships between epistemic agency and power, which seems to us particularly relevant to advances in the field, considering the already consolidated discussions about the active role of the student in learning. We argue that research on epistemic agency would benefit from a more solid foundation in theories of power, which would allow: *i)* to situate the aspects considered relevant in the analyses, *ii)* to operationalize concepts specific to theories of power for analysis; *iii)* to articulate theoretical proposals about power and notions of science learning used in the field; and iv) advance understanding of transformations in learning contexts.

Keywords: Epistemic agency; Science Education; Power relations.

Resumo

Um dos desafios emergentes do ensino de ciências envolve o compartilhamento de responsabilidades epistêmicas entre professores e estudantes nos processos de construção do conhecimento. Nesse contexto, o construto agência epistêmica tem sido mobilizado como uma proposta promissora entre pesquisadores da

área de Educação em Ciências. Com o propósito de discutir os significados do conceito para a área, abordamos a maneira pela qual pesquisadores têm interpretado e investigado a agência epistêmica, dando enfoque aos significados atribuídos aos dois componentes do construto: "agência" e "epistêmico". Para isso, buscamos situar a noção de agência no campo educacional mais amplo, considerando aquelas pesquisas que buscam relações entre agência, como construto mais amplo e interseccional, e aprendizagem. De modo articulado, discutimos aspectos epistêmicos comumente considerados nas análises da agência epistêmica. Por fim, discutimos relações entre agência epistêmica e poder, o que nos parece particularmente relevante para os avanços no campo, considerando as discussões já consolidadas sobre o papel ativo do estudante na aprendizagem. Defendemos que as pesquisas sobre agência epistêmica se beneficiariam de uma fundamentação mais sólida em teorias de poder, o que permitiria: *i)* situar os aspectos considerados relevantes nas análises, *ii)* operacionalizar conceitos próprios de teorias de poder para análise; *iii)* articular proposições teóricas sobre poder a noções de aprendizagem de ciências usadas no campo; *iv)* avançar na compreensão sobre transformações de contextos de aprendizagem.

Palavras-Chave: Agência epistêmica; Educação em Ciências; Relações de poder.

INTRODUCTION

In this article, we present a theoretical discussion about the epistemic agency construct in the Science Education field. The interest in the construct and the perception that a debate is relevant to deepen it are due to the substantial increase in publications on the topic in recent years (Miller, Manz, Russ, Stroupe, & Berland 2018; Stroupe, Caballero, & White, 2018; Alzen, Edwards, Penuel, Reiser, Passmore, Griesemer, Zivic, Murzynski, Buell, 2022; Cherbow, 2023; Miller-Rushing & Hufnagel, 2022; Odden, Malthe-Sørenssen, & Silva, 2022; Zhang, Ian, Yuan, & Tao, 2022; Akgun & Sharma, 2023; Yang & Gong, 2023). Such publications have as their motto the idea that science teaching should also address the differences in the spaces of power occupied by students and teachers in the classroom (Ko & Krist, 2019; Miller *et al.*, 2018).

By mobilizing the notion of agency, such studies evoke an intersectional construct crossed by different fields, such as Philosophy, Religion, Ethics, Law, Sociology and Psychology (Sugarman & Sokol 2012; Matusov, Duyke & Kayumova, 2016). Over time, different theoretical understandings of human agency have been constructed, generating a profusion of conceptions (see Schlosser, 2015).

In Classical Philosophy, since Aristotle, human agency has been understood as intentional, conscious, autonomous and, in a certain sense, free action. Proposals from different fields share this elementary notion, starting from the idea that agency represents someone's ability to exercise control over the course of their actions, determining how to apply their will to their actions and allowing individuals to be autonomous in relation to the context in which they are inserted (Engel, 2017). In this sense, having agency is sometimes used as a synonym for assigning choice, making decisions, taking responsibility. However, many studies use the concept without defining or operationalizing it (Matusov, Duyke & Kayumova, 2016). Taking into account this particularity of studies on agency, Miller-Rushing and Hufnagel (2022) highlight the contextual and highly individualized characteristic of studies on agency in a broader sense, which can also be observed in studies on epistemic agency. Along with this observation, the authors warn that this theoretical construct needs to be supported by an analytical movement that considers the complexity and fundamental elements for participants in relation to each context.

In recent decades, notions of agency and its implications have also started to be explored by research in education, considering the demands and specificities of this field. Based on a discussion about student accountability in the learning process, Scardamalia and Bereiter (1991), precursors of the proposal, mobilized this construct to analyse the actions of students in the process of knowledge construction. This dimension of agency was called "epistemic agency" by Scardamalia, in 2002. Subsequently, Damşa and collaborators (2010) have resumed the discussion about the construct, indicating theoretical gaps in previous proposals and exploring notions about epistemic agency in the educational field.

Specifically, in the Science Education field, the use of the construct has specificities relevant to the discussion we propose in this article. Authors in the area who have been working with epistemic agency, in general, are involved in research on science teaching methodologies (e.g., inquiry-based science teaching, use of socio-scientific issues), and/or on student engagement in epistemic aspects of science (e.g., epistemic practices, epistemic cognition) (Akgun & Sharma, 2023; Cherbow; 2023; Damşa, Kirschner, Andriessen, Erkens, & Sins, 2010; González-Howard & McNeill, 2020; Ko & Krist, 2019; Stroupe, Caballero e White, 2018). The argument of these researchers is that, even in learning scenarios considered "innovative", students can

be seen being positioned as "technicians" of the teaching and learning processes. The technical term is used by Miller and collaborators (2018) to indicate that students would limit themselves to acting as "imitators" of a set of practices selected a priori without permission to shape practices related to the creation and review of explanatory models or the criteria for analysing data and evidence. Such limitations would be related to the roles and structures of the classroom community culture (Ko & Krist, 2019; Miller *et al.*, 2018).

In the format in which science classrooms operate in everyday school life, the figure of the teacher occupies a central place in the various actions of an epistemic nature, such as the tasks of selecting the scientific knowledge that will be studied and the inquiry-based practices to be adopted by students, the organization of teaching modules, the fulfilment of curricular proposals, the planning and modelling of activities, as well as the formal assessment of students and the organization of the learning space (Manz, 2015; Miller *et al.*, 2018). As the most powerful figure in the classroom, epistemic authority is recognised in the teacher, being positioned as the main decision-making agent in working with knowledge.

As a construct of intersection of areas, different dimensions of life in society are explored by authors who have investigated epistemic agency. Among them we can mention the dialogue between macrostructural aspects of society and learning in the classroom (e.g., Kane, 2015; Carlone, Johnson & Scott, 2015), aspects related to power relations in interactions between teacher and students (Akgun & Sharma, 2023; Miller et al., 2018; Stroupe, Caballero & White, 2018), and challenges faced by teachers when proposing changes in spaces of power in the classroom (Miller-Rushing & Hufnagel, 2023).

Such studies are based on the conception that the school is challenged by structures engendered by social institutions, gender relations, race, religion, and social class (Kane, 2015; Carlone, Johnson & Scott, 2015) and by the interests/disputes that permeate political choices. Opportunities for epistemic agency, in this context, are fostered through the possibility for students to express who they are and want to be, adapt, recreate and give new meanings to epistemic practices (Barton & Tan, 2010; Miller *et al.*, 2018). The learning environment, the actions of the teachers and the decision-making power with students regarding the teaching and learning processes in science classes would be relevant aspects in the construction of such opportunities. Despite this, understanding education as a complex phenomenon, simply creating learning environments rich in opportunities to engage in epistemic practices would not be enough to overcome the paradigm of the "technical" student, who imitates practices, and the consequent failure of science teaching to promote the good use of scientific knowledge in the collective space.

In this sense, the use of the epistemic agency construct emerges in the midst of the debate about the power relations that exist in these decision-making processes, mainly in the sharing of responsibilities in the construction of knowledge (e.g., Miller *et al.*, 2018; Odden *et al.*, 2022; Stroupe, 2018). However, there are some relevant issues in this context, which require theoretical deepening and an analysis of possible methodological implications for research dedicated to the use of the construct. In order to contribute to this debate, we propose the following questions:

i)   Considering that the concept of agency is prior to and broader than the concept of epistemic agency, is there something about agency, as an intersectional construct, in epistemic agency?
ii)   Considering the role that epistemic aspects have assumed in science teaching and learning, is there something about epistemic in the construct of epistemic agency?
iii)   Considering that the field already has discussions about the role of the student in learning (e.g., active student, intellectual freedom, levels of autonomy), how does the epistemic agency construct offer advances for research?

To build answers to these questions, we propose a theoretical research in which, starting from the delimitation of the field of interest, we discuss the meanings of concepts in studies in the area (e.g. agency, epistemic, power), map ideas and trends we consider central for operationalization of such concepts, as well as differences between them. Furthermore, we dedicated ourselves to a synthesis operation, presenting our arguments in response to each research question (Martins & Lavoura, 2018). Although this is not a state of the art on epistemic agency, we chose a collection to be analysed, based on some selection criteria. We consulted the database of Brazilian papers from the Coordination for the Improvement of Higher Education Personnel (CAPES), and, for international papers, the Educational Resources Information Center (ERIC) database, in addition to a search in journals of Science Education field.

On CAPES portal, we used the keyword "Epistemic Agency". The papers found referred mainly to the fields of research in Philosophy and Sociology, fields of origin for studies on agency. In a second search, we

used the "advanced search" tool, adding the term "Science Education". Considering only peer-reviewed papers, we found 5 articles. However, after analysing the title and abstract available on the platform, we observed that none of them were related to the construct we are interested. Next, we performed a third search with the keyword "Epistemic Agent". We found 177 articles, which we read the title and abstract. From this survey, only 01 article on epistemic agency in science teaching was found. In addition to the platforms mentioned above, we consulted journals considered relevant to the field in the Brazilian context[1]. This survey also did not lead us to articles on the topic. In any case, we selected papers on agency found in national research to contextualize the notions of agency in the field of research in education and help identify possible approximations and/or theoretical controversies in work in the area of Science Education (Engel, 2017; Foucault, 1982; Latour, 2013; Schlosser, 2015; Sewell, 1992; Sugarman & Sokol, 2012).

On ERIC platform, in turn, we used the descriptors "Epistemic practice" and "Agency" and "Epistemic Agency". We found 151 papers. Through the results, we observed that interest in the construct has increased. Between 2019 and 2024, 92 new works were published, 35 of which were concentrated in a one-year interval (February 2023 to February 2024). From this set, we selected 31 empirical and theoretical works that were specifically related to epistemic agency in the field of Science Education. Such numbers are an important indication of the construct as an emerging point of interest among international research. In Brazil, studies on epistemic agency in the field of Science Education are still incipient. Through the survey described previously, we found only one article produced in Latin America (Ramos, Mendonça & Mozzer, 2021).

Based on the collection listed, we organized the article into four sections:

First, we situate the notion of agency in the broader educational field, considering those studies that seek relationships between agency and learning. Such studies are relevant as they support subsequent definitions of epistemic agency in the Science Education field. Basic principles and conceptions of those studies are central to understanding how the area has understood and mobilized the construct. Furthermore, we discuss how propositions arising from Sociology traditions have been mobilized to consider the structure-agency dialectic in the classroom. Specifically, such propositions are relevant to the extent that they situate the epistemic agency construct in the debate on power relations. The mention of power relations is present in the definitions of the construct commonly adopted by the area. From this discussion, we gathered elements to answer the first question.

Next, we discuss epistemic aspects commonly considered in the analyses of epistemic agency. In addition to listing lists of epistemic practices, we discuss how such practices are proposed, negotiated and given new meanings in those studies. In this way, we gathered elements to answer the second research question.

Next, we discuss relationships between epistemic agency and power, which seems to us particularly relevant to advances in the field, considering the already consolidated discussions about the active role of the student in learning. From this discussion, we argue that the use of theories of power to analyse epistemic agency allows greater visibility to hidden dynamics of the process of change in the roles of students and teachers in the construction of knowledge in the classroom. We then propose the mobilization of a theoretical model of power, based on indications from Ethnography in Education, to analyse epistemic agency in the classroom. In this way, we gathered elements to answer the third research question.

Finally, based on a synthesis of such discussions, we present answers to the three research questions, and situate each of them in the emerging research agenda on epistemic agency.

IS THERE SOMETHING ABOUT AGENCY IN EPISTEMIC AGENCY?

Different fields of research have started to adopt/adapt the notion of agency in recent decades[2] (see Engel, 2017). In the educational field, in the same way, different relationships have been established with the

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[1] Amazônia; Caderno Brasileiro de Ensino de Física; Ciência e Educação; Ensaio: Pesquisa em Educação e Ciências; Revista Brasileira de Pesquisa em Educação em Ciências; Ensino de Ciências e Tecnologia em Revista; Investigação em Ensino de Ciências; Revista Brasileira de Ensino de Ciências e Matemática; Revista de Educação, Ciência e Cultura; Revista Debates em Ensino de Química; Ciência e Tecnologia e Revista Eletrônica Debates em Educação e Tecnologia.

[2] The notion of agency has also been appropriated by other fields of research besides education, coming to designate distinct and specific proposals. Engel (2017) discusses some examples, such as theories of collective agency, related to group actions; relational agency, which involves interpersonal actions and their implications on individual action; artificial agency, related to robotics and artificial intelligence systems.

agency construct. The review by Nieminen, Boud e Henderson (2021) presents different fronts in this direction. A first conceptualization of agency, which has been mobilized, comes from the Foucauldian tradition and examines how agency is constructed through discourse. Agency, from this discursive point of view, means determining how discursive practices produce agency within certain positions between subjects. Subjects occupy positions from which they can exercise agency under structures of power (Foucault, 1982). Another perspective, based on Latourian propositions, considers sociomaterial phenomena situated in the complex of relationships between humans and non-humans (Latour, 2013) and their contexts, including objects, places, systems, space and time. Agency, in this case, emerges from the interaction of the actors that make up a network, both human and non-human. From another perspective, based on sociocultural learning traditions, agency emerges dynamically through the actions of subjects who are situated in a social and relational environment. These traditions, based on Vygotsky's sociocultural psychology, are particularly relevant to the discussions in this article, as the relationships between agency and learning in a sociocultural perspective constitute the theoretical basis on which research on epistemic agency in the Science Education field is based. In this way, we focused on the discussions of these studies for our analyses and proposals.

The study by Scardamalia and Bereiter (1991) is representative of this type of perspective. These authors were not talking about epistemic agency, but about the agency of the student in a broader sense of learning – agency in learning. This article has become to be commonly cited by authors who published later research on epistemic agency. Thus, even though Scardamalia and Bereiter (1991) did not mention the expression epistemic agency, their ideas have begun to be mobilized in research on the topic.

The proposal of these authors is very much in queue with the various discussions related to the sociocultural perspective with a focus on positioning the student as an active subject in the learning processes. Scardamalia and Bereiter assume that the notion of agency, when considered in school contexts, may vary depending on the notion of learning adopted. The authors indicate that this variation can occur from more radical notions of constructivism, in which agency would mean a limited (or none) intervention by the teacher and the responsibility of students in learning, to notions that propose a greater balance, in which the student assumes a more active stance in learning, but the role of the teacher in mediating this process is considered, a concept consolidated in the Vygotsky tradition.

When developing their proposals, Scardamalia and Bereiter investigated competences so that students could become agents of their own educational process. To achieve this, the study was developed using a virtual environment called Computer Supported Intentional Learning Environment (CSILE), in which students used a database system with texts and graphic representations about various contents from different school subjects. The results of the research indicate that more experienced students experienced a learning process that involved understanding the content worked in classes and its representation in the world in a more autonomous way. The less experienced students, on the other hand, in order to achieve the same instructional objectives, required more support from the teacher, such as the use of guiding commands during the activities (e.g., *"that is not very convincing because..." "my own feelings about this are..."*) (Scardamalia & Bereiter, 1991, p. 43, our translation). Through this type of strategy, the teacher provided support for higher-order cognitive processes and situated these processes at the collective level of the class. In this way, reflections similar to those of the more experienced students were observed among the less experienced ones.

These results indicate that different levels of experience imply different levels of instructional support necessary for student autonomy. Such indicators, for Scardamalia and Bereiter (1991), would be important in identifying opportunities for student agency in the construction of knowledge. Scardamalia and Bereiter (1991) also discuss other teacher strategies to encourage agency in learning. An example is the focus on proposing questions from the students themselves. The teacher assumed the responsibility of assisting students in preparing questions considered most pertinent, having to deal with the implications arising from this change in focus of responsibility, considering that before teachers were the ones who decided which questions should guide the studies in the classroom.

In this teaching model, which the authors call reciprocal teaching, the nature of the activities was considered a second relevant aspect to foster agency opportunities. The authors indicate that discussion activities would be important in this model for negotiating rules and as a way of promoting student protagonism. In this way, there would be two relevant movements for developing agency in the classroom: one starting from the student, as an active participant in the learning process, and the other starting from an external assistance, provided by the teacher.

About a decade after the publication of Scardamalia and Bereiter (1991), Scardamalia (2002) resumed such discussions, proposing the name *epistemic agency* to this "new" form of agency. In this work, the author

takes up notions from the original article and emphasizes the collective responsibility of students, and agency is understood as a socio-cognitive aspect of the knowledge construction process. Notions used by recent studies in the Science Education field are mobilized from this work: i) the importance of involving students in the management of aspects that, in general, are the responsibility of teachers, such as proposing objectives, planning and evaluation of the dynamics experienced in the classroom; and ii) agency as a means that supports the advancement and improvement of knowledge based on practices of negotiating ideas at the collective level of the classroom.

Researchers in the Science Education field also recurrently use the proposals for epistemic agency elaborated by Damşa and collaborators (2010). For the authors, starting from a perspective of learning as a process of knowledge construction, agency can be considered epistemic when it expresses an intentional involvement sustained by students in collaborative activities. Within this view of learning, epistemic agency involves positioning students not as mere "carriers" of knowledge, but as productive participants in collaborative activities.

The study by Damşa and collaborators (2010) was developed in the context of a course for university students, lasting 10 weeks, through three phases. The first phase consisted of planning a project, in which students in small groups should become aware of problematic situations, recognizing their lack of knowledge on the topics and developing action strategies. The subsequent phase was the construction of analyses. In this process, there were deliberate attempts by the groups to overcome the lack of knowledge through actions, such as examining sources, collecting data, and constructing new concepts from the information obtained. And finally, in the last phase, a product generated by the project was presented. In this phase, shared understandings were established, aiming to align the level of knowledge among the participants.

When analysing the data, the authors propose two dimensions of agency: the epistemic and the regulatory dimension. The first one is related to actions that contribute to the construction of knowledge in a collaborative environment. The regulatory dimension, in turn, is related to the processes necessary to direct collaborative activity and its management, involving elements of an intentional and intersubjective nature of knowledge construction.

The regulatory dimension of the proposal is uncommon in Science Education. We found only one article that mentions this dimension in its analyses: Tan and collaborators (2021). Thus, most researchers in the Science Education field use the study by Damşa and collaborators (2010) to defend the collective nature of epistemic agency, an aspect emphasized by the epistemic dimension of their proposals (Carlone *et al.*, 2015; Kane *et al.*, 2015; Krist and Ko, 2019; Miller *et al.*, 2018; Stroupe, 2014; Stroupe *et al.*, 2018; Akgun & Sharma, 2023).

Such proposals are relevant, as they represent a first movement in the educational literature towards establishing relationships between the notion of agency and learning processes. As we indicated, this occurred in the midst of constructivist discussions about the active role of the student in the classroom. Recent studies in the Science Education field return to the proposals of Scardamalia and Bereiter (1991), Scardamalia (2002) and Damşa and collaborators (2010) when seeking a basis for their analyses. Specifically, three elements of these articles are frequently taken up by authors in the field: i) the role of students in guiding the construction of knowledge; ii) the collaborative work involved; and iii) the role of the teacher in supporting student agency.

It is important to emphasise that these elements do not explicitly refer to power relations in the classroom, although we recognise deep connections. By way of example, we could think about how strategies for working on student autonomy, the sharing of responsibilities between teachers and students and the collectivization of discussions would generate tensions between the ways of establishing autonomy, responsibilities and discussions previously operating in classroom dynamics. classroom. However, power relations were not mentioned in these seminal papers, despite being relevant to the definitions of epistemic agency among authors in the Science Education field. This is due to a dialogue and the incorporation of traditions from the Sociology field, which see the school as a historically and culturally situated and constructed space.

Expressions of this type of notion are reflected in the "structure-agency" debates in Sociology (see Sugarman & Sokol, 2012) which, in general, are in dialogue with the work of Durkheim (1949/1893). Durkheim defended the priority of "social facts" in sociological analysis. Social facts would be material and non-material aspects of the social structure that restrict agency. From this perspective, agency is thought of in association with factors external to the mind, related to the context, which provides conditions and constitutes resources for agency. This, in turn, is shared between individuals and not specifically located in one participant or another

(Sugarman & Sokol, 2012). In this way, the school is challenged by structures engendered by social institutions, gender relations, race, religion and social class. This means starting from the principle that the school is not a social island and that translocal dimensions of culture are found in this space, a notion shared by the works of Science Education that have analysed epistemic agency (Kane, 2015; Carlone, Johnson & Scott, 2015; Akgun & Sharma, 2023; Yang & Gong, 2023).

In this sense, social structures generate implications for choices and actions in the school space and, consequently, in science classes (Carlone, Johnson & Scott, 2015; Akgun & Sharma, 2023). Kane (2015), for example, uses the definition of structure of Sewell (1992): "sets of mutually sustainable schemes and resources that strengthen or constrain social action" (p. 19, our translation). In the school context, these schemes and resources would be "standardized social arrangements that define and guide the ways in which teachers and students interact and negotiate established rules and routines" (Kane, 2015, p. 3, our translation). School interests and demands, such as compliance with the curriculum, rules and task routines, influence the way the teacher deals with the formative processes of the students. When a space for conflict and contestation of these current structures is generated (Kane, 2015; Carlone, Johnson & Scott, 2015; Ko & Krist, 2018), there would be opportunities for agency on the part of students. In the work of Carlone and collaborators (2015), for example, the metaphor of cracks in the structure is used to think about situations in which agency could manifest itself.

Seemingly simple actions, such as proposing activities in which students themselves ask questions, can be ways of generating these cracks. However, the recognition of these possibilities does not reduce the challenges that paradigm shifts of this nature (initially focused on learning objectives, changing the emphasis to promoting agency opportunities) generate both for the teacher and for the institutions (Akgun & Sharma, 2023). Every action that appears to be simple carries conflicts of interest (economic, political, curricular, social) that go beyond the decisions of the teacher.

Some studies present representative results of these actions. The study of Barton and Tan (2010) explores the epistemic agency of students in an informal science teaching environment, an environment less controlled by structural pressures, such as curriculum, and strictly established roles, such as the teacher-student relationship. In this research, the authors analysed a group of twenty students participating in an extracurricular program called *Green Energy Technologies in the City* or *GET City*. The participants in this program were students between 10 and 14 years old with problems at school and in difficult situations in their families. The notion of agency involved in this study considers the structure-agency dialectic, recognizing the impacts of different social instances on the conceptions and ways of acting of people in groups. The learning environment experienced by the group involved embracing the identities and forms of communication of the students and the redistribution of power through more horizontal decision-making practices. Furthermore, the proposition of the projects developed involved the inquiry of scientific problems relevant to society, such as the indiscriminate increase in the use of energy produced from non-renewable sources, and participation in different discussion spaces, such as conversations between peers and with people responsible for public policies involving the topic investigated or experts in the field. The results of this work indicate that bringing the social world of the participants closer to the ways of doing and speaking science can generate opportunities for agency that emerge in recreating spaces of current structures, especially with regard to the freedom of decision-making of the participants throughout all stages of the developed project.

Ko and Krist (2018), in a similar direction, but based on the analysis of school contexts, discuss epistemic agency based on different levels of openness to participation and decision-making by students in science classes. In the three cases analysed in this article, tensions were observed generated throughout the actions of the teachers in favour of a redistribution of power in the classroom. One of these tensions concerns the credibility that students receive from the teacher in the decision-making process. Also in this direction, Yang and Gong (2023) highlight the dilemmas faced by a teacher in training in seeking to balance the use of authority and management of engagement in the classroom. Epistemic agency, in this sense, happens when epistemic authority is experienced in the collective, which implies the perception by students of themselves, their peers and teachers as legitimate participants in the community with the right to participate in the construction of knowledge.

This agency-structure dialectic, then, is explored with the purpose of assessing expectations of behaviour, participation and performance in the school community, as well as the ruptures of these expectations, which offer opportunities related to equity in science education (Carlone, Johnson & Scott, 2015) and opportunities for students to exercise their agency. The tensions generated in this process are an important point of study, as they describe situations in which the structure generates limitations to the agency and point out key aspects necessary for the transformation of the paradigms operating in the school space.

The work of Carlone and collaborators (2015) is an example in this direction. When assessing the identity performance of race and gender over time in science classes, the study considers situations that indicate opportunities for epistemic agency. The authors focused on the way girls performed gender discursively in the structure of science classes from the fourth grade onwards. In this context, agency was assessed between students who belonged to two minority groups: Latin American (ethnicity) girls (gender).

Carlone and collaborators (2015) analyse the agency of students through the contrast between expectations and actions carried out by them throughout one academic year to the next. The results indicate that, for the girls being monitored, encouraging good performance in science classes would be a subversive practice given the current structure. The work explores, for example, the case of student Mirabel. As a Latin American student, her performance changed over time to better fit the developmental expectations expected of girls in her age group. To explain this phenomenon, the authors propose that social situations suppressed possibilities for expanding the cracks observed in the structure and that would provide space for the agency of the student. Despite this, structural cracks may not have been observed, as the period following the history of the class did not allow for processes of rupture and transformation sensitive to the analytical lenses used.

In a similar direction, Kane (2015) studied the opportunities for expressing the agency of African-American students in the third year of junior school at a peripheral school in an instructional context of dialogic teaching. The author argues that "dialogic teaching in science offers opportunities for students to understand their ideas and connect science with their understanding of the world and life." (p. 2). In the observed class, situations of contestation of the current educational structure were observed. The teacher of this class explored the physical proximity between classmates in different ways in order to provide exchanges between peers, as well as exploring different resources used in the classroom, such as working together using books or browsing websites. These strategies were used so that ideas that emerged between peers could be used as resources by the entire group.

The analysis proposed by Kane points out that, when interactive norms for organizing the discussion and welcoming the ideas of the students were established, opportunities for agency occurred with the support of the dialogical movements of the teacher. A stance of epistemic authority of this teacher was observed when leading the discussions and helping the students back to the initial questions. However, it was possible to observe that she also distributed this authority by providing different opportunities for students to participate throughout the activities. Multiple questions and evaluations of ideas occurred in situations of contestation, both by the teacher and the students, and vice versa, and by the students among themselves. The author discusses how participants positioned themselves as agents, questioning and shaping practices based on the use of available resources.

Although this type of analysis, such as that of Kane (2015) and Carlone and collaborators (2015), is not the most recurrent among studies in the Science Education field, authors in the area return to this relationship between structure (macro) and agency to theoretical foundation of their discussions on epistemic agency. Miller and collaborators (2018), for example, discuss skills that actors - *teachers and students* - have when mobilizing resources for their own objectives, shaping the system in which they operate, being able to break established structures and reconfigure them. Such skills would be related to epistemic agency. The authors indicate that it is important to consider not only the specific ways in which students are positioned in the community, but also the expectations and changes that their actions can generate through the "cracks", as well as how they perceive themselves in this process. Other studies in the area also share the agency-structure dialectical relationship, but focusing on specific aspects of this relationship, for example: distribution of authority in the classroom (Akgun & Sharma, 2023; Yang & Gong, 2023); levels of openness of activities to active student participation (Ko & Krist, 2018; Ramos *et al.*, 2021); the safety of students in classroom discussions and tasks (Stroupe, 2014; Stroupe *et al.*, 2018).

The approaches (authority, levels of openness, student perceptions) related to the agency-structure dialectic characterize means and tools for establishing power relations in science classroom. As a key piece in the construction of students' positioning as epistemic agents, González-Howard and McNeill (2020) argue that epistemic agency happens when epistemic authority is experienced in the collective. The search for intellectual autonomy, for example, to foster spaces in which students act on opportunities for epistemic agency, would be linked to instructional contexts that seek greater levels of openness and redistribution of epistemic responsibilities (e.g. Alzen et al., 2022; Cherbow & McNeill, 2022; Stroupe, Caballero, & White, 2018). This implies that students perceive themselves, their peers and teachers as legitimate participants in the community, with credibility and the right to participate in the construction of knowledge (Ko and Krist, 2019. Miler et al., 2018). Although they consider these elements, the studies do not aim to highlight how the

transformations of these aspects occur at the level of power relations, a fundamental dimension for understanding the ways of carrying out the desired transformations in learning spaces.

These studies, despite giving visibility to specific aspects of the agency, offer analyses that revolve around a common issue: the power relations that constitute the classroom. Power relations, in these studies, are fundamental to understanding the construction of the positioning of the students as epistemic agents (Stroupe, 2014). This gives us clues about how the Science Education field has begun to incorporate power relations as a relevant aspect in proposals about epistemic agency. Despite this, in most of these studies, there is no discussion of what power means in the classroom or what theory of power underlies the analyses. We know that power relations influence opportunities for agency in the classroom, without, however, explaining ways to operationalize analyses on how this occurs.

IS THERE SOMETHING EPISTEMIC IN EPISTEMIC AGENCY?

Epistemic aspects of science classrooms have gained visibility in the Science Education literature over the last few decades (Duschl, 2008; Kelly, 2008; Stroupe, 2014; Motta Medeiros, & Motokane, 2018). These aspects make up what is considered the epistemic domain of knowledge construction, which involves the adoption of criteria through which a community proposes, communicates, evaluates and legitimizes knowledge (Duschl, 2008; Kelly, 2008). Student agency is a relevant aspect in this context, as it is related to the ways in which students themselves interpret and conduct these construction and evaluation processes (Eriksson & Lindberg, 2016).

Specifically, aspects of the epistemic domain are recurrent among research on epistemic agency, such as: recognition, negotiation and legitimization of shared ideas; use of arguments to support ideas and peer evaluations of students; student participation in decision-making (e.g. Akgun & Sharma, 2023; Cherbow; 2023; Damşa et al., 2010; González-Howard & McNeill, 2020; Ko & Krist, 2019; Stroupe, Caballero e White, 2018). Thus, there are no noticeable major differences among the practices that are commonly analysed in studies on epistemic practices. The practices, or the types of practices analysed, are the same. The difference, however, arises from the way in which such practices are proposed and/or developed. Barton and Tan (2010), for example, argue that learning corresponds to the recreation of practices from other communities, redefined in a way that makes sense for the community itself. In the case of epistemic practices, it is not enough to simply reproduce them at school in order to transform science teaching. It is necessary, through agency, to create meanings of these practices for the classroom community (Kelly, 2001).

Part of this research has sought to understand how science teachers, through an appropriate instructional context, can foster students' opportunities for epistemic agency. We understand the instructional context as the set of activities proposed in the classroom and the possible relationships between these activities and their effects on learning (see Bloome & Green, 1982; Franco & Munford, 2020). The definition by Miller and collaborators (2018) is particularly relevant for an analysis of this difference. The authors define epistemic agency as: "students *being positioned with, perceiving themselves as, and acting on* opportunities to shape the work of knowledge construction in their classroom community" (p. 6, emphasis added). Studies in the area, in general, focus on one of these three aspects listed in the definition by Miller and collaborators.

The first aspect of this definition involves the student being positioned as an epistemic agent. Through the privileged condition for decision-making, including on ways to build knowledge, the teacher becomes an essential participant in establishing an environment conducive to generating opportunities for epistemic agency. Although we do not intend to determine who has or how much agency is held or not in the classroom, the ways of negotiating and validating scientific knowledge imply complex communication practices, without which students would be unlikely to have contact in an independent way. Returning to Scardamalia and Bereiter (1991), the instructional context and the teacher's actions are relevant to the emergence of opportunities for epistemic agency.

Talking about "being positioned", then, has to do with the epistemic barriers of classrooms commonly delimited by the decision-making power of the teacher or the instructional authority in charge of defining what should be taught (Stroupe, 2018). In research on epistemic agency, this appears in different ways, from stages of teaching planning to its implementation in practice contexts and subsequent evaluations and changes.

Stroupe, Caballero and White (2018), for example, develop analyses from the stage of developing a didactic sequence for students in the 6th year of junior school, indicating the role of planning capable of positioning students with epistemic agency. In this analysis, the authors indicated how the participants involved

in planning the sequence were concerned with thinking of solutions to disagreements about how to position students in this way throughout classes. A first negotiated solution was to agree that, although teachers offered a schedule of structured activities, students could suggest changes at any time during the activity. A second solution involved maintaining opportunities for students to discuss their ideas on the public and interactional level of the classroom. It was also agreed that the team would avoid conversations about right answers.

Ko and Krist (2018) also present results in this direction, but with a focus on the actions of the teachers. The authors evaluate how three teachers supported students to act as epistemic agents, keeping in mind the curricular objectives to be achieved. In the first case, the teacher offered the opportunity for students to participate by proposing methodologies and tools to be used in inquiry-based activities with the aim of collecting data and analysing evidence. In the second case, in turn, students had opportunities to generate new explanations about the phenomenon studied throughout a sequence of classes. In the third case, the curiosity of the students to investigate an aspect of the content led the teacher to reorganize the entire subsequent teaching unit. Not only at this moment, but at others in this teaching unit, this teacher considered the decisions of the students and readjusted the planning. In the three cases presented in Ko and Krist (2018), one aspect highlighted in the analyses was the role assumed by students in decision-making throughout the activities on how to carry them out. The need for teachers to make adaptations and changes in their planning throughout classes was also highlighted, which corroborates the indications of Stroupe, Caballero and White (2018).

Such results help us realize that not just any instructional proposal will position students as epistemic agents. Based on the recognition of the hierarchization of the expected roles of a teacher and a student, instructional proposals rich in opportunities for epistemic agency would enable the negotiation and transformation of power relations in order to provide a continuous and gradual process of horizontalization of expectations intended to these roles and the relationships established between them (Miller *et al.*, 2018). This process of horizontalization does not imply epistemically equalizing the responsibilities of teachers and students, due to the clear recognition of the different levels of mastery of the epistemic and conceptual dimensions that exist between teacher and student. In the process of horizontalizing power relations, the aim is, then, to welcome the proposition of a learning environment that recognizes the student's curiosity, enabling the negotiation of epistemic practices and social norms that are closer to the forms of building knowledge typical of science, and favors collective decision-making, even if this involves dealing with unpredictability and continuous planning of teaching units (Ko & Krist, 2019; Stroupe, Caballero & White, 2018).

The studies by Stroupe, Caballero and White (2018) and Ko and Krist (2018) are illustrative of this effort. Other authors offer indications in this same direction and constitute the majority of research on epistemic agency (e.g., Akgun & Sharma, 2023; Cherbow, 2022; González-Howard & McNeill; Miller *et al.*, 2018; Ramos, Mendonça & Mozzer, 2021; Stroupe, 2014). Research in this dimension, therefore, has sought to understand how science teachers, through planning an appropriate instructional context and its mediation in the classroom, can foster the opportunities of the students for epistemic agency. This is a dialogue about how the proposed activities provide opportunities for students to participate in the process of constructing knowledge by given new meanings (for that community) to epistemic practices.

In addition to the student being positioned as an epistemic agent, perceiving and acting as an epistemic agent constitute the other aspects highlighted in the definition by Miller and collaborators (2018). In this case, the focus of the researchers falls, more significantly, on the students and less on the instructional context or the role of the teacher. In the work of Stroupe (2014), for example, this dimension is explored through the contrast between different classrooms. For students who participated in inquiry-based lessons, which the author calls ambitious, the learning environment welcomed the sharing of ideas and the debate. The process of recognizing and acting as an epistemic agent was constituted from practices, such as: students proposing themes to be investigated; reflect on such topics, in addition to correct answers to the questions asked; direct and seek to resolve the problems raised. In this sense, learning in these classes was constituted as a collective enterprise, which depended on the engagement in practices for the mutual benefit of the participants: teacher and students. In conservative classrooms, on the other hand, with environments that promoted the view of science as an accumulation of knowledge, learning was understood as an individual endeavour. The data of the authors indicate the limitations to the experience of epistemic practices, such as the discussion of ideas on a collective level. Even if movements of epistemic agency came from students, they were not sustained by the norms of interaction cultivated in these groups. In this type of context, students tended to repeat the performance of the previous context. Finding it difficult to recognise themselves as epistemic agents, students tended to ask for permission to act legitimately. In these cases, students sought to explore knowledge in the

way most common to them, for example, through memorization or searching for right answers in the book or other forms of consultation.

The study by Cappelle and collaborators (2023), in turn, also offers indications in this direction. The authors analysed events in temporally distant science classes in the same class throughout the first three years of junior school. One of the aspects of the analyses indicated who took the lead as an agent of the actions taking place in class interactions. The variations in the positioning of this agent indicate that, over time, the class began to perceive itself as an agent who, collectively, conducted investigations. In this way, students recognise themselves and act as epistemic agents to the extent that their learning objectives begin to be considered at the social level of the class and they feel responsible for what is studied in their science classes.

This set of studies, both those that focus on the role of the teacher and those that emphasise student participation, reiterate some challenges that, in an articulated way, point to the need for multidimensional changes in the school and classroom context, namely: i) epistemic authority needs to be redistributed and not be concentrated in the hands of the teacher, even in inquiry-based activities (Miller *et al.*, 2018); ii) this redistribution of power demands intentional action from the teacher and/or school, as students themselves are unlikely to assume roles as epistemic agents in current education systems (Ko & Krist, 2019); and iii) students must feel safe to take on new roles, proposing topics for inquiry, making decisions throughout the process and feeling responsible for what is studied (Stroupe *et al.*, 2018). As we discussed in the previous topic, a relevant aspect of these discussions involves power relations in the classroom. Positioning students as epistemic agents requires changing the power dynamics in the classroom. Recognizing oneself and acting with agency, in the same way, demands other power dynamics in the relationships between teacher and students.

EPISTEMIC AGENCY AND POWER

Aspects of epistemic agency discussed by the Science Education field are considered by studies that position students as active subjects in the process of knowledge construction. In our discussion, we understand these aspects as means and tools that constitute part of the process of negotiating power relations in science classrooms. Without losing sight of the potential of epistemic agency as an intersectional construct, which mobilizes theoretical bases from different areas of knowledge, the integration of these elements – *repositioning participants in the knowledge construction process, sharing epistemic responsibilities, providing the opening of instructional levels* – to other theories, it contributes to the construction of multidimensional interpretations of everyday classroom life. Therefore, in this section we seek to situate ourselves in relation to the literature in the field of Science Education. In studies on Inquiry-based Science Teaching, the majority teaching approach in research on epistemic agency, the active role of studies is a premise. In part, such relationships go back to the bases of this research, associated with theories that position students in this way.

In the proposals of Vygotsky, for example, we find an understanding of the mediating role of the teacher in the classroom and the interaction between peers for the negotiation of culturally and historically situated meanings. The implications of the theory of Vygotsky on the roles of the student and the teacher lead, to a lesser or greater extent, to considerations about epistemic authority, a central aspect of epistemic agency. In this sense, even in studies that do not mention epistemic agency, there are aspects that are central to the construct.

Carvalho (2018), for example, discusses the relationship between inquiry-based teaching and the intellectual freedom of the students. For the author, regardless of the strategies adopted by the teacher, "the main guideline of an inquiry-based activity is the care of the teacher with the level of intellectual freedom given to the student and with the elaboration of the problem" (...) and "without intellectual freedom they will not have the courage to expose their thoughts, their reasoning and their arguments" (p. 767). The recommendations of Carvalho are in queue with the necessary security and confidence that students should feel when participating in science classes, recurring aspects in studies on epistemic agency.

Based on previous studies and proposals, the author presents different levels of freedom in inquiry-based activities, whether through the use of experiments, problem solving or discussions of texts about historical cases. Figure 1 shows one of these proposals.

	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
PROBLEM	T	T	T	T	S
HYPOTHESES	T	T/S	T/S	S	S
WORK PLAN	T	T/S	S/T	S	S
DATA COLLECTION	S	S	S	S	S
CONCLUSIONS	T	S/T/Class	S/T/Class	S/T/Class	S/T/Class

Figure 1: Levels of freedom in an experimental activity based on Carvalho*,* Ricardo, Sasseron, Abib e Pietrocola (2010)[3].

In this type of proposal, the responsibilities of students and teachers are different, according to the level of freedom. Other authors explore similar proposals. Banch and Bell (2008) and Bell, Smetana, e Binns (2005) propose four levels of openness: confirmatory inquiry, structured inquiry, guided inquiry and open inquiry. In confirmatory inquiry, students know the question, the inquiry procedures. At the next level, structured inquiry, students begin to propose explanations based on data. In guided inquiry, students simply receive the question from their teachers and design the inquiry method. In open inquiry, students themselves propose the problem and plan its resolution. Batista (2010), in turn, summarized the representation of a continuum of the opening of inquiry-based activities at three levels (Figure 2).
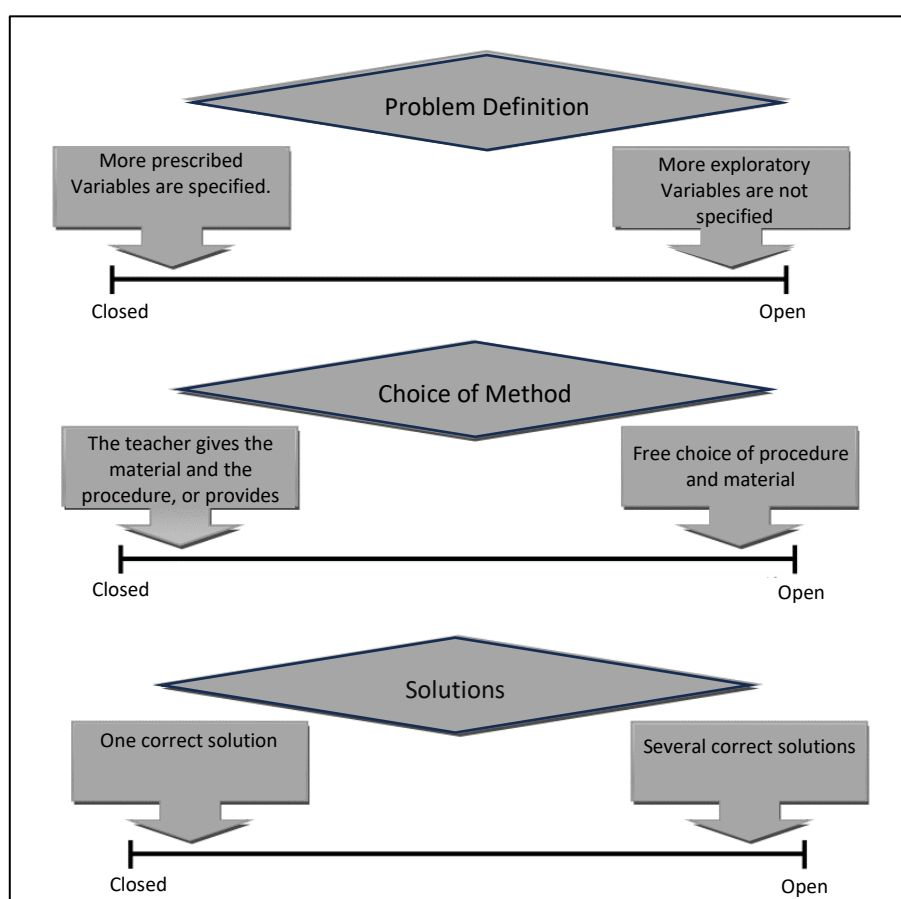

Figure 2: Continuum of levels of openness in inquiry-based activities.

The first level refers to the problem definition stage. At this stage, the lowest level of openness refers to the definition of variables, while the highest level of openness refers to more exploratory degrees of the inquiry. The second stage of the continuum refers to the choice of method, where in the most closed level the teacher provides the material and in the most open level the students have free choice about the procedures and materials to be used. The third stage refers to the solutions. At the lowest level, there is only one solution and at the most open level there are several correct answers (Batista, 2010). The same author, based on other

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[3] S (students), T (teacher).

indications from research on inquiry-based teaching, proposes that such levels are also related to the need to give correct answers, the possibility of taking different paths to reach answers, or the level of guidance that students receive throughout the activities (Figure 3).

In a study that specifically analyses epistemic practices, Batistoni and Silva, Gerolin and Trivelato (2018) also explore aspects related to the concept of epistemic agency. The study associates the inquiry-based approach with the establishment of opportunities to experience epistemic practices. This research in particular presents an interesting approach to studies on epistemic agency. The results correlate the levels of openness to student participation (related to levels of autonomy) with the diversity of experience of epistemic practices in an inquiry-based context. Thus, teaching episodes with a great diversity of epistemic practices were also moments in which transformations occurred when students decided what would count as data, evidence, pattern and explanation in the inquiry. The power to make decisions throughout activities is one of the most recurring aspects in studies on epistemic agency.

In these works, therefore, autonomy (or intellectual freedom) is pointed out as an indication of the protagonism of students in the transformations of knowledge under construction, specifically when thinking about the level of structuring/orientation of instructional proposals in science classes. That is, the active stance of students, their engagement with greater autonomy and decision-making power are associated with the levels of openness of the inquiry-based activities. This type of analysis is close to those studies that emphasise the dimension of "being positioned with" epistemic agency.
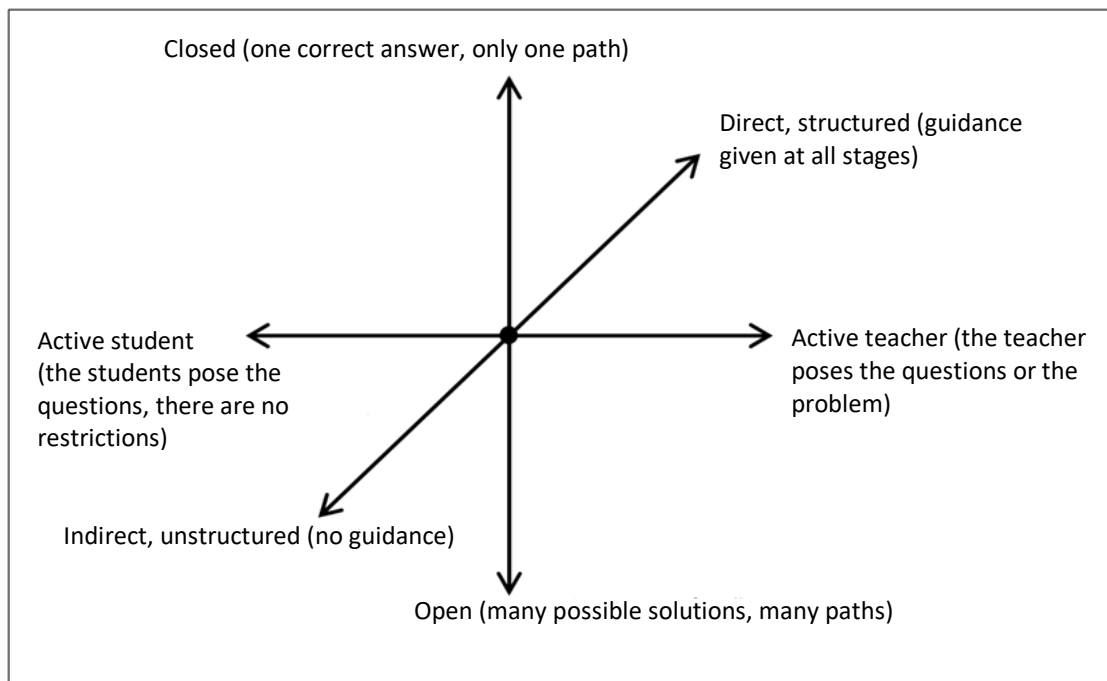

Figure 3: Different dimensions of inquiry-based activities.

Given the indications of these studies, it is worth asking: what advances does the epistemic agency construct bring to the field of research? If we start from the consensual view on the active role of students in science learning, as well as their protagonism related to different levels of autonomy in activities, the advances may not seem so significant. Despite this, there is one aspect that is continually reiterated in studies on epistemic agency: power relations in the classroom. Studies that discuss levels of openness in activities or intellectual freedom of students, even if they maintain an implicit relationship with discussions about power in the classroom, are not emphasised. Studies on epistemic agency, on the other hand, emphasise such relationships. This occurs in those definitions of epistemic agency that explicitly mention power, and/or work with categories, such as epistemic authority and its necessary redistribution, or decision-making power throughout activities.

We understand that this framework can promote advances in the field, as it expands the debate about the levels of openness and deepens the propositions about epistemic agency that have already circulated in the field more recurrently (e.g., Miller *et al.*, 2018). When we talk about epistemic agency, we give visibility to

power relations in science learning, something that, until then, was implicit in the research mentioned above. Furthermore, as pointed out in our review, even though power relations are highlighted in the definitions of epistemic agency, there is no deepening of power theories in those studies. In this way, we understand that both the field and studies on agency benefit from the theoretical-analytical mobilization of theories of power.

The concept of "power" is complex and there is a multiplicity of meanings attributed to it (Bloome Carter, Christian, Otto, & Shuart-Faris, 2005). The model of power that guides research in education generates implications for the analysis of learning and for the very conceptions of agency mobilized by the researchers.

Depending on this model, power can be understood as a **product**, which implies recognizing it as something culturally measurable. Through this notion, knowledge is understood as a form of power when it is quantified in a series of skills, concepts and tools. Members of a classroom, therefore, may possess more or less knowledge, of greater or lesser quality, or even obtain greater privileges from its use. The authors argue that, in this model, knowledge is configured as symbolic capital, from which there are possibilities for negotiation and obtaining advantages (Bloome *et al.*, 2005). When considering power as a product, maintaining the values of that product also depends on the desire and search of people for this power. Inequalities in knowledge status, for example, link this conception of power to the deficit model. The way to grant power to those individuals (or institutions) with less prestige in terms of knowledge involves offering specific knowledge. This logic also implies the unequal acquisition of the symbolic capital represented by knowledge (Bloome, Power-Carter, Baker, Castanheira, Kim, & Lindsay, 2022).

Analysing power relations from this perspective configures agency as a commodity. In this scenario, agency would be possessed, not exercised, and it would be possible to quantify and measure it based on defined parameters. The work of Odden and collaborators (2023), for example, comes close to this model of power when analysing epistemic agency in science classes. In this case, the authors quantify the level of agency (in tables and visual schemes) by associating different criteria related to the domains of scientific knowledge and theoretical pillars (inquiry, experience in scientific practices, and the social character of knowledge construction) already established in the field of research. To measure the level of agency, the analyses considered the work carried out by the students and their oral presentations throughout the classes.

By mobilizing different perspectives, power can be understood as a **process**. In this notion, it is not possible for power to be accumulated or held by an individual or group as if it were a commodity, but it is established through the process of structuring interpersonal interactions. In science classes, for example, we could see this perspective in students who, despite recognizing the epistemic authority of the teacher, act by exerting power when carrying out activities in groups. The practices and meanings negotiated by the group constitute an important aspect of this notion. From discursive interactions, ways of living in that group and their own meanings are established through which a common culture is constituted. In this way, participants use established practices to determine what is acceptable or not, what is part of the repertoire of the group or what is foreign to them. When analysing discursive situations in the classroom through this model of power, we seek to understand the processes of naturalization of skills, hierarchical concepts organized by curricular proposals (or other formatters) by that community (Bloome *et al.*, 2005).

In this model, control is found in reinforcing the interpretative structure of existing discourses and paradigms, which, through meanings and symbols accepted by the community, rejects other ways of existing - of thinking, acting or interpreting the world. These reinforcements of the interpretative structure encourage the recreation and maintenance of the dominant culture in a way that masks its coercive character. In a science classroom, this form of coercion could be perceived in the validation of scientific knowledge alone without considering other rationalities that the student could explore when constructing their discourse.

Furthermore, the knowledge to be explored in the classroom is subject to the choices made by the agents responsible for determining it. The arguments presented by them to justify the choices can be based on the operating ideologies, interests of certain sectors and the formative needs of society, among other relevant aspects. The formation of this system of choices and the relationships between agents and arguments

are part of the process of naturalizing selected knowledge and delimit what will be acceptable or not within the scope of knowledge and skills to be explored in the classroom (Bloome *et al.*, 2022).[4]

Akgun and Sharma (2023) align with this notion of power when presenting analyses of a project that involved collective planning and reflection at school that began in science classes. As a strategy to promote agency, they opted for planning that was not only focused on previously established learning objectives, but also made it possible to accept the ideas proposed by students during the activities. Throughout the classes analysed, students participated in the construction of how they would achieve the answers and were able to suggest changes in planning. The pedagogical challenges encountered by the team of educators were discussed collectively throughout the classes. The authors, then, portray the transformation in power dynamics, which was not limited to the classroom space, but expanded to other institutional dimensions of the school, in a process of negotiation of aspects, such as the format of classes, the role of students, the roles of teachers and other education professionals in the school.

Power *over* and Power *with*

Inequalities generated by power relations are historically sustained in aspects, such as oppression, exploitation and violence, guiding themes in discussions about power relations (Bloome *et al.*, 2005; 2022). Resistance to these aspects permeates transformations in the historical nature of these relationships with the recognition of the full rights of all and by all (Bloome *et al.*, 2022).

This conception of resistance, for the authors, is the basis that differentiates what they call "power *over*" from "power *with*". The characterization of "power over" is guided by relationships established through oppression, coercion, exploitation and violence. The characterization of "power with", in turn, is linked to the resistance to these aspects and related social transformations. Thus, for the authors, the interpretation of power relations experienced in a community, based on these proposals, comes through knowledge of the cultural dynamics and meanings of that group, as well as the ways in which people act and react to each other in the construction of their daily lives (Bloome *et al.*, 2022).

The proposed meaning of "power with" provides resistance to the main community implications of "power over". Thus, the agents of this relationship are not guided by the foundation of domination (recognised in those who occupy the place of the dominated and dominant group) or social hierarchy, but based on mutual recognition and care as power relations (Bloome *et al.*, 2005; 2022).

In "power with" dynamics, discourse reiterates itself as a central element of analysis. Through it, the affective dimensions of relationships are revealed, such as commitment, partnership, support, mutuality and self-determination for oneself, for others and for the community (Bloome *et al.*, 2005; 2022).

The character of resistance inherent to this model of power relations highlights the social and historical context in which the practices and forms of existence of the community that exploits it need to overcome (Bloome *et al.*, 2005; 2022). Structurally, "power over" is privileged, naturalized and belongs to common sense (Bloome *et al.*, 2005; 2022). In this way, "power with" resides in alternative dynamics of establishing relationships between participants, practices and constituent objects, even in the face of pressures and complexities existing in the relationship of resistance established between the macrostructure (feeding "power over") and the microstructure (resisting through "power with"). This perspective of power recognises the multidimensionality of the relationship of participants with their stories and experiences by enabling the formatting of their resistance as an agency articulated in the collective (Bloome *et al.*, 2022).

Such assumptions seem particularly interesting to us to support notions of epistemic agency in the classroom. Definitions such as that of Miller and collaborators recognise that epistemic agency only occurs through changes in power relations, related to knowledge construction processes, in the classroom. In this context, the role of the teacher is placed in the construction of *power with* relations in the classroom, considering that their epistemic authority is preponderant. If the construction of this environment does not come

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[4] Bloome and collaborators also propose a notion of power as relationships of care. This model proposes an alternative conception of power, in which relationships do not operate based on coercion, but on "the potential to bring people together for mutual benefit, both with regard to social relations and other achievements" (Bloome *et al.*, 2005. p. 165).

from the initiative of the teacher, it is unlikely that students, on their own, will find opportunities to recognise themselves as epistemic agents (Miller *et al.*, 2018).

The structure on which the community is based can favour greater or lesser degrees of protagonism in the classroom. Structural constraints, such as curricula, institutional organization of the school and classroom dynamics themselves, can hinder the emergence of changes in the social roles performed by the participants and the redistribution of epistemic authority (Stroupe *et al.*, 2018). Thus, when the community is not engaged in forms of "power with" relations, resistance to the oppression of "power over" relations becomes insufficient to change the operating power dynamics. However, studies in the Science Education field have already indicated that there are ways to deal with these contextual tensions to promote epistemic agency (Akgun & Sharma, 2023; Cherbow, 2022). The unilateral effort, just by the teacher or students, in search of the redistribution of epistemic authority, is not sufficient for the proposed changes. Furthermore, the efforts towards agency of different participants do not carry the same weight.

Stroupe and collaborators (2018) argue that, to position students as genuine epistemic agents, it is necessary for epistemic authorities to choose to break with the dominant dynamics, that is, through "power over" relations. To achieve this, it would be necessary to accept that students and teachers can occupy a less unequal epistemic plane of participation, as *co-designers* (Akgun and Sharma, 2023; Stroupe *et al.*, 2018), a proposal alluding to "power with" relations (Bloome *et al.*, 2022). As indicated by Stroupe and collaborators (2018), there are important aspects for science teachers to be able to make this move of positioning students as agents: i) take into account the unpredictability generated by the change in the teaching perspective; ii) readjust the instructional objectives and iii) rethink the instructional dynamics of the classroom.

Scardamalia (2002), when proposing the epistemic agency construct, indicated the difficulties that would be faced by teachers with the changes demanded. With the decrease in control, there is room for unpredictability and uncertainty regarding the possible paths to be taken throughout a teaching unit, which creates challenges for teachers (Akgun & Sharma, 2023).

The study by Stroupe and collaborators (2018) provides indications in this direction. The teachers investigated, when planning a set of lessons on *Lepidoptera*, faced some challenges reported in the research. A first challenge was related to the importance of students shaping their knowledge without solutions to learning conflicts being anxiously proposed or prescribed by the teacher to correct misconceptions. However, just as it was a great challenge for teachers to recognise this aspect, this aspect was highlighted as powerful by the authors, as it would enable students to follow the non-linearity of the knowledge construction process. A second tension faced by the teacher and researchers in this study, when planning the teaching unit, was how to redistribute part of the power historically allocated to teachers and what the role of adults would be from then on. The opening for the repositioning of the participants began with the willingness of the adults to share the space for dialogue in order to negotiate ideas. Another important aspect observed by the authors was the willingness of the students to take on these new roles. That is, the history and culture in which the students were inserted were important starting points for the movements made by the teachers in favour of the opportunities for epistemic agency.

The authors chose to establish standards and combinations of conduct that could be changed, as they were demanded and proposed by the students. In addition to favouring the expression of insights that arose among students throughout the activities, keeping the attention to the time available – *another common concern for teachers.* Stroupe and collaborators (2018) argue that the pedagogical proposal aimed at epistemic agency requires the participation of multiple classroom constituents in the negotiation process and, as a result, decisions were not individual responsibility, but collective.

Given the above, an important factor in generating opportunities for epistemic agency in the process of knowledge construction is to consider, request and explore the knowledge of students as a resource for learning. In science classrooms, the life experience of the student is generally disregarded and only one epistemology is explored, the scientific one. Although scientific knowledge is valuable and of high quality, it is not an absolute and unique truth in the lives of students (Feinstein & Waddington, 2020). Students have other experiences and contact with other epistemologies that make sense and guide their lives (Barton & Tan, 2010).

Recognizing other epistemologies that influence the knowledge of the student does not imply the relativization of scientific knowledge, but a proposal for the meaning of this form of knowledge for the student. As Miller and collaborators (2018) argue, more than recognizing the experiences and knowledge of the students as learning resources, it is necessary that they are understood by the community as valuable for the

process of constructing scientific knowledge, an aspect that is also close to the dynamics of power over (Bloome *et al.*, 2022).

These examples help us to understand how studies in the Science Education field are conceiving "acting with power to shape scientific work in the classroom" (Stroupe *et al.*, 2018, p. 1190). In the same direction as the aspects previously discussed, this action with power is linked to the conceptions of "power with" proposed by Bloome and collaborators (2022). It is through a more collaborative dynamic of knowledge construction that opportunities for agency are expanded in the classroom.

FINAL CONSIDERATIONS

Based on studies in the Science Education field, as well as productions related to notions of agency and power relations, we organized the discussions in this article around three guiding questions. We return to these questions here, aiming to present a synthesis with the constructed answers:

Considering that the concept of agency is prior to and broader than the concept of epistemic agency, is there something about agency, as an intersectional construct, in epistemic agency?

The alignment of proposals for epistemic agency occurs, predominantly, with the notion of agency originating from the sociocultural tradition (Nieminen *et al.*, 2021). This arises from the constructivist basis on the role of the student in the teaching and learning processes. Specifically, three aspects of this foundation are frequently discussed in studies on epistemic agency: i) the role of students in guiding the construction of knowledge; ii) the collaborative/collective work involved in this construction; and iii) the role of the teacher in supporting student agency.

Another theoretical construction, in this case coming from sociological theories, takes up the relationships between structure (macro) and agency to substantiate epistemic agency. The agency-structure dialectic emerges from the focus on different aspects of this relationship, such as: i) the redistribution of epistemic authority in the classroom; ii) levels of openness of activities to the active participation of students in activities; iii) the safety of students in discussions and tasks; iv) the possibilities for the teacher to change curricular and/or planning structures in force in their school community.

In short, the notions of agency that appear in studies in the Science Education field consider the impacts of historically and culturally constructed structures on the way people or groups act in the process of knowledge construction. Agency, from this perspective, would involve transformations, on a smaller or larger scale, of this structure. Such transformations would be marked by changes in aspects, such as: roles in the classroom, student protagonism, responsibility for the construction of knowledge, intellectual autonomy, security and epistemic authority. In this sense, the literature discusses ways in which opportunities for epistemic agency are stimulated. Thus, one of the main transformative forces originates in movements made by the teacher in favour of the redistribution of epistemic authority in the classroom. With this, students can explore the openings generated by these movements, exercising protagonism and advancing towards greater degrees of autonomy and participation in decisions in the process of knowledge construction.

Considering the role that epistemic aspects have assumed in science teaching and learning, is there something about epistemic in the construct of epistemic agency?

Epistemic aspects refer to what the area has considered as the epistemic domain of knowledge construction, which involves the adoption of criteria through which a community proposes, communicates, evaluates and legitimizes knowledge. In studies on epistemic agency, these aspects refer to engagement in practices, such as: recognition, negotiation and legitimation of shared ideas, use of arguments to support ideas, and peer evaluations (of ideas and arguments); the participation of students in the decision-making process of ongoing research.

In this sense, such research is close to studies that commonly deal with the analysis of epistemic practices in science classes. The difference observed in studies on epistemic agency arises from the way such practices are proposed and/or developed. It is notable that in agency studies there is a movement towards placing students in a position of greater authority in the construction of epistemic practices. Therefore, there are not only instructional objectives related to the appropriation of practices, but also to their negotiation process. In this sense, an aspect commonly highlighted is the role of students in decisions about how to carry

out activities, which generates different demands, such as the need for the teacher to make adaptations and changes in their planning throughout classes.

Thus, other practices appear in this study, such as the students proposing what will be investigated (and not the teacher), and the status of knowledge being linked to the value constructed in the community; reflect on such issues, direct and seek to solve the problems raised. Students decide and feel responsible for the inquiry, therefore, demarcate the epistemic aspects analysed in research on epistemic agency.

Considering that the field already has discussions about the role of the student in learning, how does the epistemic agency construct offer advances for research?

Research that has analysed epistemic agency shares with other research in the field the premise of the active role of students in the learning process. However, an aspect reiterated in studies on epistemic agency has little visibility in other research that does not use this construct: power relations in the classroom. In the discussion we propose in this paper, the aspects related to the agency-structure dialectic reveal means and tools for establishing power relations, which are not unique and are part of a complex and multifactorial reality. With theories of power as a theoretical-analytical contribution, studies on epistemic agency, marked by highly contextualized definitions, can favor understandings located in group culture by understanding the power tensions that exist in the power dynamics experienced in the daily classroom, as well as in moments of transformation.

Epistemic agency is a construct proposed as a meeting point between different instances that impact the process of knowledge construction and that are widely debated in educational theories: structuring issues of classroom interaction spaces; the actions of the teacher; and the perceptions and ways of acting of the students themselves. In this sense, our discussion points to the need to articulate the analysis of epistemic agency with theories about power.

Research on epistemic agency would benefit from a more solid foundation in theories of power, which would allow: i) to locate the aspects considered relevant in the analyses, ii) to operationalize concepts specific to theories of power for analysis; iii) to articulate theoretical proposals about power and notions of science learning used in the field; and iv) advance understanding of transformations in learning contexts. Taking as a perspective the representative elements of power relations present in studies on epistemic agency, we understand that theories of power mobilized as an analytical contribution can also favor the development of understandings about the interpersonal and subjective dimensions of agency, an important gap in this topic. This potential could be materialized in studies that seek to make visible how students perceive themselves and act when working with knowledge, and how they participate in the creation of spaces for collective accountability.

Furthermore, the theoretical model of power that guides research has implications for the analysis of learning and for the conceptions of agency used by researchers. Depending on this model, research recognises power in the classroom as something measurable, a product, making it possible to quantify agency based on defined parameters; or a process, something established by negotiations in everyday interpersonal interactions. From our perspective, the area would benefit from studies aligned with a model of power as a process, characterizing interactions in the classroom based on power dynamics of a more coercive (power over) or collaborative (power with) nature.

A relevant implication of using this type of model is that the concern would not be so much with indicating whether or not epistemic agency occurs in science classes, or measuring it; but characterise how opportunities for agency can be expanded or restricted. Among the challenges faced by teachers in proposing environments that foster opportunities for epistemic agency, we find the ability to move between different degrees of freedom and sharing of epistemic responsibilities, considering the reality of their classes. Agency limitations go beyond the agency exercised by the teacher himself, such as the school curriculum, institutional demands, and families' goals and expectations regarding students' academic success after school. In the literature, collective ways are indicated to work on this demand in a democratic and collective way in the school environment. Expanding this trend and considering the reality in Brazilian schools, we understand that understanding the processes of transformation of existing power relations in the classroom will also help to highlight relevant dynamics of the transition process between participants' ways of acting in the classroom. We lack studies that focus on understanding this powerful gap in the field, in order to characterize and understand elements that are still unknown in the processes of transforming work environments with knowledge in the most diverse contexts.

Students have agency, even if to different degrees. That is, *students always have agency.* For example, if they choose to resist to the instructions of a teacher, if they accept the content being taught as relevant, or if they challenge the dominant ways of speaking or thinking in the classroom, they are expressing agency. However, it is relevant for the Science Education field to focus on those opportunities for agency related to the ways in which students propose, communicate, evaluate and legitimize knowledge in science. Opportunities for epistemic agency can be generated from the possibility for students to adapt, recreate and give new meanings for epistemic practices.

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