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ARTICLE

GENDER IN SCIENCE LESSONS: A CONCEPTUAL LEARNING ANALYSIS[1]

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ABSTRACT: In the last years, gender has been one of the main issues in discussions in the educational field. In this article, we discuss gender relations in the specific context of science education field, an area that has been increasingly dedicated to studies regarding gender relations. Despite the progress in the field, studies that relate gender to learning scientific concepts in the classroom everyday life are still scarce. In this study, we explore discursive interactions in the 1st grade of Elementary School, aiming to analyze the role of gender in the construction of science learning opportunities. In order to do so, we leaned over theoretical proposals by Judith Butler regarding gender and guided the analyses from Ethnography in Education as a logic of research. The analyzed lessons indicate that conceptual science knowledge was articulated to reiterate/constrain the gender norm. These negotiations played a central role in learning the biology of an insect, more specifically, the concept of sexual dimorphism. This study is related to other research projects that point to the importance of gender discussions in education, including science education and its concepts.

Keywords: gender relations, science lessons, conceptual learning.

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GÊNERO NAS AULAS DE CIÊNCIAS: UMA ANÁLISE DA APRENDIZAGEM CONCEITUAL

RESUMO: A temática do gênero assumiu um lugar central nas discussões no campo da educação. Neste artigo, discutimos relações de gênero no contexto específico do campo da Educação em Ciências da Natureza, uma área que tem se dedicado, de modo crescente, ao estudo de relações de gênero. Apesar de avanços no campo, ainda são escassos os estudos que relacionam gênero à aprendizagem de conceitos científicos no cotidiano da sala de aula. No presente estudo, exploramos interações discursivas em uma turma do 1° ano Ensino Fundamental com o objetivo de analisar o papel do gênero na construção de oportunidades de aprendizagem de ciências. Para isso, nos apoiamos em propostas teóricas de Judith Butler sobre gênero, e orientamos as análises a partir da Etnografia em Educação como lógica de pesquisa. As aulas analisadas indicam que conhecimentos conceituais de ciências estavam articulados a processos de reiteração/contestação da norma de gênero. Tais negociações exerceram um papel central na aprendizagem sobre a biologia de um inseto, em particular, sobre o conceito de dimorfismo sexual. O estudo se une a outras pesquisas que apontam a relevância das discussões sobre gênero na educação, incluindo a disciplina escolar Ciências e seus conceitos.

Palavras-chave: relações de gênero, aulas de ciências, aprendizagem conceitual.

GÉNERO EN LAS CLASES DE CIENCIAS: UN ANÁLISIS DEL APRENDIZAJE CONCEPTUAL

RESUMEN: El género ha sido uno de los temas más discutidos cuando se habla de educación en Brasil en los últimos años. En este artículo discutimos las relaciones de género en el contexto del campo disciplinar de las Ciencias Naturales. Investigadores se han dedicado cada vez más al análisis de las relaciones de género en clases de ciencias. A pesar de los avances en el campo, aún existen pocos estudios que relacionen el género con el aprendizaje de conceptos científicos en el cotidiano del aula. En el presente estudio, exploramos las interacciones discursivas en una clase de 1° año de Educación Primaria con el objetivo de analizar el papel del género en la construcción de oportunidades de aprendizaje de las ciencias. Para ello, nos apoyamos en propuestas teóricas de Judith Butler sobre género, y orientamos el análisis desde la Etnografía en Educación como lógica de investigación. Las clases analizadas indican que el conocimiento conceptual de la ciencia estuvo vinculado a procesos de reiteración/desafío de la norma de género. Tales negociaciones jugaron un papel central en el aprendizaje sobre el concepto de dimorfismo sexual. El estudio se suma a otras investigaciones que apuntan a la relevancia de las discusiones sobre género en la educación, incluyendo la ciencia escolar y sus conceptos.

Palabras clave: relaciones de género, clases de ciencias, aprendizaje conceptual.

INTRODUCTION

This article analyzes how gender relations constitute processes of conceptual learning in science lessons. The focus of investigation in this study is part of a broader discussion that integrates the disciplinary field of natural sciences, and the school institution and the society. In recent years, gender has been one of the most debated topics regarding school, curriculum, and education (CALDEIRA; PARAÍSO, 2018). This greater prevalence of gender in the scholarly context constitutes, in the words of Guacira Louro, the inevitable "novelty" that meddled into the educational territory: schools, curriculum, and educators cannot be placed or place themselves outwards this subject. They are, oftentimes, challenged by questions that seemingly had safe, stable answers until recent times. Now, certainties escape and there is no way to ignore the "new" practices, "new" subjects, and their challenges to the norm (LOURO, 2008, p. 28).

Given this scenario, political movements diverge, controversial bills are discussed, and agents from diverse social spheres defend their interests. An example to illustrate this tension lies in the withdrawal of any mention of the words "gender" and "sexual orientation" of the last version of the National Curriculum (Base Nacional Comum Curricular, BNCC) (BRASIL, 2017). These conflicts, however, are not limited to the prescribed curriculum sphere. Curricula experienced in classrooms also generate discussions. Gender-based constraints, usage of sexist language, and the reinforcement of inequalities still prevail in classroom everyday life (CALDEIRA; PARAÍSO, 2018), including in science lessons (ALMEIDA et al., 2020). These problems have been portrayed and discussed through well-consistent literature on gender relations in science education in the last decades. Approximately fifteen years ago, Jennie Brotman and Felicia M. Moore presented a review of this area, pointing to some advances and trends from older studies in the 1970s to more recent research. In this review, the authors observed that the research projects were changing within the area of the natural sciences, organizing themselves around some topics receiving major attention.

Between the 1980s and the end of the 1990s, many of these research projects aimed to characterize and analyze the differences between boys and girls. Despite the effort in the sense of including girls in learning Science, the authors stated that most of these research ended up generating a contrary movement, reinforcing a notion of deficit based on girl-like characteristics (BROTMAN; MOORE, 2008). Throughout the 1990s, it was possible to notice a change toward a new focus: curriculum renovation. The curriculum ended up being analyzed, and the literature pointed it as excluding and misogynist. By the end of the 1990s, two shifts generated new focuses of the studies. One was related to the analyses of natural sciences and the scientific culture, the latter being understood as gendered (i.e., an establishment constituted by gender relations). The other, in turn, was related to research on identity, exploring issues such as the identification of boys and girls with subjects and/or scientific careers.

Based on a review of articles published after Brotman and Moore's study, we sought to map more recent research in the area of science education about gender relations. Part of these studies is related to the trends that these authors identified . An example lies in the expressive field of research on boys and girls' identification with scientific disciplines and careers (CHRISTIDOU et al., 2016; CONNER; DANIELSON, 2016; LIMA JÚNIOR et al., 2011; SALMI et al., 2016; SÁINZ; MÜLLER, 2017). More recently, one may highlight the advances in these studies concerning the insertion of girls in certain careers (e.g., engineering and computer sciences) (CONVERTINO, 2020; KANG et al., 2021; LAMPLEY et al., 2022; SOUZA; LOGUERCIO, 2021). In a similar direction, other research projects have aimed at characterizing the distinctions between boys and girls, for example, in the engagement in science lessons, investigative abilities, and the development

of critical thinking (DAHER et al., 2021; GAFOOR; NARAYAN, 2012; GODEC, 2020; KARAKAYA, AVGIN; KÜMPERLI, 2016; ONG et al., 2015; WANG; YI-KUAN TSENG, 2014). These studies differ from those from 1980s, portrayed by Brotman and Moore (2008), given that the distinctions between boys and girls are understood as part of a sociocultural concept. That is, participation and ability patterns are interpreted based on the processes of socialization that children and teenagers undergo inside and outside school, and that favor less (or more) identification and engagement of girls in science. Thus, such studies' efforts also intensify in analyzing how the school and science educators may amplify inclusion opportunities for girls in science. There is still research intended for the analysis of curricula and the nature of science (e.g., those that seek to scrutinize gender in teaching materials in teacher training) (BAZZUL; SYKES, 2011; CARDOSO, 2018; HEERDT; BATISTA, 2016; QUIRINO; ROCHA, 2013; SILVA; COUTINHO, 2016), or aimed at assessing the impact of instructional programs in the inclusion of girls in science (ALMEIDA et al., 2020; CONNER, PERIN; PETTIT, 2018; NOGUEIRA et al., 2011; ROBERTSON, 2013).

Two aspects in this set of studies are pivotal to the analysis we present in this article. The first one is related to the objective of analyzing gender relations; the second one is related to commonly adopted methods. In regards to the object of analysis, it is prominent that gender relations explored in the research came from the inequalities between men and women observed in society and in Science, which are also present in science lessons. In this scenario, the greater part of the research aims to analyze the relations between boys and girls regarding science (e.g., patterns of participation, motivation, identification, and inclusion). Nevertheless, in our study, the analyses did not point directly to these relations but to how inequalities also manifest themselves in other levels of school science and in scientific concepts.

Having Londa Schiebinger (2001) as a basal reference, we understand that the inequality generated by gender in science does not reflect only in the peripheral position that women have assumed in the scientific community but also in the own ways in which gender molded scientific knowledge. Schiebinger and other authors have analyzed a series of historical and contemporary cases that illustrate how concepts, theories, and models of science can be gendered. Examples of this process include the sexist character of the mammalian group classification in Linnaean taxonomy (BADINTER, 1985), the gendered anatomical descriptions in groups of non-human primate groups (SCHIEBINGER, 2001), the use of biological factors to explain social and behavioral differences between men and women (MIKKOLA, 2017), the influence of binarism in the categorization and analysis of sex hormones (OUDSHOORN, 1990), the hypotheses to explain human evolution, in addition to contemporary research designs that emerge from misogynistic premises (HEERDT; BATISTA, 2016).

Likewise, studies have sought to understand how gender constitutes scientific concepts in school science. Research by Jesse Bazzul and Heather Sykes (2011), as well as by Francisco Coutinho and Fábio Silva (2016), for example, analyze how scientific concepts (i.e., the way they are presented in teaching materials) reiterate and update gender inequalities.

Progress has been made through this research, but we still know little about how gender relations in everyday school science constitute the learning of scientific concepts. This takes us to the second aspect of research on the theme, which refers to methodological issues. Most studies on gender in education in natural sciences adopt methods based on the application of questionnaires and/or interviews. Others involve the analysis of documents, such as in the case of research with teaching materials (BAZZUL; SYKES, 2011; COUTINHO; SILVA, 2016). In this sense, research that seeks to understand gender relations by analyzing language employed in the classroom during science lessons, is still

scarce. In our survey of more recent articles, we found that only in one study the researchers adopted this type of analysis between students (LIMA JÚNIOR et al., 2010).

A look over what happens in classroom everyday life may offer relevant contributions. It is in everyday interactions that hegemonic practices are reiterated, updated, and/or contested; "gestures, movements, and senses are produced within the school space and incorporated by boys and girls (...). There, one learns to look and look oneself, to listen, to speak and to be silent, and to prefer" (LOURO, 2001, p. 61). Science lessons are not an exception. Tiffany Tindall and Burnette Hamil's (2004) analyses offer an example in this direction. Their research indicated that science educators generally interact longer and more thoroughly with boys. Usually, girls receive fewer critics but also fewer compliments and less encouragement to participate. This differentiated treatment illustrates one of the diverse practices that generate consequences in relations between the students and scientific knowledge. In our study, we sought to understand how these consequences unfold throughout the learning of conceptual sciences.

Aiming at contributing to these discussions, we analyzed interactive data of science lessons in the 1st grade of Elementary School. For conducting the analyses, we rely on theoretical assumptions by Judith Butler about gender and we are oriented by theoretical-methodological aspects of Ethnography in Education.

A LOOK OVER GENDER

Theoretical formulations on gender were based throughout history in the sense of exposing and deconstructing the hierarchical relation set between males and females (SCOTT, 1995). Feminist studies, which were the pioneer in this process, have developed very diverse approaches that, in general, are organized in different theoretical positions (LOURO, 1995; SCOTT, 1995). In this article, we explore constructs proposed by Judith Butler, who claims theoretical positions of the so-called third-wave feminism. The contemporary debate has searched to discuss paradigms established by other feminist theoretical positions, such as the one regarding gender binarism and the link set between natural sex and cultural gender.

Specifically related to Butler's work, we have found an expressive conversation set with different fields and perspectives. Butler discusses gender through a dialogue set between philosophy, psychology, literary theory, and anthropology. The appropriation of her proposals by science education research in Brazil is still incipient. In this article, we used the constructs related to gender performativity and norms to analyze classroom everyday life in science lessons. From Foucault, Butler understands that societies use markers to classify subjects by how they present themselves (bodily), their behaviors, expressions, and gestures. Bodies are compared, classified as normal or abnormal, marked, and excluded (FOUCAULT, 1979).

The normality parameter is set by the "white, heterosexual, middle-class, and Christian men, and this becomes the reference that no longer needs to be named" (LOURO, 2000, p. 12). The "others" are classified according to this parameter. The woman, therefore, is represented as "the second sex," while other manifestations of sexual orientation and gender—gays, lesbians, bisexuals, trans people—are understood as deviant and, therefore, abnormal. A normality pattern establishes a compulsory, heterosexual matrix, given it assumes all individuals have an innate inclination towards desiring romantic and sexual partners from the opposite sex.

In this sense, gender is a norm, a specific regulation that rules cultural intelligibility by establishing a hierarchy between males and females and compulsory heterosexuality (BUTLER, 2003). Through a gender norm, a specific form of sexuality is normalized and causal lines of connection between biological sex, gender, and sexuality are culturally constituted (BUTLER, 2003).

Family, school, media, church, law, and other social instances reiterate hegemonic practices that deny diverse possibilities (LOURO, 2000). In this sense, "male and female notions are produced and normalized" (BUTLER, 2014, p. 253), which is sustained by the apparent existence of two fixated, binary, and opposing sexes — male and female. What maintains this normalization set is the continuous repetition of gestures, actions, and signs that reiterate the construction of bodies (male and female) as how we perceive them in contemporaneity (BUTLER, 2003). These discussions are important for the kind of analyses that we aim to develop. That is, an analysis planned at scrutinizing the classroom everyday life and that is attentive to continuous processes of negotiation derived from our interactions.

The child already comes from an unequal world by the time she/he/they initiate the schooling process. Louro (2008) stated, the claim "It's a boy!" or "It's a girl!" is the beginning of a kind of "journey" that has, supposedly, an already established direction. In school, the repetition of gestures, actions, and signs reiterating body construction perpetuates itself. In infancy, those children considered deviant are doubly supervised (LOURO, 2000). In adolescence, discourses that demand a "manly" youngster and, as for girls, a "hard-to-get" girl, are reiterated amongst the students themselves (SALES; PARAÍSO, 2013).

This necessity of construction and reiteration throughout time is related to performativity. Gender, from this notion, is defined as the "repeated stylization of the body, a set of repeated acts within a highly rigid regulatory frame that congeal over time to produce the appearance of substance, of a natural sort of being" (BUTLER, 2003, p. 59). Butler takes up notions on the philosophy of the language (AUSTIN, 1962) for indicating that "it is in the repetition of these acts that one 'creates' gender" (BUTLER, 2003, p. 199).

Therefore, a gender norm exists only while it is "updated within the social practice" and reiterated "throughout everyday social rituals of bodily life" (BUTLER, 2014, p. 162). It indicates that there is no foundation for a substantial basis of gender. It is precisely in this lack of foundation that there are possibilities of deconstructing fixed notions of true masculinity or femininity. This aspect is relevant to our study. Suppose it is necessary to continuously reiterate the hegemonic practices. In that case, it is also possible to transgress them, establishing a continuous process of negotiation of the gender norm, including in natural sciences and science lessons. Given this scenario, in this article, we will analyze everyday classroom interactions in science lessons in the 1st grade of Elementary School to answer the following research questions:

How do students and the teacher act and react in the face of situations that constrain gender norms in sciences lessons?

In which way can negotiation processes of gender norms constitute the learning of a scientific concept?

METHODOLOGY

Data Construction

We analyzed data of a broader project, in which a class was followed throughout its three first years at Elementary School between 2012 and 2014. In this project, a multidisciplinary team of researchers accompanied the everyday routine in Portuguese Language and Science lessons, aiming at constructing knowledge about the processes of learning, insertion in scholar culture, and teacher training (for details see NEVES et al., 2017).

At the beginning of the project, the group was composed of 6 years old children, (12 girls and 13 boys). These students entered the school through public drawing lots, which reflected the team's diversity: students from different regions, which came from institutions of different early childhood education, and a heterogeneous, ethical, and socio-economical

characterization. The public and federal school was located in a Brazilian metropolis and is considered a reference in innovative approaches to teaching and learning. Karina[2], the participant educator, teaches Science and Reading and Writing (in Portuguese). The lessons were guided by Inquiry-based science teaching approach (e.g., PEDASTE et al., 2015) from a conjoint work between teacher Karina and the research team.

Data construction occurred through participating observation in the lessons (SPRADLEY, 1980), with records in the field notes and audio/video, and the collection of artifacts produced by students throughout classroom activities (GREEN et al., 2005).

Analysis Process

Guided by Ethnography in Education as a logic of inquiry, we constructed analyses in two levels: one macroscopic, the other microscopic (CASTANHEIRA et al., 2001). For the macroscopic analysis, we used our field notes for constructing a Chart of Lessons to organize general information on the science lessons throughout the three years of the project (date, place, theme, activities, produced artifacts, and materials used). From this broad representation of the class's history, we elaborated a Timeline[3]. In this new representation, we focused on the activities of each science lesson and on identifying situations when conflicts or breaks of expectations were potentially related to gender or socio-cultural issues (e.g., religion, race, social stratum).

Based on this analysis process, we identified specific events in the class's history in which gender issues appeared more explicitly in everyday discussions. Then, we selected this set of situations and elaborated descriptive charts detailing each one of these lessons[4]. By contrasting these situations, we selected the set of lessons related to the biology of the stick bug, which occurred in the second semester of the 1st grade, given its analytical potential for this study. In these lessons, the class discussed a conceptual science content — sexual dimorphism — and seemed to be intersected by gender relations. Despite seemingly relevant, other mapped events in the descriptive boards were related to issues concerning inclusion/exclusion or interest/participation of boys and girls in science lessons. As previously indicated, these aspects are broadly documented in the studies in the science education field. In this sense, we understand that analyzing lessons in which gender was related to the conceptual dimension of school science would bring more original contributions.

As for the lessons regarding the stick bug, the teacher has developed a set of nine classes by exploring the knowledge of insects' morphology, camouflage, feeding, molting, reproduction, and sexual dimorphism. The key activities of each lesson are listed in Table 1.

In the fourth lesson of this sequence, Karina took three stick bugs to the class and the students stayed with the animals until the ninth lesson, producing annotations, experiments, discussions, and investigations with the insects (Figures 1 and 2). The initial contact between the children and the three insects in the fourth lesson generated questions about the animals' sex due to the differences in their sizes. One of the insects was smaller, the other one had a median size, and the last was bigger. Initially, most students considered the bigger insect as the male one, the median as the female, and the smaller one as the pup. Throughout the lessons, one of the concepts presented by the teacher was the one regarding

[2] Pseudonyms were used for identifying the teacher, researchers, and students. The project has been approved by the Ethics Committee of the proposing institution, prioritizing the ethical principles of research with human beings.

[3] See this Timeline (in Portuguese) in the following link: https://bit.ly/3CKtj1D

[4] See the set of descriptive boards (in Portuguese) in the following link: https://bit.ly/3u3eZNJ

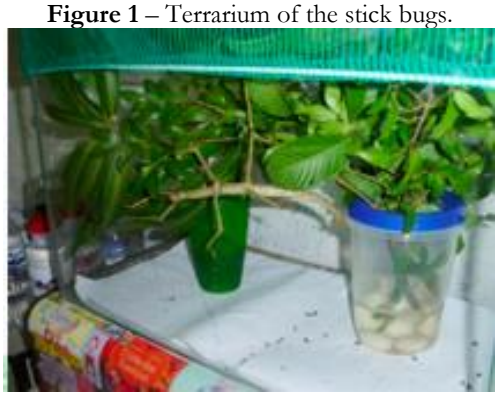
sexual dimorphism[5], which generated more explicit negotiation processes on gender norms and class interactions.

Table 1 – Summary of lessons regarding the stick bug.

Lesson	Date	Thematic	Key activities
1	10/29	Introduction to the study of stick bug	The class started reading the book "*O dilema do bicho-pau*" (The stick bug's dilemma).
2	10/31	Stick bug morphology and camouflage	Students continued the above-mentioned reading from the and produced a drawing of how they imagined the stick bug.
3	11/01	Stick bug morphology and camouflage	The class ended the book reading and started discussing the insect's camouflage.
4	11/08	Stick bug morphology and camouflage	The class started observing three stick bugs in the classroom, producing annotations and new drawings.
5	11/12	Behavior, growth, and feeding of the stick bug	Students started an experiment on feeding, reporting the behavior, and discussing molting.
6	11/19	Behavior, growth, and feeding of the stick bug	The class continued discussing the feeding and carried out reports regarding the behavior and size of the animals.
7	11/22	The stick bug's growth, feeding, and dimorphism	The children debated the identification of the animal's sex, feeding, and the molting process.
8	11/26	The stick bug morphology and sexual dimorphism	The class researched and discussed sexual dimorphism in other animals and the stick bug.
9	11/29	The stick bug's reproduction and growth	The class observed a new bug pup and discussed the growth of animals throughout the weeks.

Source: prepared by the authors.

Figure 1 – Terrarium of the stick bugs.



Source: database.

Figure 2 – Terrarium being handled student by student.

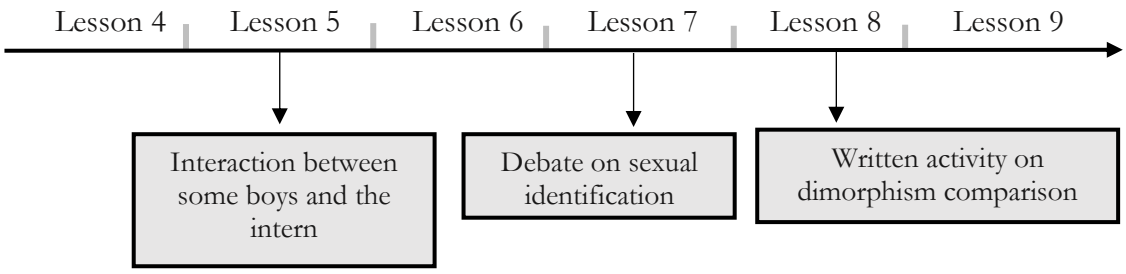
Source: database.

In our analytical process, we took this set of lessons back, intending to identify interactive events in which negotiations regarding gender norms constituted the construction of the sexual dimorphism concept. For the microscopic analysis, we transcribed in message

[5] In the stick bug's sexual dimorphism, the female is bigger than the male.

units the interactions of each one of these events (Figure 3) to reflect how the group participants would build shared boundaries of their talk in interactions (GREEN; WALLAT, 1981). These limits were identified through contextualization cues of the speech, (i.e., signals of change in intonation, emphasis, rapidity, pause, looks, gestures, etc.)(GUMPERZ, 1982).

Figure 3 – Timeline with the selected events.



Source: prepared by the authors.

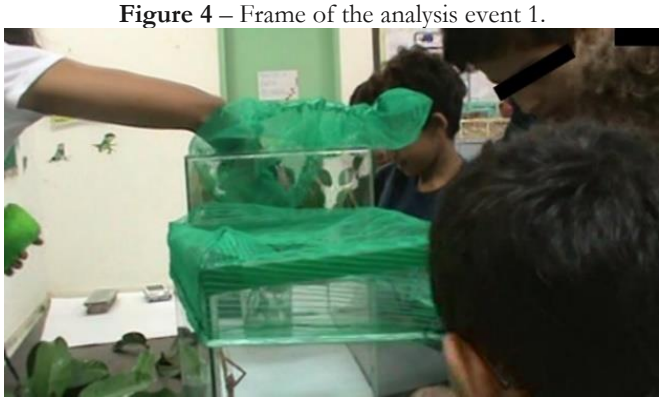
In this paper, we present the analysis of three events that occurred in lesson 5, 7, and 8. These events were identified as rich points of analysis (ÁGAR, 1994) due to the breaks of expectation identified in each one of them. These events, situations that challenged the gender norm, were succeeded by participants' reactions that evidenced how the students negotiated with the norm.

From this ethnographic perspective, we understand that the reactions in the face of ruptures of the everyday flux of a social group unravel what is important for that group, their shared practices, and bits of knowledge, as well as how the group organizes itself and interacts. Thus, we consider that these events have an analytical potential for constructing the answers to our research questions. We based our proposals on Butler's gender norm and performativity for the analysis.

RESULTS AND ANALYSES

The analysis of the first event was located in lesson 5 when students experimented with different types of leaves to investigate insects' feeding. By the end of the lesson, there was a moment in which the intern, Luana, who accompanied the class, changed insects from one terrarium to another that contained other types of leaves to ensure the continuity of the experiment (Figure 4). The teacher was near and proceeded to provide guidelines for the class. Some students, i.e., all of the boys, positioned themselves around the terrarium and started talking (Table 2).

Figure 4 – Frame of the analysis event 1.



Source: database

Table 2 – Analysis event 1[6]

Line	Speaker	Discourse
1	Student	The father ǀ
2		The father ǀ
3	Teacher	Put this little one down ǀ *talks directly to the intern*
4		And put this one right there big ǀ
5	Jonas	I have the courage to touch the father ǀ
6	Maurício	Me ǀ
7		Too ǀ
8	Ricardo	Who doesn't ↑
9		Look ǀ
10		Look ǀ
11	Student	She is not fear+ful no++ ǀ *Luana was catching the biggest animal on her hands*
12		It will fall ǀ
13		It will fall ǀ
14		Here + ǀ
15	Ricardo	What if you're stung, huh ǀ
16	Student	No way ǀ
17		No way, Evandro ǀ
18	Evandro	Why ↑
19	Student	Because ǀ
20		+Stop ǀ
21		It is moving ǀ
22	Jonas	XXXX with both hands ǀ
23	Ricardo	She is +good isn't +she ǀ
24		Look at the father right there, duh+ ǀ
25	Maurício	+Look ǀ
26		There is a little one teach+er ǀ
27	Jonas	+Turn father ǀ
28		The father ǀ
29		Turn ǀ
30		The father + ǀ
31	Teacher	The big one is the father ↑ *the teacher approaches the group*
32	Ricardo	The father liked Luana ǀ
33	Jonas	The father liked you, Luana ǀ
34	Maurício	Hmm+++ (prolonging for two seconds)
35	Luana	What ↑
36	Jonas	The father liked you ǀ
37	Ricardo	Yeah ǀ
38	Teacher	All done ǀ
39		So we're going to be looking at the lettuce leave +now ǀ

Source: prepared by the authors.

In this event, a situation that constrained the norm was as follows: the female intern, with tranquility, handled the male animal without being "fearful" (L11). The boys' reaction in the face of that break of expectation was to update the norm, alerting them on the risks of handling the insect (L15). It surprised them when noticing that Luana was capable (L9-11) of doing something that required courage. Also, another reaction was observed, given the easiness with which Luana handled the "male" stick bug. For Ricardo and Jonas, "the father liked Luana" (L32-33), triggering a reaction in Maurício: "Hmm" (L34). The expression and intonation indicate the sexual significance of the relation set

[6] Symbols used in the transcription: ↑ (intonation raised at the end of the speech); XXXX (unintelligible speech); emphasis; vowel+ (prolonged vowel); *Non-verbal behavior in italics;* ǀ (pause).

between Luana and the supposedly male insect. The boys' reaction, therefore, tried to resolve the norm dysfunction—courageous woman—through a new interpretation: she could do it because the father liked her.

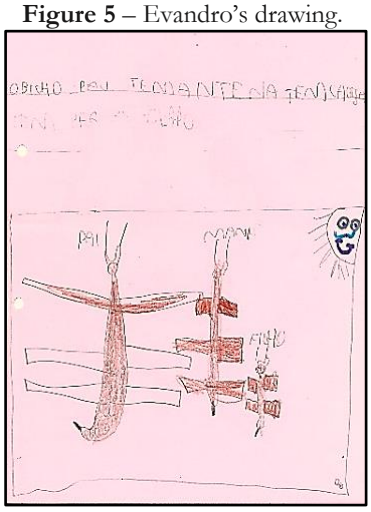
There is no explicit discussion on animal sexual dimorphism, as occurred in the other events (2 and 3), since this was a casual conversation in the final minutes of lesson 5. Nevertheless, the event is relevant for us to comprehend important aspects related to how the group constructed this concept.

Mentions of students about the "father" (L1-2, 5, 21, 24, 27-30) referenced the biggest-sized animal. The group reiterated normalized gender expressions for categorizing insects: a core family that followed the model of the reproductive heterosexual couple. The biggest-sized animal would be the father, the median animal, the mother, and, the smaller, the pup. Notions on masculinity and femininity, established by the gender norm, were used for assigning sex. These notions were already used in the previous lesson (lesson 4) when the students first interacted with the insects. The teacher asked the students to observe the animals at the terrarium and perform their reports in insect drawings. In these first registers, the larger part of students categorized the biggest-sized animal as the father, as illustrated by the student Evandro's drawing (Figure 5).

This position, indicated in lesson 4, was shared between the boys in event 1. In line 31, the teacher, when listening to the conversation of the small group, asked if the male insect was the biggest one, and no one answered. For the boys, the question was already answered. The teacher used this way of dealing with discussions on sexual dimorphism since the beginning of the observations on the insects. She knew that the biggest animal was the female. Nonetheless, at first, she did not correct the students. Throughout the lessons, this discussion was brought up repeatedly as we analyzed it as follows.

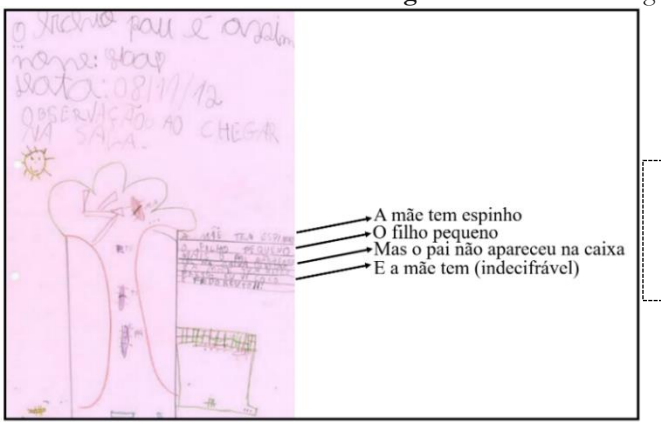
Although the consensual position the boys assumed with Luana, when interacting with her, there were disagreements since the first observations made on the insects. As Butler's indications on performativity, if the norm needs to be continually reiterated, it can also be constrained. In lesson 4, when the groups observed the animals and produced their drawings, only one student, Lívia, disagreed with her colleagues by arguing that the father was not in the terrarium. When approached by the teacher, Lívia answered that that was a family constituted only by the mother (the biggest-sized animal) and its pups (two smaller insects). Karina put Lívia's proposal into evidence for the whole class, but, at that moment, there was no adhesion between the colleagues (Figure 6).

Figure 5 – Evandro's drawing.



Source: database.

. **Figure 6** – Lívia's drawing.



Translation:
The mother has a thorn
The small pulp
But the father did not appear in the box
And the mother has (illegible)

Source: database.

Throughout the lessons, the idea that the biggest animal could be the female gained prominence, unleashing a series of discussions by the class. One of these discussions is particularly relevant and occurred during lesson 7 when the teacher proposed a debate about sexual identification (Table 3).

Table 3 – Analysis event 2

Line	Speaker	Discourse
166	Teacher	Maurício ǀ
167		I want to listen to you ǀ *Breno with his arm raised and Nara also raising her arm.*
168	Maurício	The male is the big one ǀ
169		Do you know why ↑
170		Because it is eating more ǀ
171		The mother ǀ
172		And mainly the son ǀ
173		They are eating very little ǀ
174		Because ǀ *points to the terrarium*
175		The father is the big one ǀ
176		Do you know why teacher↑
177		Because every time I see ǀ
178		It is eating ǀ
179		And the mother ǀ
180		And the son are not, no ǀ *Vinícius raises his right arm, asking to speak*
181	Teacher	The ma+le ǀ
182		You are saying that it eats mo+re ǀ
183		Is that why it is the biggest↑
184		*Maurício nods with his head*
185		You have already seen the male ǀ
186		Eating in our house ǀ
187		The insect here ↑
188	Maurício	Yes ǀ *nods with his head*
189	Teacher	Yes↑
190		And do you think that it is the +big ǀ
191		That is the male↑
192	Maurício	Yeah+ ǀ
193		Bu+t ǀ *points to the terrarium*
194		The male is the big one ǀ
195		Do you know why ↑
196		Because++ ǀ

197		The male is the one that needs to look out for the little son ǀ
198	Teacher	Hey+ Breno ǀ
199		You can speak now ǀ
200	Breno	Oh+ ǀ
201		Oh+ ǀ
202		Oh+ ǀ
203		The mother needs to be the biggest one because+ ǀ
204		It has to eat ǀ
205		More than the ma+le ǀ
206		For it to have more +pups ǀ

Source: prepared by the authors.

In this event, Maurício reiterated the gender norm (L170, L197) by articulating arguments that carried a notion of masculinity that assumed the biological trait status. The male, an intrinsic waster of energy, "naturally" eats more, which is why it is bigger. The male is the one that protects the family and, therefore, it needs to be the biggest and strongest. Breno, however, broke Maurício expectations, and he reverted the logic of the colleague's argument: the female is the one that should be eating more and, therefore, have a bigger size (L196-199).

In prior events, Breno had already defended that the male would be the biggest. However, in lesson 7, minutes before the discussion between Breno and Maurício, the idea that the female would have to be the biggest was raised by a colleague, Marcelo (Table 4).

Table 4 – Interaction that occurred in lesson 7, moments before the analysis of event 2.

Line	Speaker	Speech
41	Teacher	Marcelo ǀ
42	Marcelo	I+ ǀ
43		The little one ǀ
44		The little one is the male ǀ
45	Teacher	Why Marcelo ↑
46		The little one is the male ↑
47	Marcelo	It is because the female ǀ
48		Has to lay +eggs ǀ
49		Didn't we say the other day ↑
50		That+ ↑
51		Stick bugs laid eggs ↑
52	Maurício	But why↑ *turns himself to Marcelo, in revolt, and becomes visibly perplexed*
53		I am not understanding this ↑ *he turns his face upright and, then, to the teacher / gesticulates with both arms and raises them*
54	Teacher	Maurício ǀ
55		In just one minute ǀ

Source: prepared by the authors.

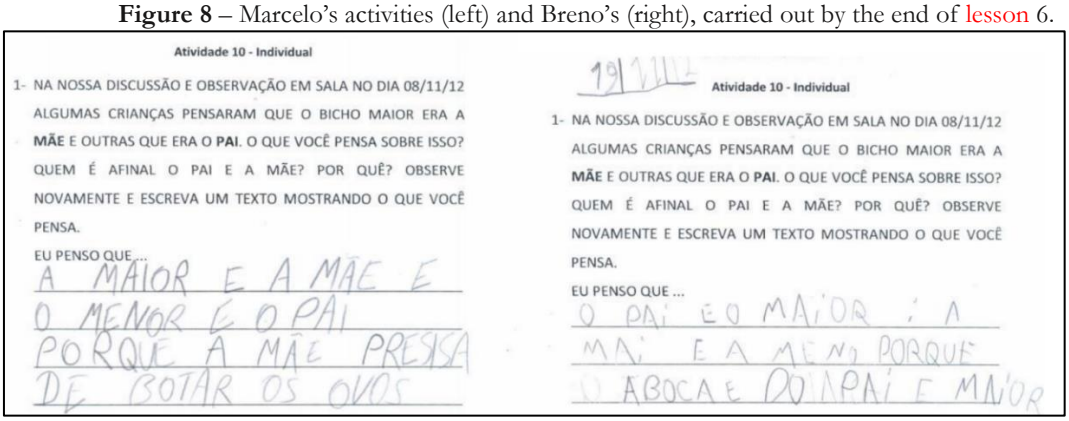
Marcelo used the idea that the female "has to lay eggs" (L47-48), and this is why it would be bigger. In the analysis of event 2, Breno used Marcelo's ideas and inverted Maurício's proposal: if the female is the one that lays the eggs, it is the one who would eat more and, therefore, be bigger. Maurício's reaction in face of the norm's constraint indicates outrage (L52-53). Maurício turned himself directly to Marcelo, his classmate sitting behind him, and gesticulated, indicating doubt (Figure 7). When Maurício said "*But why? I am not understanding this!*" (L52-53), he expressed outrage in face of the distinct position that arose throughout the debate.

Figure 7 – Maurício's frames (blue triangle) when he turns himself to Marcelo (red triangle).

Source: database.

Breno, until lesson 7, considered that the male insect would be the biggest. Nonetheless, given Marcelo's argument, he changed his mind. It is possible to note the positioning of both in an activity carried out by the end of lesson 6, dated 11/19, just one lesson before the debate. Marcelo was already using the argument exposed in lesson 7, whereas Breno was still considering otherwise (Figure 8). In posterior interactions, Marcelo revealed that he saw the information on the stick bug's eggs in a book that his colleague Jonas took in school. The book was about animals[7], and it was taken by Jonas on 11/14 when there was no science lesson. Some colleagues saw the book and Marcelo read a few pages about the stick bug.

Figure 8 – Marcelo's activities (left) and Breno's (right), carried out by the end of lesson 6.



Source: database

Even in the face of his colleagues' arguments, Maurício was not open to considering that the mother insect would be bigger than the father. By the end of the discussion of lesson 7, Breno reaffirmed his rationale (L274-281) and Maurício's reaction was emphatic (Figure 9). He looked directly at his colleague, who was sitting behind him, to reaffirm that both disagreed and that he was "talking a very impor+tant thing" (L290-291) (Table 5).

Table 5 – Interaction that occurred in lesson 7, moments before the analysis of event 2.

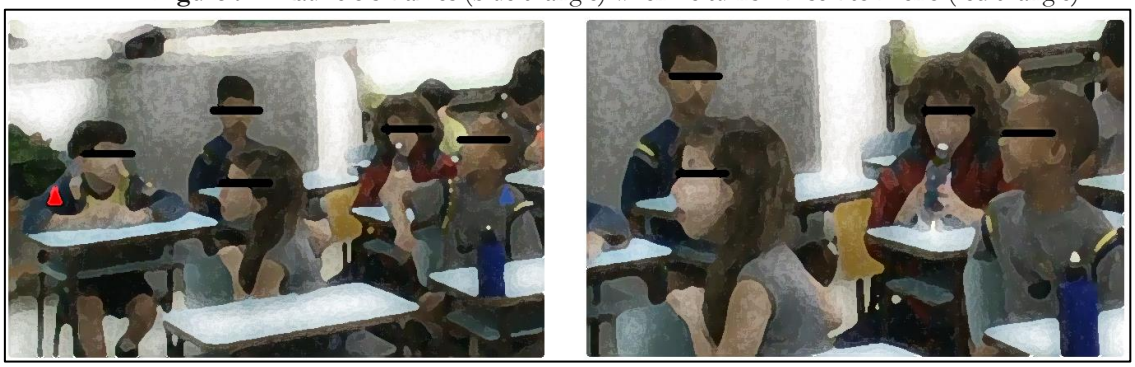
Line	Speaker	Speech
274	Breno	The female is the biggest **I**
275		Because it has to eat more than the father **I**
276		so she can **I**
277	Mariana	XXXX *she comments something in a lower voice, directly toward Breno, and she is in front of him and seems irritated with Maurício's reactions while Breno is speaking*

[7] Book: Os bichos (1970), São Paulo, Abril Cultural, 4 volumes, 228p.

278	Breno	lay the eggs I
279		So that others can be born I
280	Student	Teach+er I
281	Breno	Other stick bug I
282	Maurício	I +know Breno I *turns back and stares at Breno*
283		But I
284		But your opin+ion I *points the index finger to Breno while saying the word "your"*
285		Opinion I *points the index finger again*
286	Mariana	Oh my God I *stands the left hand to Maurício*
287	Marcelo	*raises the right arm*
288	Maurício	It is different from mine I
289		And I am talking one thing I
290		That is ver+y important I

Source: prepared by the authors.

Figure 9 – Maurício's frames (blue triangle) when he turns himself to Breno (red triangle).



Source: database.

Maurício's arguments and his reactions throughout the interactions indicated difficulties in considering the possibility of the female being bigger than the male. This aspect is particularly relevant for the learning of that conceptual content. There is no universal pattern of sexual dimorphism amongst animals. As for the stick insect's sexual dimorphism, the female is bigger than the male and the evolutive ecology explains this phenomenon based on the energy demand that the production of eggs requires from females, which manifests itself in size difference (FAIRBAIRN, 2013). In this sense, learning about a sexual dimorphism concept requires openness to the idea that differences between sexes do not necessarily occur uniquely (i.e., there is no unique norm). Females can be bigger than males, males can be smaller and parasitic, and ornaments and colors are also diverse. Not considering these possibilities can generate implications for conceptual learning. Learning about sexual dimorphism, therefore, would demand constraining, to a certain measure, the hegemonic gender norm.

Finally, the third event that was analyzed took place in lesson 8, during the correction of homework. In a previous lesson, the teacher asked their students to research other cases of sexual dimorphism, in addition to the stick bugs. Throughout these interactions, we discuss the sex of the gecko (Table 6).

Table 6 – Analysis event 3.

Line	Speaker	Discourse
1	Teacher	Hey Breno I
2		You are saying something important I
3		That few people know I
4		Repeat it please I
5		Listen to what Breno is saying I

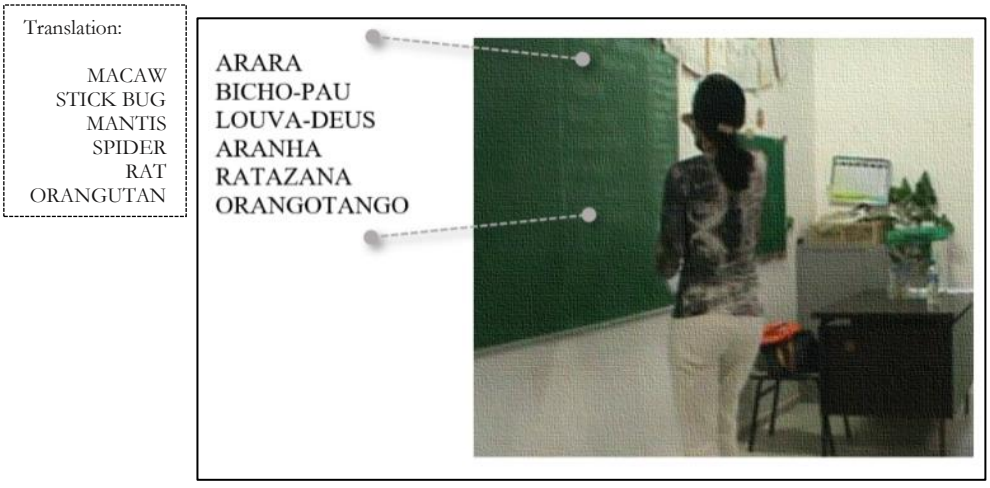
6	Breno	That+ ↑
7		Some animals can change sex ǀ
8	Teacher	How↑
9	Breno	It's like this ǀ
10		I saw it at my sister's Biology book ǀ
11	Teacher	Biology↑
12		Oh+ ǀ
13		You can say it ǀ
14	Breno	Then+ ǀ
15		It said that+ ǀ
16		That+ ↑
17		The geck+o ǀ
18	Teacher	Oh+ ǀ
19	Breno	That when it is small ǀ
20		It is a male ǀ
21		And when it grows ǀ
22		It turns into a female ǀ

Source: prepared by the authors.

The gecko's example surprised the teacher, who asked the student to repeat the idea for everyone to listen. By saying that the gecko could be male when small, and then turn into a female, Breno constrained the gender norm by breaking biological sex fixity, which is constantly reiterated in daily social rituals. Adaptation, present in nature and pointed out in the biology book, puts the possibility of constraining the gender norm in evidence. Different from what we observed in the two prior events when the norm was constrained, in this event, the reaction highlighted the proposal. Karina put Breno's talk in evidence, pointing to the relevance of the information (L2) and indicating that it is not common knowledge (L3), therefore asking it to be repeated (L4).

Regarding science learning, this event offered crucial elements from the lens of Butler's performativity. By the first lessons on the stick bug, there was an expressive moment of norm reiteration. From lesson 7 onwards, most students started considering that the female would be the most significant animal. The students leaned over previous discussions and homework corrections moments before event 3.

Figure 10 – Moment in which the teacher discussed the homework in lesson 8.



Source: database.

During the correction, the teacher discussed the diverse possibilities of sex dimorphism existing in nature and highlighted the differences between the examples brought

by the children from their homes: cases in which males and females did not exhibit dimorphism (i.e., macaw), cases in which the female would be bigger than the male (i.e., bee, hyena), and cases in which both female's and male's size was the same but the dimorphism took place by other circumstances (i.e., lion, peacock) (Figure 10).

Thus, in a space in which causality relations between gender norms and the traits of two fixed, opposed sexes constituted the comprehension of the behavior and biology of animals, students constructed a change of position by recognizing that females could be bigger than males and that other configurations are equally possible, to the point of a student having the freedom of mentioning that males becoming females would be possible (L7, L19-22). This does not mean that this interactive space has become "immune" to the continual practices of gender norm reiteration. Future events in the history of this class, throughout the 2nd and 3rd grades, indicated that practices that reiterated or defied norms were in constant negotiation between the participants (see FRANCO, 2018).

CONCLUSIONS OF THE STUDY AND THE DIALOGUE WITH OTHER RESEARCH

How do students and the teacher act and react in the face of situations that constrain gender norms in science lessons?

Our results reiterate what other studies have indicated regarding how children act in situations that constrain gender norms in school. Overall, the most common actions are pointed at protecting the norm (RINGROSE, 2010). The first analysis of this research indicates that some boys, in the face of a situation that constrained the norm, reiterated normalized notions of masculinity and femininity based on courage and fear, respectively. As for the second event, situations that constrained the gender norm raised energetic reactions. Contextual cues in Maurício's talk indicated the certainty and obviousness that the bigger animal would be the male, in addition to highlighting outrage signals in the face of the possibility of considering the other way around.

Marios Kostas's (2016) study presents similar results when showing how boys tend to worry more about expressing traits such as courage and heroism. These results are related to children's actions when their teachers work on reading a book that constrains gender norms since it brings an alternative version to the Snow-White tale. The tale highlighted a more decisive and heroic role by the protagonist, who became the liberator of victims of a cruel queen. In the face of this new version, many children disagreed, especially boys, who defended courage and heroism as traits directly related to masculinity. Jane Felipe (2000) offered important statements to comprehend this kind of reaction. For her, these attributes result from a historic construction of the school space in which behavior expectancies for boys and girls are continually reiterated in documents and practices. Important elements in constructing the "ideal boy" would be courage, energy, boldness, and virility. For the girl, discretion and modesty are virtues (FELIPE, 2000).

Nonetheless, in light of Butler's performativity, movements of gender norm reiteration were not the only ones throughout the lessons. Lívia's drawing, for example, pointed to the possibility of changing an answer that was seemingly shared by the greater part of students, even if it would represent breaking a social expectancy and normalized notions of family. In this sense, the analysis of events 3 revealed a distinct reaction from the ones in events 1 and 2. In interactions on the gecko's sex change, a student shared a phenomenon that constrained the norm, which gained prominence and was valued by the students.

Some studies have indicated similar results and point that, despite seemingly linear gender relations in school, there are still other ones, such as the elaboration of alternative notions on men's and women's roles in society and different family models

(GUERREIRO et al., 2014); the presence of alternative speeches different from the one of the "male youngster" and the "hard to get the girl" (SALES; PARAÍSO, 2013), playing practices that constrained the norm (NEVES, 2008), as well as the usage of instructional materials that broke with the social expectancy that sustains the norm (KOSTAS, 2016).

In which way can negotiation processes of gender norms constitute the learning of a scientific concept?

In the class, we analyzed, learning about what determined an animal's sex, something regulated by what is natural/biological, was being constructed through movements of reiteration/constraining of gender norms. That is, gender norms played a pivotal role in the learning processes in that class, and alignment to the gender norm made learning difficult. The interactions we analyzed highlighted Maurício's case, in which the boy did not recognize the possibility of the female being bigger than the male; therefore, he faced problems for arguing in compliance with the instructional expectancy in natural sciences and comprehending sex dimorphism as a diverse phenomenon.

A study by Alandeom Oliveira, Valarie Akerson, and Martha Oldfield (2012) presents a similar case. The students discussed environmental issues and started arguing about what to do when encountering an exotic animal–a deer–on the road. This dilemma generated an unexpected reaction: one of the students commented that he would opt to take the animal home and his colleagues started engaging with homophobic insinuations. In this situation, an unsafe environment was created among all of the other colleagues. The class, then, agreed upon a quick solution for that conversation. The analyses indicate that the discussion was very distinct from the other environmental issues in which this unsafe ambiance did not emerge. In other situations, the students had the opportunity of deepening discussions, search for data to sustain their stands, disagree with their colleagues, and try to reach a common ground. As for the discussion regarding the deer, however, the gender norm alignment made it difficult to engage in more complex argumentative practices[8].

This result complies with our analyses by highlighting how gender can generate impacts on learning opportunities regarding natural sciences. In light of the performativity, our results advance when indicating that it was not only the gender norm reiteration that left significant consequences. Constant norm tensioning also played a relevant role in science learning. Throughout the lessons analyzed in this study, the idea that the female one could be bigger than the male was already present since the students' first contact with the insects. Therefore, there was a growing uncertainty around this issue, which exposed the limits of the preponderant idea, i.e., that the male insect would be bigger than the female one. Thus, negotiating gender generated a movement in this class: a certainty, seemingly consolidated, was destabilized, and the lack of conviction drove students to the discussion on what criteria should be adopted when defining insects' sex. This movement was relevant from the perspective of learning about sex dimorphism, considering that this phenomenon involves understanding the diversity of sex differences among animals.

The teacher's role is highlighted in this process. Since the first observations, the teacher did not "tell" the students the correct answer. Throughout the lessons, she maintained an environment of uncertainty and favored discussions that helped children to change their stands. Throughout the negotiation process, the children learned to identify the sex of an insect and that there is no universal pattern for this identification. The students

[8] Jokes relating the delicate behavior of the deer with the one portrayed by gay men is a practice common to the Brazilian culture.

articulated these pieces of knowledge in future events when facing similar situations in 2nd and 3rd grades (see FRANCO, 2018).

RESEARCH CONTRIBUTIONS AND PEDAGOGICAL IMPLICATIONS

A primary contribution of this study concerns how gender constituted the learning processes of natural sciences conceptualizations. For researchers like Butler, gender manifests itself in all dimensions of our existence. In class, gender is part of the everyday life and constitutes school science, including its concepts. However, we lack the proper sensitivity and tools to spot and analyze it in seemingly "immune" contexts to the gender norm. Research in science education may benefit from theoretical contributions on gender to deepen understanding of pivotal issues in the area. One implication in this sense regards using these constructs for analyzing interactions in science lessons. We agree with Paulo Lima Júnior, Fernanda Ostermann, and Flavia Resende's (2010) position that: it is necessary to understand gender by analyzing the language used inside classrooms. In daily interactions inside the classroom, the norm is continually legitimized, reiterated, challenged, or revised. In compliance with the events analyzed in this study, it was through conversations with colleagues, homework corrections, casual comments, and activities of discussion and arguing that gender was negotiated in science lessons. It is relevant to the research to scrutinize the life that unfolds in everyday life in science lessons.

Another contribution of this study is related to the description and interpretation of science curricula and the role of educators. There is a tendency among science teachers and researchers to look over gender relations that are constructed in interactions inside the classroom (QUIRINO; ROCHA, 2013). Science curricula also present this tendency. In 1997, Alberto Rodriguez analyzed curriculum proposals considered to be innovative at the time. The author indicates that those were proposals with expressive reforms for science education, but they used a discourse based on invisibility. Although inserted in a proposal related to the egalitarian access to science, they did not directly explore issues concerning gender, race, or socioeconomic matters that influence the teaching and learning of science in schools. Nowadays, approximately twenty years later, despite advances, curriculum policies on science still do not highlight these issues (CARDOSO, 2018).

Thusly, the argument that gender issues should not be mixed with natural science teaching and learning is still present since it is supposedly not directly linked to this disciplinary field. In this light, scientific knowledge would be more "objective," with a more delimited focus, and, therefore, bringing gender to this school subject could compromise the aims of teaching. Nevertheless, even when not directly and openly emphasizing gender, what happens inside the classroom is permeated by gender relations.

Our analyses indicate the relevance of a more complex view of classroom interactions under the perspective of gender for a better understanding of how people learn science. It means that gender cannot be neglected, even when it is not explicitly discussed. The analyzed lessons were not elaborated on to promote this kind of discussion. However, breaks of expectation that constrained gender norms were visible in the negotiations between participants and generated learning implications.

This aspect of the study seemed to us particularly important to the current Brazilian educational context. Proposals prohibiting discussions that explicitly address gender inside the classroom seem to impede students from talking about their own lives, who they are, and their takes on the world. Therefore, this study is aligned with other research in the field of education by indicating that talking about gender is a necessary, urgent tool for understanding a classroom. Our results show how little children already possess normalized notions of masculinity and femininity that legitimize hierarchical processes

between men and women and how these notions influence their learning. We must move forward in our curricular and teaching proposals, not backward.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare that there is no conflict of interest with this article.