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ARTICLE

Science learning: an analysis of discursive interactions and different space-temporal dimensions in the classroom daily life

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ABSTRACT

In this paper, we analyze the construction of Natural Sciences science learning opportunities in a group in elementary school. Guided by ethnography in education, we followed the daily life of a group over three years. Using a historical analysis of science lessons, we selected an event with analytical potential. We explored discursive interactions in this event, characterizing movements in which the participants recognized, shared and/or deviated from proposals of engagement in practices and use of knowledge related to the conceptual, epistemic and social domains of science. The results indicate how learning processes were constituted from articulations between such movements and intercontextual relationships coming from different space-times with translocal meanings. We discuss potentialities and challenges facing different contexts in the classroom daily life, as well as implications for the notion of contextualization.

KEYWORDS

science learning; discursive interactions; intercontextual relationships; ethnography in education.

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APRENDIZAGEM DE CIÊNCIAS: UMA ANÁLISE DE INTERAÇÕES DISCURSIVAS E DIFERENTES DIMENSÕES ESPAÇO-TEMPORAIS NO COTIDIANO DA SALA DE AULA

RESUMO
Neste artigo analisamos a construção de oportunidades de aprendizagem de Ciências da Natureza em uma turma no início do ensino fundamental. Orientados pela etnografia em educação, acompanhamos o cotidiano desse grupo ao longo de três anos, construímos uma análise histórica das aulas de ciências e selecionamos um evento com maior potencialidade analítica. Exploramos interações discursivas nesse evento, caracterizando movimentos em que os participantes reconheciam, compartilhavam e/ou se desviavam de propostas de engajamento em práticas e uso de conhecimentos relacionados aos domínios conceitual, epistêmico e social da ciência. Os resultados indicam como os processos de aprendizagem se constituíram mediante de articulações entre tais movimentos e relações entre contextos provindos de diversos espaços-tempos com significados translocais. Discutimos potencialidades e desafios diante de diferentes contextos no cotidiano da sala de aula, bem como implicações para a noção de contextualização.

PALAVRAS-CHAVE
aprendizagem de ciências; interações discursivas; relações intercontextuais; etnografia em educação.

APRENDIZAJE DE CIENCIAS: UN ANÁLISIS DE INTERACCIONES DISCURSIVAS Y DIFERENTES DIMENSIONES TEMPORALES-ESPACIALES EN EL COTIDIANO DE LA SALA DE CLASE

RESUMEN
En este artículo, analizamos la construcción de oportunidades de aprendizaje de Ciencias de la Naturaleza en una clase al princípio de la escuela primaria. Orientados por la etnografía en educación, acompañamos el cotidiano de ese grupo a lo largo de tres años, construimos un análisis histórico de las lecciones de ciencias y seleccionamos un evento con potencial analítico. Exploramos interacciones discursivas en este evento, caracterizando movimientos en los cuales los participantes reconocían, compartían y/o se desvían de propuestas de participación en prácticas y uso de conocimientos relacionados a los dominios conceptuales, epistémicos y sociales de la ciencia. Los resultados indican cómo los procesos de aprendizaje se constituyeron a partir de articulaciones entre tales movimientos y relaciones entre contextos provenientes de diversos espacios-tiempos con significados translocales. Discutimos las potencialidades y los desafíos frente a diferentes contextos en el cotidiano del aula, así como las implicaciones para la noción de contextualización.

PALABRAS CLAVE
aprendizaje de ciencias; interacciones discursivas; relaciones intercontextuales; etnografía en la educación.

INTRODUCTION

In this paper, we analyze how different spatial-temporal dimensions play a role in the construction of natural sciences learning opportunities in a class from the early years of elementary school. Informed by elements of ethnography in education, we followed this group's science classes throughout three years. Adopting an analysis situated in time and space, we explored discursive interactions aiming to give visibility to participants' perspectives.

There is an extensive literature that discusses learning in science. Notions of learning as a social construction (Driver *et al.*, 1999; Kelly, 2014; Lemke, 1990), instead of an individualistic process that occurs in the minds of each student, had gained recognition in the field. This shift resulted in investigations about how learning is constructed through interactions, highlighting the relevance of language use during science lessons (Lin, Lin and Tsai, 2014). One aspect that has been discussed concerning this interactional construction is the challenge teachers face when dealing with diverse experiences and insights students bring to the interactions in the classroom (Blommaert and Backus, 2011; Scarpa, Sasseron and Silva, 2017).

As questioned by Scarpa, Sasseron and Silva (2017), what should teachers do in these diverse situations? How should teachers position themselves and coordinate different contexts in interactions to promote science learning? One answer to these questions has been the development of contextualized teaching (Gilbert, 2014; Ramsden, 1997). That is, instructional proposals capable of contemplating students' contexts, such as the programs Context-based science teaching (Bennett, Lubben and Hogarth, 2007) and Conceptual Profile (Mortimer *et al.*, 2014). These proposals aim to overcome a fragmented way of teaching scientific knowledge, having in mind the integration with concrete realities. Moreover, they are a potential way of sparking interest and promoting the participation of students (Gilbert, 2014).

In the same direction, research in science education has also been continuously questioned concerning how to explore the social and cultural contexts of students when analyzing discursive interactions in the classroom (Gomes, Mortimer and Kelly, 2010; Lemke, 2001; Oliveira, Akerson and Oldfield, 2012; Upadhya, 2009). Studies have tried to change the instructional focus of science teaching to contextual elements that go beyond the limits of the classroom, taking into consideration different spatial-temporal dimensions in which students and teachers are inserted (Blommaert, 2015; Franco and Munford, 2018).

Some researchers have explored, for example, relationships between learning science, family life and the community that the school is inserted in. Upadhyay (2009) pointed out how learning about the growth of plants during interactions in the classroom kept the connection with the traditional knowledge of native Vietnamese who lived close to the school. Sasseron and Carvalho (2006) also highlight this type of connection through the analysis of interactions in science lessons at a Brazilian indigenous school. Their results show that the practices of the indigenous community influenced the group project that went beyond simple collaboration between classmates, involving the need for action in the search of solutions that would benefit the group.

At the same time, Bricker and Bell's (2014) research analyzed interactions established by a student during science lessons and the process of learning was connected to various spaces-times of the social life of the student. The authors mobilized different episodes of the girl's life in her family and community: experiences with her mother and grandmother, playing with friends, trips to the dentist, and visits to science museums. The analysis indicated how these spaces-times were related to learning and the student's role in science classroom interactions. Reinhart and colleagues (2016), pointed out that the patterns of participation of students' families in their school activities might influence the development of investigative actions in science classes.

Other studies address spatial-temporal dimensions that involve translocal meanings based on broader contexts. For instance, Oliveira Akerson and Oldfield (2012), for example, analyzed how sexism and homophobia, present on a macro social scale, questioned classroom interactions, having significative consequences like: unsafe environment, difficulties in the appropriation of scientific reasoning elements and, consequently, hinder the learning process. Gomes, Mortimer and Kelly (2010) evidenced that there are mutual influences between learning and patterns of students' inclusion/exclusion in chemistry lessons. Such patterns were identified in discursive interactions based on the analysis of students' trajectories at school in contrast to contextual aspects like race, class, and gender.

Despite the specificities of each of these studies, the analysis of interactions made it possible to identify the same analytic movement that relates science learning to different spatial-temporal dimensions that constitute the classroom. The results of such research are promising, and they bring relevant knowledge in face of the goals of science education in the 21st century (Lemke, 2001). However, studies like these are still scarce, as discussed in greater detail in Franco and Munford (2018). These analyses offer great potential to understand how students learn science. First, because they have brought light to aspects that, despite being closely related to the classroom, go beyond its spatial-temporal limits — *families, communities, culture, race, class, gender and religion issues.* These elements are a part of students' and teachers' lives and they are intertwined with classroom everyday life. To ignore them is to leave unexamined components that may be essential to understand how people negotiate, share and build knowledge at school (Kelly, 2005).

The analyses presented in this paper are part of this debate. We aim to contribute to the field by investigating discursive interactions during science lessons, answering the following question: *How do teachers and students in the early years of an elementary school classroom connect different spatial-temporal dimensions to knowledge and practices to create learning opportunities in science lessons?*

THEORETICAL-METHODOLOGICAL ASSUMPTIONS

Our understanding of science learning was guided by the discussions of Kelly (2005), who proposes the use of ethnographic perspective elements associated to constructs from the science education academic field. This approach gives focus to the daily lives of the social groups under investigation, with the purpose of analyzing learning as a process situated in time and space and based on meanings shared by the group itself.

Specifically, we develop this discussion based on the notion of *science learning opportunities* (Duschl, 2008; Munford and Teles, 2015; Rex, 2006; Stroupe, 2015). Rex (2006) mentioned different forms of understanding learning, based on references to ethnography in education and she synthesized them when proposing the notion of learning opportunities. As proposed, learning opportunities are "social events in which a person or persons are positioned to adopt and take up a set of social and cultural practices associated with academic domains" (Rex, 2006, p. 165).

This type of proposal is important to ethnographic investigations given it makes it possible to describe classroom everyday life. That is, when thinking of science learning processes, we were interested in describing and interpreting social events in which there was potential for science learning. It is worth emphasizing that we did not have the goals to measure possible instructional progress after various classes.

Having this in mind, we took into consideration the main purpose of discourse in this process. Discourse, in this case, is a semiotic tool with which people act and react to one another to share, negotiate, and reconstruct everyday life practices (Bloome *et al.*, 2008). In class, teachers and students create science learning opportunities by acting and reacting to each other through discursive interactions (Rex, 2006). We established relationships between these conceptions with Duschl's (2008) proposal that three domains of scientific knowledge should be developed during science classes: the conceptual knowledge domain, the epistemic domain, and the social domain of science (Munford and Teles, 2015).

The conceptual knowledge domain involves opportunities that the students have to learn scientific explanations about the natural world and use the body of knowledge that represents these explanations (Duschl, 2008; Stroupe, 2015). That is, the set of laws, theories, and concepts. The epistemic domain is related to opportunities that students have to use epistemic criteria that the scientific community uses to construct knowledge. These criteria allow students to recognize what they know and why they are convinced that they know that (Stroupe, 2015). Finally, the social domain involves opportunities for understanding "processes and contexts that shape how knowledge is communicated, represented, argued, and debated" (Duschl, 2008, p. 277). In the context of the classroom, as proposed by Stroupe (2015), this domain can be characterized by the routines from which students develop, criticize and apply ideas to build knowledge.

The epistemic and social domains still have little visibility in science classes. Despite that, as highlighted by Kelly (2014), in the same way that we value the "know-what" as an important aspect of science learning, the "know-how" should not be overlooked. This perspective considers knowing scientific concepts and ideas as important as helping students to understand how this knowledge is constructed, and how it creates opportunities for them to also engage in this construction.

Our analysis aimed to understand how students positioned themselves to adopt a set of practices and knowledge from the conceptual, epistemic and social domains of Natural Sciences. Based on aspects of ethnography in education, we intended to analyze this process in a way that considers that participants have a unique history and that history is constructed when different contexts in which they are situated are intertwined (Blommaert, 2015; Bloome *et al.*, 2008; Kelly, 2005).

The focus of the analysis is deeply related to these assumptions. We followed the same class throughout three years, characterized the history of this group in science classes and identified events with greater analytical potential considering the purposes of the current investigation.

To do that, we developed an analysis based on the *telling case* approach. This approach assumes that all the events that make up the life of a social group do not have the same analytic status, because they do not have the same relevance within the daily lives of the group. That is, there are events that are more meaningful for participants in relation to some aspect of their social life and therefore become more relevant to the ethnographic research (Mitchell, 1984).

That way, based on a broader historical analysis, we emphasized a smaller number of events capable of showcasing unique features of the group. The selection of these events was done based on the identification and analysis of frameclashes. Frameclashes are situations in which the ordinary flow of everyday life in a group is disrupted, by conflicts or breaches of expectation among participants (Agar, 1994). These types of situations have been considered excellent for ethnographic analysis, as they are moments in which things that are no longer identifiable in a group's practices become more expressive and, thus, give more visibility to some aspects of their social life.

This movement from *macro* history to *micro* events (Green, Dixon and Zaharlick, 2005) was guided by an analysis situated in time and space, through which we intend to establish connections between different contexts that are intertwined in classrooms. We were oriented by Blommaert's (2015) discussions, in particular, who proposes the construction of different multidimensional context models. Such models consider that there is a series of contextual elements involved, coming from various spaces-times in a classroom interaction. Using the notion of chronotope, from Bakhtin, Blommaert emphasizes how time and space in human social action cannot be separated and proposes a theoretical lens that sees context as an *amalgam of different spatial-temporal dimensions.*

This means that, when constructing our analysis, we did not select one or another contextual element *a priori*, in order to measure its possible impact on science learning. Rather, we looked at the science learning opportunities as discursive events situated in time and space whose translocal meanings "are continuously reconstituted within the flows and contingencies of situated activity" (Blommaert, 2015, p. 108). Thus, we acknowledge that science classes are not isolated from the social world. On the contrary, during science classes, each act of contextualization in interactions operates using (in)validated invocations of collective socio-historical schemes with translocal meanings (Blommaert, 2015).

RESEARCH SETTING

The study took place in a public lottery school in the Southeast region of Brazil. Our research group had followed the same class since the beginning of elementary school. In 2012, when we started the research, the class had 25 students that were in the 1st year of elementary school. The children had attended Preschool in different institutions. Because students were selected for admission through a draw, there was considerable diversity in terms of previous school experiences, as well as ethnically and socioeconomically.

The science and Portuguese teacher, Karina,[1] was a pedagogue with a lot of experience in literacy but very little in science teaching. That same teacher stayed with the group throughout the first three years. Beginning in the 4th year, science teachers changed every year.

The topics discussed during science classes throughout the first three years of elementary school, between 2012 and 2014, are synthesized in Figure 1. We highlighted a detailed set of nine classes that happened between October and November 2012, when the class was in first grade, since the event analyzed in this article is part of the history of events that took place throughout the years/lessons.

DATA CONSTRUCTION AND ANALYTICAL PROCESS

The immersion in the class' everyday life throughout three years happened based on participant observation in the classroom (Spradley, 1980), and from analysis of the data set: videos of Science and Portuguese lessons, field notes that were digitalized, photographs, materials from various activities, and worksheets with activities developed during classes.

Although we worked with this extensive data bank we did not try to analyze every detail of the group's history. As we previously noted, we conducted this research with the purpose of selecting events with a greater analytical potential, following the logic of *telling case*.

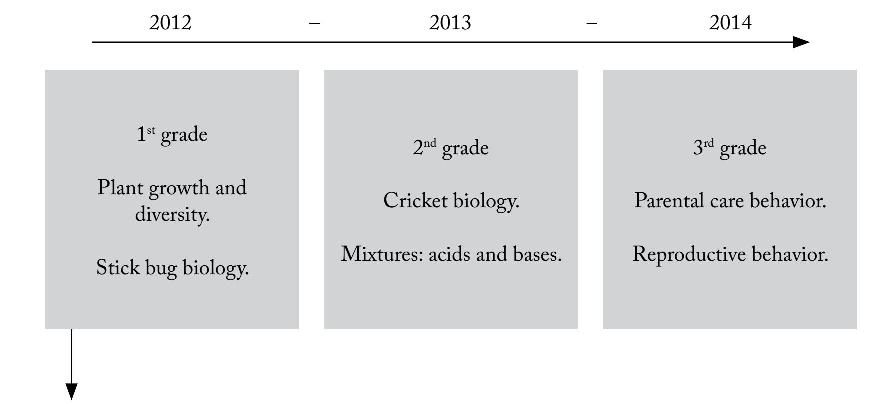
By asking broader questions, we *zoomed in* to the group's history (Wolcott, 1994), obtaining answers that allowed the successive elaboration of more specific questions, having in mind the analytic potential of the events. Figure 2 illustrates this process.

In the first level of analysis (question 1, Figure 2), we elaborated broad descriptions of the set of science lessons. We characterized the activities that occurred in class and identified situations in which the participants evoked

1 We used pseudonyms to identify the teacher and the students. With the intention of preserving the rights, privacy, and well-being of the participants (Spradley, 1980), the kids were previously consulted, and we had discussions about the study and how the data would be used. The project in question was submitted to analysis and approval to the Ethics Committee of the responsible institution and the adults involved — parents, teachers, and interns — were also consulted and signed an informed consent form.

spaces-times with translocal meaning like *family experiences, activities outside of school, friendships, mentions of external sources of information, comments about religion, gender, race*.

We selected a new set of events, asking ourselves which events would have more analytic potential (question 2, Figure 2). First, to select events, we identified frameclashes. We selected 23 situations of conflict and/or breaches of expectation.

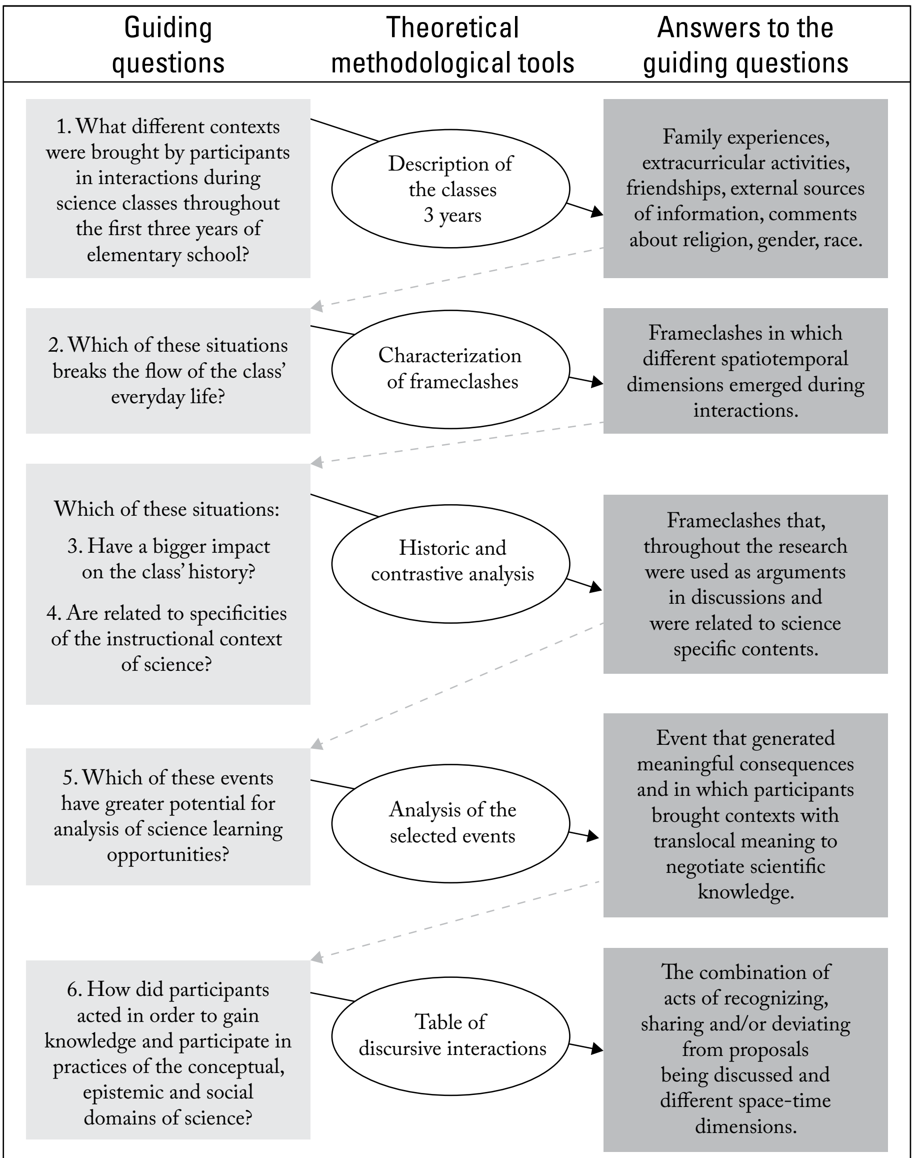


Lesson	Date	Matter	Key activities
1	10/29	Introduction to the study of stick bug	The group starts reading the book “The stick bug dilemma”.
2	10/31	Stick bug morphology and camouflage	The group continues reading the book and produces the drawing “I think the stick bug is like this ...”
3	11/01	Stick bug morphology and camouflage	The group finishes reading the book and discusses the camouflage of the stick bug.
4	11/08	Stick bug morphology and camouflage	Children receive three stick bugs in the classroom, observe morphology and make records.
5	11/12	Behavior, ecdysis and feeding of the stick bug	Children use different leaves to feed the bugs and record their behavior. They also discuss ecdysis.
6	11/19	Behavior, ecdysis and feeding of the stick bug	Children discuss feeding and bug’s behavior and size. There is disagreement about bug’s sexual identification.
7	11/22	Sexual dimorphism, ecdysis and feeding	Children discuss sexual identification of the bugs, its feeding and the ecdysis.
8	11/26	Stick bug morphology and sexual dimorphism	Children argue about sexual dimorphism in other animals and on stick bug.
9	11/29	Stick bug reproduction and growth	The class watches the pup that was born in the terrarium and discuss the record of the bug’s growth.

Source: research database.

Figure 1 – Science lessons timeline between 2012 and 2014. Highlight for Class 7.

These situations then went through another selective process: a historical and contrasting analysis. Based on the historical analysis, we aim to grant greater visibility to the participants' perspectives, questioning which of those situations had more significative developments in the lives of the class (question 3, Figure 2). This was done based on a recapitulation of the broader history of the class in which we iden-



Source: research database.

Figure 2 – Analysis process guided by the telling case logic.

tified other events when frame clashes became resources mobilized by participants in later discussions.

On the other hand, with the contrastive analysis, we were able to rise questions about which of those situations were linked to specificities of science teaching (question 4, Figure 2). To accomplish that, we established contrasts between the frameclashes identified during science classes and those identified during Portuguese classes. It was possible to see that certain conflicts and breaches in expectations happened in both classes, indicating certain typicality of the group's routine. However, others occurred in only one of the disciplines or appeared in a very different manner in each one of them. We then selected those that happened in discussions more related to specific aspects of science, for example, concepts from this field of study.

The historical dimension of this analysis allowed us to intentionally select a set of data and valued the participants' perspectives, since we used evidence in the history of the class that showed that certain events were more significant in the long term. The contrasting dimension, in turn, allowed for visibility to specificities of the instructional context of science, since our main objective is to understand the construction of learning opportunities in this field. Among all selected frameclashes, we decided to explore with greater detail an event that occurred when the class was in 1st grade of elementary school, based on the question: "*Which of these events has a greater potential for analyzing science learning opportunities?*" (question 5, Figure 2).

This event occurred when the class was studying aspects of the stick-bug (Figure 1). There was a conflict, as some students defended that the largest insect was the male and others that the largest was the female, so the teacher promoted a debate.

In the situations preceding this debate, most of the students agreed that the larger stick bug was the male. In the event being analyzed, on the other hand, we noted more significant disagreements regarding the matter. In the events that followed, the majority agreed that the female stick bug was bigger. The shift in students' opinions is an indication that this event had significant consequences in the classroom.

The event was characterized by an atmosphere of uncertainty related to what was being discussed, unlike from future and past events. This discussion was also resumed in later years, in 2013 and 2014, and was used as a resource when new discussions about identifying the sex of other animals emerged, providing us with more evidence of its relevance to the participants themselves.

These unexpected events also gave visibility to translocal meanings that were brought up by students while defined the criteria to identify the sex of the insect, related to gender issues. The participants based themselves on aspects like *being stronger* or *eating more, being calmer, passive* or *aggressive*. This way, the local study activity on the concept of sexual dimorphism was happening, in this class, through negotiations about what it means to "be a man" and "be a woman". This indicated the great analytical potential to the goals of the research that this event had, once that a scientific concept was being constructed in combination with spatial-temporal dimensions with translocal meaning.

Once we selected the event that would be analyzed, we started to question about how the participants acted in order to gain knowledge and to participate in practices of the conceptual, epistemic and social domains of science (question 6, Figure 2). To construct answers, we elaborated a chart of interactions with three columns. Each column was created to give visibility to a relevant aspect of the construction of science learning opportunities. In the first column, we have the transcriptions of the interactions; in the second, an analysis of the way the participants positioned themselves during the event; and in the third one, we identified different spatial-temporal dimensions.

To give more visibility to the way participants acted and reacted to one another, we transcribed the interactions in message units. These units are established based on clues that people use to indicate to one another what is happening and are able to attribute meaning to their behavior (Erickson and Shultz, 1977). These signals were identified through what Gumperz (1982) calls *contextualization clues*. They include verbal and non-verbal language and prosodic signals, such as changes in the tone of voice, rhythm, emphasis, pauses, gestures, and looks.

The second column indicates how participants positioned themselves during interactions. We associated elements from the ethnographic perspective with proposals from science education. Based on Bloome and Egan-Roberton's (1993) discussions about intertextual relationships, we characterized how the participants recognized, shared and/or deviated from proposals for the use of scientific knowledge and engagement in practices related to the conceptual, epistemic and/or social domains of science (Duschl, 2008).

The characterization was built based on four axes. The first three axes are:

1. *Proposal* – when a student or teacher, through discursive interactions, proposed to engage in a practice or use of knowledge related to the conceptual, epistemic and/or social domains of science;
2. *Recognition* – when a participant recognized the proposal being discussed;
3. *Sharing* – when the children interacted between themselves and used each other's contributions to recognize the proposal being discussed.

In addition, as a fourth axis of analysis, we also identified discursive movement characterized as *Deviations*. Not everything that is said during a science lesson is related to the movements of proposing, recognizing or sharing. A deviation occurred, for example, when engaging in practices involved in the construction of knowledge did not happen in the manner that was expected, that is, considering instructional expectations in science education. What indicated movements of deviation was evidence derived from the reactions of participants.

Finally, the third column was elaborated exploring a multidimensional concept of contexts (Blommaert, 2015), by identifying intercontextual relations in interactions (Bloome *et al.*, 2009). It is a matter of relationships that students themselves constructed by bringing up different spatial-temporal dimensions: evoking events of the class' own history or events outside the classroom and evoking contexts with translocal meaning. The charts provided evidence in the discourse for analyzing the construction of science learning opportunities in the class that was studied, as discussed below.

The interactions in the events under analysis were organized in three interactional units. Each interactional unit corresponds to a block of conversation through which the members of the group engage in the construction of what they are doing in the classroom and organize their interaction (Bloome *et al.*, 2008). We presented each unit through a Chart of Interactions, followed by an analysis that tried to explore:

- how participants acted in order to gain knowledge and to participate in practices of the Natural Science during interactions; and
- how different spatial-temporal dimensions worked together in the construction of learning opportunities.

RESULTS

As presented in Figure 1, the event analyzed occurred when the teacher was teaching a sequence of nine lessons about "Stick Bug Biology", exploring conceptual knowledge like: morphology of insects, camouflage, eating habits, sexual dimorphism, and reproduction.

The teacher brought three stick bugs of different sizes to the classroom in the 4th Lesson, and the students started to observe the animals periodically. Starting in the 4th Lesson, there were discussions about the sexual identity of the insects.[2] In the first lessons, there was a relative agreement that the bigger insect would be the "dad", the medium-sized one the "mother", and the smaller one the "baby". However, the idea that the bigger insect could be the female became more accepted as the lessons progressed, creating frameclashes between students.

In this sequence of lessons, the transcribed event occurred during the Class 7, when the interaction with the greatest uncertainty related to the sexual identification of the insects occurred. Karina promoted a debate based on questions about themes that they had studied until that moment, including discussions about sexual dimorphism. The event is organized in three interaction units.

INTERACTIONAL UNIT 1

In the first interactional unit,[3] the teacher started a discussion involving the shared participation of Camila, Marcelo and Ramon (Chart 1):

2 Learning about sexual dimorphism requires considering that the differences between the sexes do not follow a single pattern and there are possibilities for occurrences of the phenomenon in nature. To explain its occurrence in arthropods, the field of Evolutionary Ecology has used different proposals (Fairbairn, 2013). One of the most accepted proposals indicates that, as females produce the eggs, there is a greater energetic demand and protection for the offspring, which is manifests in the difference in size. Thus, there are females bigger than males, which is the case of the stick bug. However, there is not a single pattern of sexual dimorphism, so there are other explanations for differences between males and females.

3 Since the interaction is very long, we selected sections of greater interest for analysis presented in this article.

Chart 1 – Interactional unit 1.

Line	Speaker	Message unit	Science learning opportunities				Inter contextual relations
			Pr	Re	Sh	De	
1.1	T	Marcelo tell us I	■				
1.2		What do you think ↑	■				
1.3	Marcelo	Here+ I		●			
1.4		The+ I		●			
1.5		The+ I		●			
1.6		Big one is the mother I		●			
1.7	T	Why do you think I	■				
1.8		That the big one is the mother ↑	■				
1.9	Marcelo	Because she needs to lay e+ggs I		●			Bringing up a previous event in the class history
1.10		Didn't Camila say I			●		
1.11		That stick bug lays eggs ↑ *Mariana raises her hand*			●		
1.12	T	Camila I			■		
1.13		Did you say that stick bugs lay eggs8			■		
1.14	Camila	*Nods her head indicating yes*			●		
1.15	T	Lay eggs ↑	■				Source of information external to the classroom
1.16		How did you find that out ↑	■				
1.17	Camila	In the internet I		●			
1.18	T	In the internet ↑					
1.19		Did you search it ↑					
1.20	Camila	*The student continues to nod positively*		●			
1.21	T	Why+ did you search that in the internet ↑	■				
1.22	Camila	To be su+re I		●			
1.23	T	To be sure I	■				
1.24		Do you think I	■				
1.25		That on the internet I	■				

Continue...

Chart 1 – Continuation.

Line	Speaker	Message unit	Science learning opportunities				Inter contextual relations
			Pr	Re	Sh	De	
1.26		Everything said there I	■				
1.27		Is tru+e ↑	■				
1.28	Ramon	No I		●			
1.29		No I		●			
1.30	Camila	*Camila has her arms extended*					
1.31	Ramon	Not everything I		●			
1.32	Camila	Some yes I		●			
1.33		Some no I		●			

Pr: proposal; Re: recognition; Sh: sharing; De: deviations.
■ (teacher speaking); ● (student speaking); ↑ (increase in intonation at the end of the sentence); ↓ (lowering in intonation); XXXX (indecipherable line); emphasis; ▲ (higher volume); ▼ (lower volume); spoken faster; vowel+ (prolonged vowel); *Non-verbal behavior in italica*; I (pause); IIII (long pause); - (incomplete word).

At the beginning of this discussion, Marcelo acknowledged the teacher's proposal of using the information that the stick bug lays eggs (L1.9), mobilizing knowledge of the conceptual domain of the insect's biology. The student developed an argument based on a form-function relation of the animal as a criterion for constructing the affirmation — *if the female lays eggs, she should have the bigger body,* which indicates the engagement in a practice of the epistemic domain. Marcelo, in addition to acknowledging the teacher's proposal, used as baseline the information provided by his classmate Camila (L1.10).

Marcelo's position also indicates the engagement in a practice of the social domain of scientific knowledge. By including Camila's "data" in his argument, we have evidence that the students were taking into consideration the contributions of their peers during the discussion. Moreover, this process opened up possibilities for the creation of a new proposal in the flow of the interaction, related to the evaluation of data sources (L1.23-27).

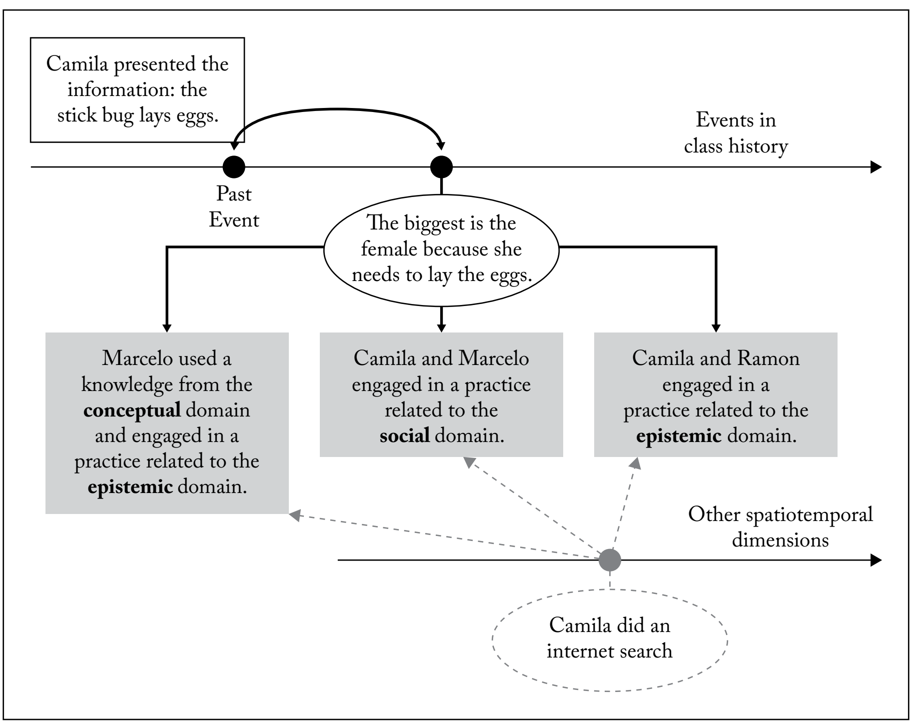
Data from other spatial-temporal sources are linked to learning opportunities being constructed. That is because the contribution of Camila was about a concept that had yet to be discussed. It entered the discussion from an external spatial-temporal source: the internet. The teacher's reaction was to make a new proposal: to evaluate the internet as a data source during science lessons. The proposal, as well as acknowledging Camila and Ramon contributions, indicated the engagement related to the epistemic domain of scientific knowledge: to explain why you know what you say you know, and the need to evaluate data sources in science.

Another relevant aspect of this articulation is that the analysis of past events indicated that Camila did not agree with Marcelo: she considered that the male would be bigger than the female. However, in the interactional unity 1 it would be contradictory if she disagreed with the results of internet search that she herself conducted. Thus, the resource that Camila brought was used to attack her own point of view. Marcelo's argumentation supported the idea that the female could be bigger than the male. The characterization of the learning opportunity being constructed is illustrated in Figure 3.

INTERACTIONAL UNIT 2

In the sequence of the interaction, the teacher continued the discussion, sharing the proposition with the students Maurício and Breno (Chart 2):

The second interactional unit starts with Maurício's contribution. The student had an argument: every time he looked at the terrarium, the male was eating more (L2.5-15). The idea was that, if the male ate more, it makes sense considering that he was the bigger one, which is plausible. But, the student distanced himself from the proposal being shared by the group. It is important to note that, when looking at the terrarium, Maurício did not see the male eating more and the female eating less, but the bigger animal eating more and the smaller one eating less. The deviation was evidenced by the teacher's reaction. She did not accept the argument



Source: research database.

Figure 3 – Characterization of the learning opportunity in interactional unit 1.

Chart 2 – Interactional unit 2.

Line	Speaker	Message unit	Science learning opportunities				Inter contextual relations
			Pr	Re	Sh	De	
2.1	T	Maurício I			■		
2.2		I want to hear you I *Breno has his hand up*			■		
2.3	Maurício	The male is the big one I		●			
2.4		You know why ↑		●			
2.5		Because he's eating more I				●	Bringing up translocal meanings related to gender issues
2.6		The mom I				●	
2.7		And the son especially I				●	
2.8		Are eating very little I				●	
2.9		Because I *points at the terrarium*				●	
2.10		The dad is the big one I				●	
2.11		You know why teacher↑				●	
2.12		Because every time I see him I				●	
2.13		He's eating I				●	
2.14		And the mother I				●	
2.15		And the son aren't I *Vinícius raises his right hand*				●	
2.16	T	The ma+le I	■				
2.17		Are you saying he eats mo+re I	■				Bringing up possible past events in the classroom
2.18		And that's why he's bigger↑	■				
2.19	Maurício	*Maurício nod shis head positively*		●			
2.20	T	Have you seen the male I	■				
2.21		Eating in our bug I	■				
2.22		House here ↑	■				Bringing up translocal meanings related to gender issues
2.23	Maurício	Yes I *nods his head*				●	
2.24	T	Yes	■				
2.25		And you think that the big o+ne I	■				
2.26		Is the male↑	■				
2.27	Maurício	Yeah+ I				●	
2.28		Bu+t I *points to the aquarium*				●	

Continue...

Chart 2 – Continuation.

Line	Speaker	Message unit	Science learning opportunities				Inter contextual relations
			Pr	Re	Sh	De	
2.29		The big one is the male I				●	
2.30		Do you know why↑				●	
2.31		Because++ I				●	
2.32		The male has to watch out for the little son I				●	
2.33	T	Hey+ Breno I			■		
2.34		You can talk now I			■		
2.35	Breno	The+ I		●			
2.36		The+ I		●			
2.37		The+ I		●			Bringing up past events and experiences outside of the classroom
2.38		The mother has to be the bigger one because+ I		●			
2.39		She has to eat I		●			
2.40		More than the ma+le I		●			
2.41		So she can have babys I		●			
2.42		And sometimes the e+ggs I				●	Bringing up an experience at home
2.43		Can be like poo I				●	
2.44	T	Sure I	■				
2.45		You know that I	■				
2.46		Breno I	■				
2.47		Did you discover that I	■				
2.48		In our classroom ↑	■				
2.49		Or did you search for it somewhere else ↑	■				
2.50		Did you search for it in other bo+oks I	■				
2.51		In the interne+t ↑	■				
2.52	Breno	No++o I		●			
2.53	T	Did you talk to someone↑	■				
2.54	Breno	There are stick bugs in my house I		●			
2.55	T	Ah!	■				
2.56		In your house there are I	■				
2.57	Breno	In the trees I *Points up*		●			

Continue...

Chart 2 – Continuation.

Line	Speaker	Message unit	Science learning opportunities				Inter contextual relations
			Pr	Re	Sh	De	
2.58	T	And you in your house I	■				
2.59		Had already observed	■				
2.60		That the female was bigger ↑	■				
2.61	Breno	*Nods positively*		●			
2.62	T	How do you look and see if she is a female ↑	■				
2.63		Is there a way ↑	■				
2.64	Breno	Because I				●	
2.65		The female has to eat more than the male I				●	
2.66	T	And you XXXX *Maurício speaks loudly*					
2.67	Maurício	XXXX *Raises his hand, but what he says is inaudible*					
2.68	T	It seem like I *she points to Maurício*			■		
2.69		That your opinion is different from Maurício'sI			■		

Pr: proposal; Re: recognition; Sh: sharing; De: deviations.
■ (teacher speaking); ● (student speaking); ↑ (increase in intonation at the end of the sentence); ↓ (lowering in intonation); XXXX (indecipherable line); emphasis; ▲ (higher volume); ▼ (lower volume); spoken faster; vowel+ (prolonged vowel); *Non-verbal behavior in italica*; I (pause); IIII (long pause); - (incomplete word).

without first trying to establish the relationships present in Maurício's discourse by asking: "Have you already seen the male eating in our bug house here?" (L2.21-22). Karina was trying to clarify possible connections that would be necessary for the student to recognize the proposal.

The epistemic criterion Maurício adopted distanced his argument from what the group was sharing. Maurício considered the idea that the male was bigger as a premise. Thus, the student did not distinguish theory from evidence. Stating that the "male" ate more meant only that he saw the bigger one eating more. Since the bigger one [already] was considered to be the male, he concluded that the male ate more. This statement corroborates the idea, but does not correspond to an actual explanation.

Maurício's deviation brings us to what had already been discussed about difficulties that young children face in adopting epistemic criteria of scientific knowledge. However, the historical analysis (Figure 2) shows that some children already had the resources to coordinate data and conclusions, as Marcelo had done in unit 1 (L1.9). Maurício himself, in discussions about other topics in the past and in the future, was able to formulate good arguments, which leads us to think that it was not just a student's inability to engage properly in these practices.

As we noted, throughout the period of classes about the stick bug, the participants evoked translocal meanings of hegemonic gender relationships in society during interactions. Maurício played a leading role in defending that the bigger animal should necessarily be the male. The student had difficulty recognizing that the male could be smaller than the female. In this interactional unit, for example, Maurício's argument mobilized the notion that the male, who consumed large amounts of energy, naturally eats more, and therefore is bigger.

The historical analysis offers elements for an alternative interpretation of the manner that Maurício positioned himself. It is as if, regardless of any discussion, the student's answer was already defined. When saying that the male ate more, Maurício was saying that the bigger one ate more, and since the bigger one "was" the male, he used that observation [eating more] as information to legitimate his position. The same goes for the argument that "the male has to watch out for the little son" (L2.32), also used by Maurício. In fact, in this case, the student did not even mention any observation that would support his proposal, which would make his argument even more fragile.

In this sense, Maurícios's deviation not only distanced himself from the practices of the epistemic domain the group shared, but it also involved the conceptual domain. One of the central aspects of the notion of sexual dimorphism is understanding that there is not one single way of differentiating between males and females across different species, given the diversity of the biological world. Not recognizing the possibility that the female could be bigger than the male indicates a distance from the instructional expectations related to the concept under construction.

In following this interaction, Breno recognized the proposal under discussion. The student established relationships between Maurícios's idea about the insect eating more (L2.5), to Marcelo's argument about the role of generating offspring (L1.9). Thus, Breno created a different interpretation to the eating behavior of the stick bug: it is the mother that needs to eat more, and not the male, based on the knowledge that it is the female that will "*have babies*". Maurício's idea was used as a counter-argument in light of the form-function relationship proposed by Marcelo, indicating the mobilization of knowledge from the conceptual domain, as well as his engagement in a practice related to the epistemic domain of scientific knowledge. Breno articulated contributions from his partners to defend his own point of view, which also shows the engagement in a practice related to the social domain of scientific knowledge.

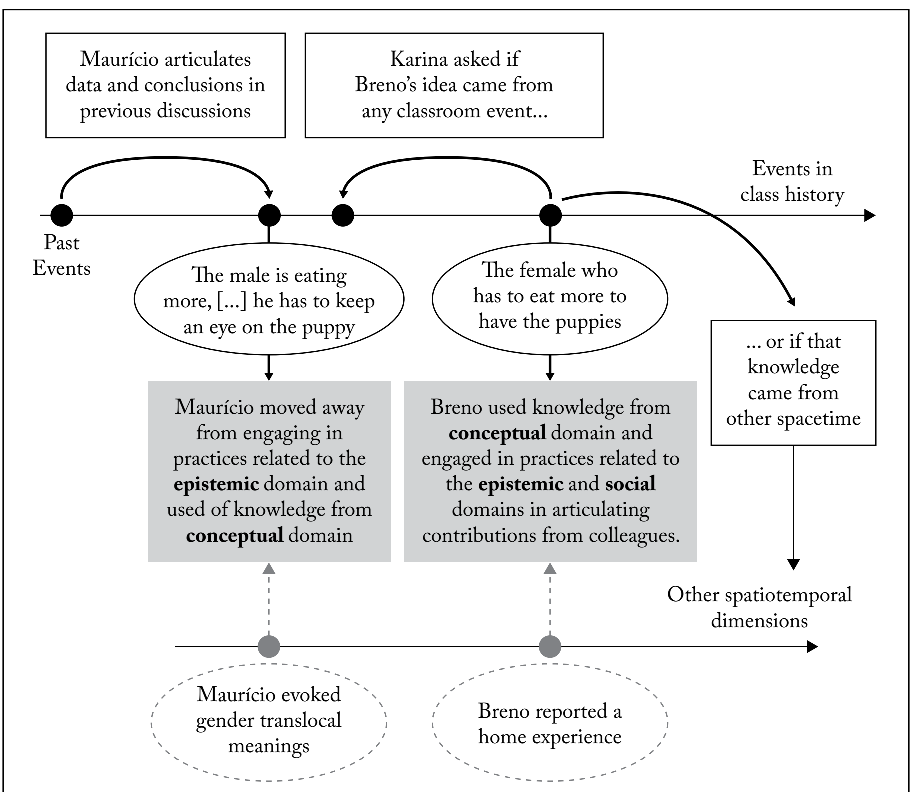
Karina asked how Breno knew that, eliciting sources of information external to the classroom, like books, the internet, conversations with other people (L2.44-51). Breno referred to a different space-time: his own house (L2.54). Breno lived in a house similar to a ranch and, in future events, he even brought a stick bug to school that he found in the trees in his house. The historical analysis indicates that Breno established constructive connections between what was studied in class and his experiences at home, especially with regard to playing and imagination.

Despite the fact that experiences at home strengthened Breno's argument, the teacher's expectation was that students would present some other type of evidence, by asking: "How do you look and know it is a female?" (L2.62). The student's reaction was to resume the argument previously mentioned (L2.64-65). At the end of the interaction, the teacher brought back the disagreement between the children and asked the students to repeat their arguments. However, the doubt in regard to the sexual identity was not resolved at this moment. Figure 4 illustrates the characterization, in this unit, of the learning opportunity being constructed.

INTERACTIONAL UNIT 3

The third and final interactional unit covers a discussion between Karina and Ricardo (Chart 3):

At the beginning of this unit, Ricardo recognized the proposal of defining the sex of the stick bug N (L3.15-16). However, when explaining his argument, he created a deviation when he based his explanation on experiences with his family. The student had trouble expressing himself and was embarrassed (L3.23-29).



Source: research database.

Figure 4 – Characterization of the learning opportunity in interactional unit 2.

Chart 3 – Interactional unit 3.

Line	Speaker	Message unit	Science learning opportunities				Inter contextual relations
			Pr	Re	Sh	De	
3.1	T	Ricardo you can speak			■		
3.2	Ricardo	Remember that day I		●			Bringing up a past event that happened in the classroom
3.3		When Samara took the bugs out of I		●			
3.4		That aquarium I *points to the other terrarium*		●			
3.5		To put them in that one ↑		●			
3.6	T	I re+member I					
3.7		Exactly I					
3.8		She did that one day I					
3.9	Ricardo	The bi+g one I *Camila raises her hand*		●			Bringing up translocal meanings related to gender issues
3.10		She let her put it I *looking at the teacher*		●			
3.11		And the me+dium I		●			
3.12		He stayed I		●			
3.13		There moving a lot I		●			
3.14		So I		●			
3.15		It seems that the medium I		●			
3.16		Is the ma+le I		●			
3.17		The me+dium I		●			
3.18		The+ I				●	Bringing up family experiences
3.19		Ma+le I				●	
3.20		I think is stronger I				●	
3.21		Because I				●	
3.22		Always I				●	
3.23		I+s ▼ *lowers his head*				●	
3.24		In my ho+use I ▼ *Puts his hand on his head*				●	
3.25		My I ▼				●	
3.26		My mo+m I ▼ *Looking down*				●	
3.27		XXXX with my dad I ▼				●	
3.28		Then my dad I ▼				●	

Continue...

Chart 3 – Continuation.

Line	Speaker	Message unit	Science learning opportunities				Inter contextual relations
			Pr	Re	Sh	De	
3.29		Always wins I ▼*leans down with the arms on the table*				•	
3.30	T	What is it ↑					
3.31		That final part we didn't understand I					
3.32		In your house I					
3.33		Your mom and dad I					
3.34		What ↑					
3.35	Ricardo	Play I				•	
3.36	T	Play I					
3.37		And then what happens when they play ↑					
3.38	Ricardo	My dad I				•	
3.39		Always wins I *quietly*				•	
3.40	T	The dad always wins I	■				
3.41		And when Samara I	■				
3.42		Went to move the bugs I *Puts his hand on his mouth*	■				
3.43		What happened ↑	■				
3.44		That you can think of I	■				
3.45		That that one may be the male↑	■				
3.46	Ricardo	Because+ *Ramon starts talking at the same time*		•			
3.47		The male was I		•			
3.48		Moving too much I		•			
3.49	T	The male was moving too much I	■				
3.50		And in his house the dad also stays moving too much ↑	■				
3.51		Student: XXXX					Bringing up translocal meanings related to gender issues
3.52	Ricardo	Yes I *with his right hand over his mouth*		•			
3.53	T	So why do you think ↑	■				
3.54		That I	■				

Continue...

Chart 3 – Continuation.

Line	Speaker	Message unit	Science learning opportunities				Inter contextual relations
			Pr	Re	Sh	De	
3.55		It's that medium on there I	■				
3.56		No I	■				
3.57	Ricardo	It's because I think that the male I		●			
3.58		Got angry I		●			
3.59	T	Ah++ I					
3.60		And why the me- I					
3.61		The one that is medium I					
3.62		That we are calling I					
3.63		That is sma+ller I					
3.64		Than that big one I					
3.65		Stayed I					
3.66		Moving too much I					

Pr: proposal; Re: recognition; Sh: sharing; De: deviations.
■ (teacher speaking); ● (student speaking); ↑ (increase in intonation at the end of the sentence); ↓ (lowering in intonation); XXXX (indecipherable line); <u>emphasis</u>; ▲ (higher volume); ▼ (lower volume); <u>spoken faster</u>; vowel+ (prolonged vowel); *Non-verbal behavior in italica*; I (pause); IIII (long pause); - (incomplete word).

The student presented three ideas:

1. the male would be the smaller animal (L3.15-16);
2. this animal (the smaller one) was moving more in the day it was changed from terrariums (L3.13); and
3. in his house, his dad always wins against his mom (L3.28-29).

The teacher's reaction, when faced with the third idea, indicates the deviation. The teacher tried to understand the student's line of thought (L3.30) and her questions helps to understand what connections he was establishing between the three ideas (L3.40-45, 3.49-53).

Ricardo, then, understood what was being proposed and the teacher's reaction indicated the comprehension of the relationship: the smaller animal seemed to move more when he switched terrariums, similar to how, in his house, the dad also "moves more", because he is more nervous. When saying "*Ah*++" (L3.59), the teacher understood the relationship the student established with the meaning of the phrase moving too much: "*got angry*" (L3.58). The teacher immediately reacted positively to his position. In this case, the recognition occurred when Ricardo was able to indicate how he was constructing the relationship between data and conclusion. Ricardo's position indicated his engagement in a practice involving the epistemic domain of scientific knowledge, despite not having the knowledge of the conceptual domain of science about sexual dimorphism.

The connections that Ricardo established were complex and they involved elements from various spatial-temporal dimensions. Based on experience from a classroom, in the past, the student observed a phenomenon and concluded that the smaller animal seemed to be angrier and stronger, because he moved more when Sâmara changed them from terrariums. This conclusion was reached based on an experience external to the school: the father always "won" against the mother at home.[4] These elements had a feature in common: both (his father and the small stick bug) are angry. Therefore, the conclusion was that the small stick bug that was angry like the father, was also male.

In this case, the translocal meaning of "being a man" and "being a woman" were evoked by Ricardo and influenced his interpretation of what was observed in the classroom: nervousness/strength as attributes of the male (L3.20, 57-58) and passiveness as an attribute of the female (L3.10). Figure 5 illustrates the characterization, in this unit, of the learning opportunity being constructed.

At the end of the debate, the class had not yet resolved the disagreements. Despite this, based on this event, most of the students changed the way that they identified the sex of the insects: the female would be bigger than the male. Other criteria for identification, besides size, were discussed afterwards, in Classes 7 and 8. In Class 9, the last one about the stick bug, the group constructed a collective text with the conclusions of the study and registered three criteria for defining the insect's sex: size [the female is bigger than the male], presence of wings [the male has wings], and laying eggs [the female lays eggs].

CONCLUSIONS AND IMPLICATIONS FOR THE RESEARCH

In the present study, we characterized science learning opportunities based on the way that the teacher and the students recognized, shared and/or deviated from proposals of using knowledge and engaging in practices related to the conceptual, epistemic, and social domains of science. The analysis gave visibility to the ways that this knowledge and these practices were related to the participants' social world.

Part of this discussion in the field of Science Education focuses on understanding this "social world" as a sort of scenery in which the script of science teaching and learning takes place. Therefore, the sociocultural contexts of students are recognized in the field (Gilbert, 2014; Lemke, 2001), but a lot of the times they have a secondary role in the analysis. The tendency is not to take into consideration how such contexts can influence results or the interpretation and analysis of science learning processes (Franco and Munford, 2018).

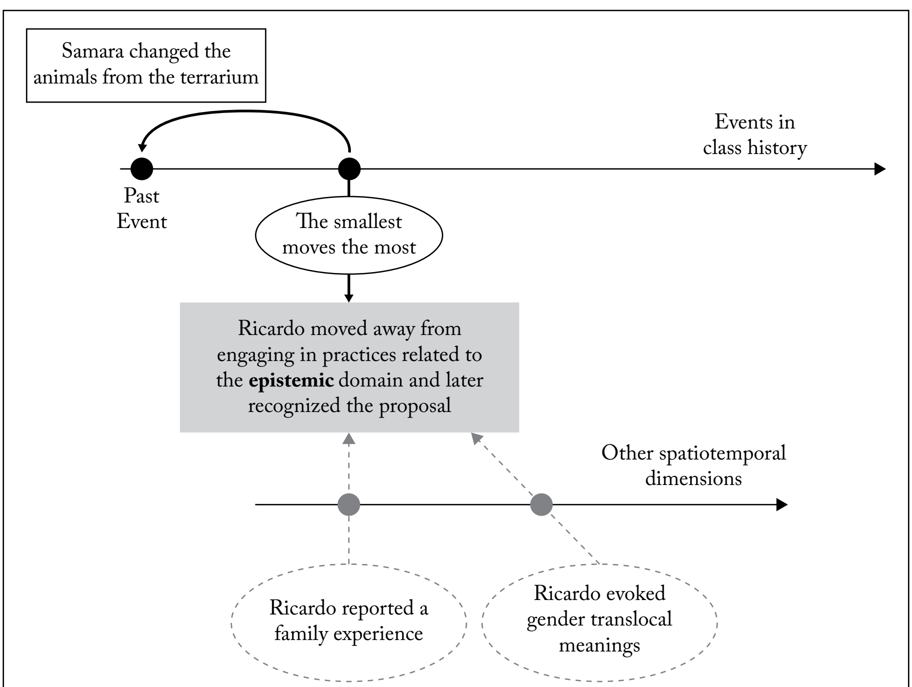
Our results indicated how knowledge from the conceptual, epistemic and social domains of science was constructed in a way situated in time and in space,

4 Based on the video footage it was not possible to understand what the student said in L3.27. At this moment, the student started to talk quietly with his head down. In L3.35, Ricardo said that his mother and father "play". In a conversation afterward with the teacher, she indicated that she had heard the student say "fight" the first time. Despite this, we did not have access to further information on the student's family context.

valuing contextual elements. The historical analysis and the event presented indicate that life in the classroom is constituted by a series of experiences from different moments in the trajectory of the class itself, as well as spaces-times with translocal meaning, like family experiences, the use of the internet, and gender issues.

In this sense, we highlight the importance that the field of Science Education expands notions about the context that it has adopted, having in mind that life in the classroom entails more than just presenting students with a set of academic knowledge (Bloome *et al.*, 2008). It entails negotiating worldviews and constituting the participant as a person, no longer as abstract categories of teacher or student, which demands a deeper understanding of the classroom (Blommaert, 2015; Kelly, 2005). It is urgent that our research participants are contextualized in space and time and understood based on the various contexts that they belong to/participate in.

In this research, we did not have the intention of exhausting the diversity of contexts related to what was built in the classroom. That would be challenging considering that we are dealing with so many races, religions, social classes, family circumstances and experiences that constituted very diverse repertoires in this classroom and that constitute the diversity of any classroom. However, it was possible to follow paths that are more sensitive to these contexts. Let us think, for example, about the relationships between the learning opportunities being constructed and gender issues in the classroom, one of the dimensions explored in our analysis. In the



Source: research database.

Figure 5 – Characterization of the learning opportunity in interactional unit 3.

field of Science Education, these relationships are normally established based on the assumption that there is a context "external" to the classroom that infiltrates this space, making students replicate (or not) broader sociocultural patterns (Brickhouse, 2011; Brotman and Moore, 2008; Tindall and Hamil, 2004).

Most of this literature has focused on analyzing questions like the identification of boys and girls with science and scientific careers, or their performances in science learning related to their experiences outside of the school (Conner, Perin and Pettit, 2018; Gafoor and Narayan, 2012; Sáinz and Müller, 2018). With these studies, the field presents alternatives capable of promoting inclusion for girls, considering a variety of contextual factors, like curriculum limitations, macro social patterns of gender, qualification of teachers and others (Brickhouse, 2011), and these indications have been essential in the construction of scientific education of excellence.

However, what we defended here is the need to move forward in understanding this contrast between what is "inside" and "outside" the classroom to avoid the risk of constructing very limited images of students' and teachers' agency in the classroom in face of the influence of what happens "outside" it. Our analyses contribute when considering that in a communicative event there are different spatial-temporal dimensions that are interconnected in a non-deterministic manner. What is "outside", in fact, is "inside" the classroom, as students do not simply replicate their contexts, but also negotiate them, moment by moment, while learning science. So, it is up to us to try to overcome this internal/external dichotomy, understanding that in the classroom one also negotiates what is, apparently, outside of it.

So far, we have focused on the relationships between the process of science learning and different contexts. However, another relevant aspect for the field of science education is the notion of "contextualization" of teaching, which is very present in most of the current curricula and is in agreement with the results we presented (Bennet, Lubben and Hogarth, 2007; Gilbert, 2014).

A limited understanding of contextualization that has guided the development of lots of curricula/materials, as well as the way teachers practice pedagogy, is the necessity of associating academic knowledge with the student's everyday life. It is said that, the value of this knowledge has to be clear to the student, reflecting a point of view that the students' knowledge will "harmonize" with new academic knowledge (Duarte, 2010). We understand that this point of view may lead to an inaccurate comprehension that the context of the student determines what should be taught or gives meaning to what is being studied. What we propose is that new meanings are constructed based on negotiations of translocal meanings that happen *during interactions* in the classroom.

In this sense, it is necessary to question how contextualization materializes itself in curricular proposals. Recently, Costa and Lopes (2018) indicated how knowledge claimed to be "contextualized" in curricula tends to not take into consideration the multiple, unpredicted possibilities and unique characteristics of the students. The authors show how the contexts, in educational contextualization, are often previously defined by some, who can be based on limited and hegemonic points of view, supporting particular interests. The contextualization, in these cases, restricts the possibilities of taking action.

In other words, what is valued is what is considered relevant in the student's context and not necessarily the experiences that emerge in daily life in the classroom. Thus, the notion of "contextualization in the classroom" has been far less explored regarding academic researches. Somehow, this tendency reinforces even more Costa and Lopes' (2018) criticism, as it indicates that contextualization is not usually constructed in spaces of interaction.

What would be contextualization in the classroom's interaction space? What does this form of "contextualization" generate/allows, regarding learning? Who does/can do the contextualization? We still know very little about these questions, but we offered some contributions. In the classroom we investigated, learning scientific practices of academic science was based on knowledge and practices from different spaces-times. Knowledge originating from the internet or from home has become data in the construction of arguments in discussions. Translocal meanings demanded explanations from the process of interpretation of this data, like notions of masculinity and femininity negotiated by the students.

The students applied knowledge from their contexts to give meaning to what was being studied in class. Thus, beyond the creation of curricula and of schedules that consider, *a priori*, students' experiences and contexts, our results indicate how contexts emerge during interactions, creating unexpected situations of uncertainty and instability. Experiences from different contexts continuously emerge in classes and they are a part of the science learning opportunities being constructed.

Through the concept of *intercontextuality* (Bloome *et al.*, 2009) it was possible to give visibility to such contexts based on what *happens* in the classroom. Intercontextuality, therefore, is able to assist in understanding the different ways in which teacher and students construct, as a group, relationships between historical contexts and contexts with translocal meaning. This form of contextualization, *in interaction*, gives greater visibility to the points of view of the group itself and, thus, favors the emergence of contexts considered relevant in the classroom.

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