



SEX/GENDER IN THE CONSTITUTION OF SOCIAL NORMS OF KNOWLEDGE CONSTRUCTION IN BIOLOGY CLASSES

ARTICLE

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ABSTRACT:

In science education, several authors have pointed out the importance of thinking about how sex/gender can be incorporated into research and teaching in order to overcome inequalities. Taking high school biology classes as a context, we analyzed the interactions of a group of students to understand how sex/gender influences the social norms of knowledge construction. We found evidence that indicates an imbalance in the moderate equality of group members, with cis boys' contributions being more valued. The use of public analysis standards ensured the visibility and acceptance of cis girls' arguments. We discuss how the recognition that the social norms of construction of knowledge in the classroom are influenced by sex/gender and how it can contribute to research on epistemic learning, as well as assist teachers in establishing practices that contribute to constructing an equitable environment for epistemic learning.

Keywords:

Sex/gender;
Equity;
Epistemic learning.

SEXO/GÉNERO EN LA CONSTITUCIÓN DE LAS NORMAS SOCIALES PARA LA CONSTRUCCIÓN DEL CONOCIMIENTO EN CLASES DE BIOLOGÍA

RESUMEN:

En la enseñanza de ciencias, diferentes autores han señalado la importancia de reflexionar sobre cómo es posible incorporar el sexo/género a la investigación y las prácticas didácticas, para superar las desigualdades. Tomando como contexto clases de biología de la educación secundaria, analizamos las interacciones de un grupo de estudiantes para comprender cómo el sexo/género influye en las normas sociales de construcción del conocimiento. Encontramos evidencias del desequilibrio en la igualdad moderada de los miembros del grupo, siendo más valoradas las contribuciones de los niños cis. El uso de estándares públicos de análisis aseguró la visibilidad y aceptación de los argumentos de las niñas cis. Discutimos cómo la comprensión de que las normas sociales de construcción del conocimiento en la clase están influenciadas por el sexo/género puede contribuir a la investigación sobre el aprendizaje epistémico, así como ayudar a los docentes a establecer prácticas que contribuyan a la construcción de un ambiente equitativo para el aprendizaje epistémico.

Palabras clave:

Sexo/género;
Equidad;
Aprendizaje epistémico.

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SEXO/GÊNERO NA CONSTITUIÇÃO DE NORMAS SOCIAIS DE CONSTRUÇÃO DO CONHECIMENTO EM AULAS DE BIOLOGIA

RESUMO:

Na educação em ciências, diferentes autores apontaram a importância de pensar como sexo/gênero pode ser incorporado às pesquisas e às práticas didáticas, visando a superação de desigualdades. Tendo como contexto aulas de biologia no ensino médio, analisamos as interações de um grupo de estudantes para compreender como sexo/gênero influenciam as normas sociais de construção do conhecimento. Encontramos evidências que indicam desequilíbrio na igualdade moderada dos integrantes do grupo, sendo mais valoradas as contribuições dos meninos cis. O uso dos padrões públicos de análise garantiu a visibilidade e aceitação dos argumentos das meninas cis. Discutimos como o reconhecimento de que as normas sociais de construção do conhecimento em sala de aula são influenciadas por sexo/gênero pode contribuir para pesquisas sobre aprendizagem epistêmica, assim como auxiliar docentes no estabelecimento de práticas que contribuam para a construção de um ambiente equitativo para a aprendizagem epistêmica.

Palavras-chave:

Sexo/Gênero;
Equidade;
Aprendizagem epistêmica.

INTRODUCTION

In science education research field, different studies have pointed out the importance of thinking about how gender relations can be incorporated into investigations about educational processes and didactic practices (see Brotman & Moore, 2008; Heerdt et al., 2018). These discussions about bodies and genres have pointed to the constitution of a field of research with multiple theoretical, methodological, and epistemological perspectives (Santos, Souza & Bastos, 2021).

Two systematic literature reviews show this diversity of perspectives. At the international level, Brotman and Moore (2008) mapped the thematic approaches taken by the authors of works in the field of science education that dealt with the engagement of girls in the sciences. The authors identified four thematic approaches: i. Equity and access; ii. Curriculum and pedagogy; iii. Reconstruction of the nature and culture of science; and iv. Identity.

In the national context, Heerdt et al. (2018) set out to identify the thematic focuses of research related to gender issues and science teaching in Brazil in the 2008-2018 decade. The authors evidenced an increase in publications in the field in the analyzed period, and although they identified ten thematic focuses, the works concentrated mainly on only three of them: i. Gender and participation of women in science (analyze the participation of women in the history and current science); ii. Gender, practices, and teacher education (analyze conceptions and teacher education about gender issues); and iii. Gender and didactic materials (analyze how gender representations occur in textbooks). Despite the scarcity of productions so far, the authors also list other relevant thematic focuses and justify efforts to take a deeper look at new works. They are: iv. Gender and inferences of interpretation; v. Gender and theoretical studies; vi. Gender and interventions; vii. Gender and science in the media; viii. Gender and science learning; ix. Gender and interactions/perceptions in science classes; and x. Gender and scientific production (Heerdt et al., 2018).

In this paper, we understand that gender relations influence opportunities for science learning and are interested in understanding how they impact the social norms of knowledge construction established in biology classes. We consider that our work is part of the thematic approach “Equity and access” by Brotman and Moore (2008), as we are included among those who “emphasize that, for the engagement of girls in science, we

need to build an environment with equitable opportunities” (Brotman & Moore, 2008, p. 974, our translation). In addition, in Brazilian literature, this work contributes to a thematic focus that has been little addressed, ix. Gender and interactions/perceptions in science classes (Heerdt et al., 2018). In recent years, only two studies have sought to understand gender relations based on the analysis of language in use in science classes: Lima Júnior et al. (2010) investigated the construction of leaders in discursive dynamics in a debate between physics undergraduates, while Franco and Munford (2023) analyzed how the processes of negotiating the gender norm influence the learning of a scientific concept among students in the 1st year of elementary school.

CONSIDERATIONS ABOUT SEX, GENDER, INEQUALITIES, AND STEREOTYPES

Socially, a person is only recognized as a person when their gender performance can be intelligible by the community since gender is the first characteristic recognized in interactions with the other (Butler, 2003). Butler (2003) explains that in the process of understanding the other as a person, therefore, of recognizing and interpreting their gender identity, people use meanings that they attribute to bodies, and these meanings originate in cultural conceptions that attribute difference to sexual bodies based on what is expected of each of them (stereotypes), consequently affecting the participation in the community of some individuals (cis and trans women and other dissident bodies) to the detriment of those who represent the universal (cis men).

The widespread notion of gender and sex as two opposing concepts, one derived from social construction and the other from biological conditions, is questioned by feminist researchers such as Fausto-Sterling (2019) and Butler herself (2022). For these authors, sex is not a natural and fixed data but a category that, in the individual, is formed in a procedural and in a performative way. In addition, the socially elaborated construction of gender only exists from what is understood about sex. Thus, in this work, we adopt a biosocial approach to gender, which understands the concepts of sex and gender not as dichotomous or independent, but from an overlap (Fausto-Sterling, 2019), so we will adopt the term sex/gender to refer to this construct from this point on in the text.

Socially conceived constructions about gender, arising from the sex/gender duality, translate into a power dynamic that can produce inequalities based (albeit mistakenly) on biological terms. From these conceptions, the spaces that bodies can occupy in different social spheres are also delimited. Structurally, stereotypes are constructed that impose “sex-generated social performances” (Carvalho, 2021, p. 435). Relationships are unevenly established based on the “perceived differences” between the gender considered normative (cis masculine) and the other expressions of sex/gender and result in identities constructed by disciplinary practices that stigmatize and denaturalize bodies, evidencing themselves through relational interactions, serving to justify disparate power relations (Carvalho, 2021).

SOCIAL NORMS OF KNOWLEDGE CONSTRUCTION IN SCIENCE CLASSROOMS

For Longino (2002), science can rationally produce forms of legitimate knowledge, as it is a social practice built and shared by a group of people who share practices, language, norms, and values. This assertion that science is a social activity is often interpreted as conceiving it as arbitrary and non-objective. In fact, for philosophers such as Harding (1986) and Longino (1990), science is permeated by values that influence its development at different times, with an interaction between the constitutive values of science, that is, those that guide scientific and epistemic practices (such as accuracy, simplicity and comprehensiveness) and contextual values, which are part of the historical and socio-cultural context of the scientific endeavor, as well as the interests and

ideologies of each scientist. However, these authors also argue that science is not arbitrary, and it is possible to attribute objectivity to it due to constant questioning and evaluation, practices of a genuinely social nature.

Considering the above ideas, Longino (2002) highlights four social norms necessary for collective participation and, consequently, for the establishment of objectivity:

- a) Public forum: refers to the existence of publicly recognized spaces for exhibition and discussion of scientific processes and results, such as scientific meetings or the peer review process;
- b) Receptivity to criticism: relates to the need to receive criticism and dialogue with them, incorporating them when relevant, which can lead to changes in the ideas accepted by the community;
- c) Public standards of analysis: refer to publicly recognized normative criteria according to which scientific processes and results will be discussed, such as the need to base conclusions on evidence;
- d) Moderate equality of intellectual authority relates to the existence of equal authority so that several community members can participate in the discussion forums without excluding certain groups. We say moderate equality insofar as the difference in expertise and knowledge between the members is considered.

This collective participation must be heterogeneous, formed by diverse agents, in order to enable the plurality of positions so that the knowledge legitimized by the scientific community is the one that survives criticism from different points of view. For Longino (2002) and Harding (1986), the epistemic strength of science is the result of its diversity.

The conception of science as social practice allows us to bring another look at science classrooms and also understand science teaching as practice. Despite being different contexts and, therefore, composed of different norms and practices, the social norms explained by Longino are elements that can be promoted in an adapted way in science teaching (Kelly, 2004). To promote a tool for investigating these norms and social practices in the classroom, Nascimento and Sasseron (2019) proposed an adaptation of the social norms highlighted by Longino (2002) to the norms that govern the process of building explanations in science classrooms. Thus, the authors analyzed discursive interactions between students and between students and teachers and proposed indicators of the occurrence of norms in the classroom.

Armed with the tool proposed by Nascimento and Sasseron (2019), Ribeiro, Barcellos, and Coelho (2021) analyzed interactions between students and teachers in a physics class and identified scientific norms and practices established in the classroom. With regard to norms, the authors highlighted the presence of critical receptivity and the constitution of moderate equality and attributed this to the investigative character of the didactic activity that contemplated greater student involvement in the construction of ideas in the classroom.

Understanding the construction of scientific knowledge at school as a social practice, social norms are evidenced in the interactions experienced between teachers and students in the classroom and are built from the elements of each educational context. Thus, resuming the considerations already pointed out about the influence of gender construction on learning, we can assume that these social norms are also built under the influence of gender-generated logic.

Considering this, we seek to understand how sex/gender impacts the social norms of knowledge construction established during group work in biology classes.

FEMALE LEARNING IN SCHOOL

Understanding science as a social practice (Longino, 2002) depends on recognizing that science is produced by people who share objectives and values. It is important to say that, among these values, the production of scientific knowledge is socially understood as part of the male domain, which is not neutral but

permeated by gender-based biases and exclusions (Harding, 1986). Conceiving science as a social practice also impacts the purposes and strategies of science teaching because we understand that scientific learning requires student participation in science practices, values, and norms (Duschl, 2008; Valois & Sasseron, 2021).

In school learning, Gedoz, Pereira, and Pavani (2020) state that stereotypes about sex/gender influence learning, since each individual builds their perceptions of the world from a personal perspective. The “personal narratives” that outline each individual’s worldview are based on forms of expression created by different cultures, that is, the very expression of an individual’s identity is not unique but based on what is socially constructed and accepted (Louro, 2000) and, among the ways of presenting oneself to the world and recognizing oneself, the first is gender identity from the body (Butler, 2003; Louro, 2000). These constructions affect the daily relationship of each person and, of course, are also reflected in the school context: therefore, the way women and girls can learn is affected, because many spaces reinforce their exclusion (Gedoz, Pereira & Pavani, 2020), guided by this reading of what is the expected behavior of each body.

The school is a space for the socialization of bodies, but also a disciplinary space, where behaviors or social positions are naturalized, also based on consolidated gender inequalities. Louro (2000) discusses how the school institution, despite not being responsible for building distinctions between genders, uses the distinctions that already circulate in society to assign roles, reward expected behaviors, punish divergent behaviors, and establish hierarchies.

The school is not only a space for building knowledge but also a space that “manufactures subjects” (Louro, 2001), that is, it prints/reinforces/rewards worldviews based on social divisions, which are part of what influences students when they form their own gender, sexual, ethnic identities (Louro, 2001) and, thus, thinking specifically about sex/gender, perpetuates behaviors associated with what is expected of each of the bodies, always seen in the binary of male and female. Thus, from subtle instruments (language, looks, ...) reiterated daily, the stereotypes associated with sex/gender of right or wrong in constructing each individual are instituted: desires, interests, behaviors (Carvalho, 2021; Louro, 2001).

Louro (2001) points out that the observation of difference (which is what generates stereotypes and expected behaviors) is always connected to power relations because the difference can only be explained or “named” from what is considered normative, a place of reference (Louro, 2001) and, in the case of gender expressions of sexed bodies, the norm materializes in cis-masculine bodies.

By analyzing the many ways in which cis women learn, Belenky and collaborators (1986) show that learning through “Silence” is a recurring aspect. The silence reported by the authors does not say about the inability of these women to claim a speech space but about not being able to make their speeches serve to construct meanings in the group (Gedoz, Pereira & Pavani, 2020).

From these references, we understand that, in different ways, the school reinforces social patterns of power distribution associated with sex/gender and that this inequality impacts the construction of knowledge in science and biology classes. Resuming the conception of science as a social practice and the importance of diversity of points of view for its production, when defending the approximation of student people to the social norms of scientific knowledge production, we need to pay attention to promote an environment with equitable learning opportunities for all social groups, where people of different sexes/genders can speak, be heard and properly considered. Thus, in this work, we seek to understand how sex/gender influences the social norms of knowledge construction during group work in biology classes.

METHODOLOGICAL ASPECTS

Research context

The school where the research was carried out is located on the limits of the expanded center of the city of São Paulo and is mostly attended by students from salaried middle-class families, in addition to being characterized by its students' cultural and ethnic-racial diversity. Most of the students attended school since the beginning of elementary school, and, given that the data in this research refer to a class of the 1st year of high school, the people who made up the class shared a school history of almost a decade.

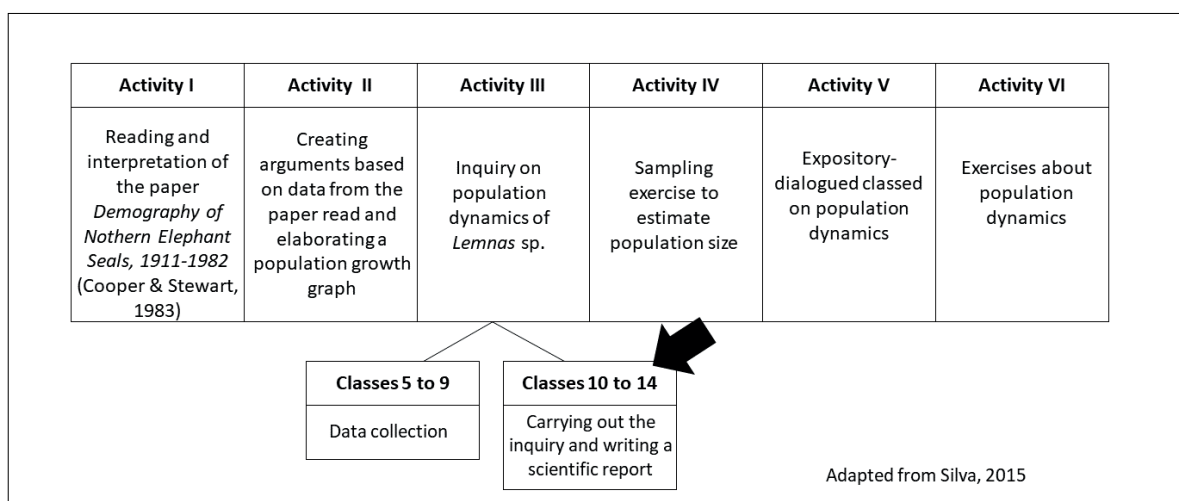
The data used for the research were collected while applying an investigative didactic sequence (SDI) in the Biology component in the second semester of 2013.

The SDI was prepared by the third author of this work, the teacher in the class, as part of her doctoral research (Silva, 2015). Other works developed from the application of this SDI have already been engaged in investigating knowledge construction practices (Silva, 2015; Silva, Gerolin & Trivelato, 2018; Silva, Gerolin & Trivelato, 2017), but this is the first to propose a reading of the established implications of sex/gender in the group for classroom learning.

Initially, these data demonstrated that the didactic context analyzed promoted epistemic learning. We decided to revisit the data to consider the effects of social constructions on sex/gender in classroom interactions. By bringing this analytical perspective, we are not questioning whether or not an unequal distribution of power oriented by sex/gender in the classroom, which has been demonstrated in several recent studies (Carvalho, 2021; Lima et al., 2021; Santos & Gianella, 2021), but we want to characterize how this unequal distribution of power, the result of social interpretations of sex/gender, influences the social norms of the construction of scientific knowledge in investigative activity.

The central theme of the SDI was “Population Dynamics”, which consisted of six activities, as shown in Figure 1.

Figure 1. Organization of applied SDI and selected classes for analysis



The teacher initiated the research activity (Activity III) with the following question: “What happens to a biological population after colonization by some individuals in an environment with the ideal conditions for the development of the species?”. Between classes 5 and 9, the groups collected the data for the investigation (daily photos of the population) and in classes 10 to 14, they worked on writing the scientific report from a handout with guidelines on the nature of the text and what should compose each item.

The people who participated as subjects and their guardians were informed about the research and signed, respectively, the Terms of Assent and Informed Consent. In addition, following guidelines from the Ethics Committee of the Faculdade de Educação da Universidade de São Paulo [Faculty of Education of the University of São Paulo], all participants had their names omitted to ensure anonymity.

Regarding sex/gender identification, it is important to note that, as the data were collected to answer other research questions, there was no information on the students' self-determination. To carry out this study, students were contacted in 2022, informed about the objectives of this new research and asked about their gender identity, whether cis-feminine, cis-masculine, or other, or if they preferred not to identify themselves. Of the people participating in this analysis (selection criteria below), two students identified themselves with the cis-female gender and two students with the cis-masculine gender.

Data production

We selected as a corpus for this research the interactions that occurred during Activity 3 of the SDI, an investigation on population dynamics of *Lemna* sp. plants, and defined as a focus five classes related to the development of the investigation stage of the activity (Figure 1). The students investigated the data collection stage, which was made daily with photographs of the population of *Lemna* sp. under the group's responsibility.

The audio and video records of the interactions of this activity were transcribed according to the rules of Preti (1999) by the second author and are available in her master's thesis (Gerolin, 2017). The interactions were transcribed in turns, and the records related to the performance of Activity III were kept; the other shifts, which involved parallel conversations or other activities, were excluded from the transcription. The transcript was divided into episodes, determined by the moments when people were engaged in discussions with clear theme boundaries, carrying out specific tasks, or when new people joined the interaction (Gerolin, 2017).

We are guided by the methodological aspects of qualitative research, conducting a case study in this work, as we investigate a phenomenon in its real context (Kelly, 2023), a context that is the science classroom. For this, we selected for analysis the transcripts of a group (Group C) consisting of two cis girls and two cis boys. The criteria for choosing this group were engagement and satisfactory performance in carrying out the activity, which would offer us a greater occurrence of interactions for analysis, and mixed composition with people with male and female gender identities, which allowed us to observe sex/gender relations and respond to the objective of this research. According to the perception of the class teacher, the four students in Group C had good oral participation, that is, they expressed doubts and made pertinent contributions to classroom discussions. However, the performance in the formal assessments (tests, assignments, and reports) of the two cis girl students was satisfactory, while that of the cis boy students was unsatisfactory and, therefore, they attended support classes after school.

Analysis of social norms of knowledge construction

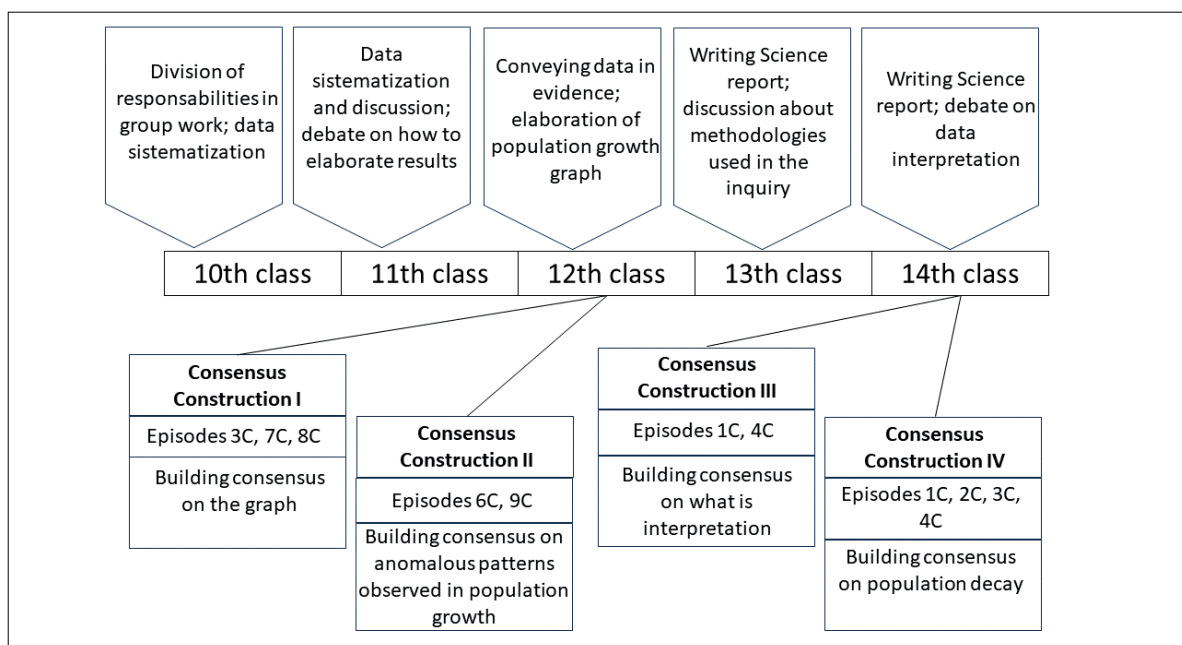
Nascimento and Sasseron (2019) proposed an analysis tool in which they point out cultural operations through which we can understand the occurrence of social norms of knowledge construction in the classroom.

To use this tool, we take the discourse in the classroom as an action (Bloome et al., 2008) and, in a situated way, as the "cultural operations" mentioned by Nascimento and Sasseron (2019). Thus, when students and/or teachers interact using language, they act on and with others (Bloome et al., 2008), and throughout this process, meanings are constantly shared, negotiated and modified. In the classroom context, these meanings can refer to concepts, valid norms for the construction of knowledge in the group, and the role of different social groups, such as different bodies in relation to sex/gender.

Constitution of the units of analysis

For Longino (2002), when we affirm that science is a social practice, the term “social” means interactive and, in this sense, considers that the “social” is constitutive of knowledge. We understand that the occurrence of a space for presentation and critical evaluation of evidence, methods, and hypotheses, among other ideas, that is, the occurrence of a public forum, is a primary condition for the other social norms proposed by Longino (2002) to be built in the context of the classroom. Thus, the criterion for selecting the episodes of interactions was the existence of evidence that the student people were engaged in building consensus on the distinct stages of the investigation. These moments constitute longer interactions and have the participation of different interlocutors who make proposals or evaluate the idea of a person in the group, which allows us to have evidence of the constitution of other social norms (if there is receptivity to criticism, if the evaluations of the propositions of the people who make up the group are based on the public criteria of analysis and if there is moderate equality between these people). Considering the existence of a public forum, we selected four sets of episodes to constitute the moments of consensus building (Figure 2).

Figure 2. Timeline of investigative activity and location of units of analysis



RESULTS AND DISCUSSION

SHARING PUBLIC STANDARDS OF ANALYSIS

As a moment of sharing public standards of analysis, we identified the guidelines for preparing the group’s research report that explains a norm to validate production: ideas must be evaluated in the light of empirical data produced in the investigation or by concepts and processes already studied in class. We also know the history of the class, and we know that the students of this school had, as a school culture, the habit of conducting investigations and writing reports that followed similar guidelines, consolidating these guidelines as a way to share public standards for the analysis of ideas in the group.

During Consensus Construction II (CCII - Chart 1), when they noticed an anomalous behavior in the group’s data (the number of individuals in the population had decreased overnight), Student L expressed

doubts about the reliability of the data and asked if the number of individuals was correct. The group acknowledged her question and Student G argued that the population could fall, validating what her colleague had observed. For this, she rescued the graph analyzed in the class in Activity 1 of the didactic sequence. In this interaction, when she presented evidence to defend the idea that population size can decrease, Student G rescued a process similar to that found in her data (using the graph studied in previous classes) to support the possibility of reducing population size. As is evident in the other parts of the interaction, the group accepted the argument and sought explanations for the population decline.

Chart 1. Interactions during Consensus Building II (Lesson 12 - Episode 9C)

Turn	Person	Speak	Action
1	Student L	It is 258, is that right?	Count of <i>Lemna</i> individuals present in photos
2	Student G	It depends on the amount you spend...	
3	Student L	204... 277... Mine is 258, G.	
4	Student G	It may fall... The other one also has a fall... Look at the other graphic... Where is the other graphic?	The "other" refers to a graph about the elephant seal population used by the teacher in previous classes to discuss population dynamics.
5	Student L	Where is the other graphic, V.?	
6	Student B	It's right there, look!	
7	Student V	Look... She fell... Wait, I'll get it... ()	
8	Student L	()	
9	Student V	So, what is it?	
10	Student L	I don't know... ()	
11	Student G	Look there, L. There is a fall ((on the graph))	

Student G's action and the fact that the group used knowledge previously studied in the classroom to validate the data obtained exemplify the existence of a public standard of analysis. In the classroom, public standards of analysis are often established in the instruction process and the establishment of norms and conducts that guide the discussions (Ribeiro, Barcellos & Coelho, 2021), processes introduced through the teacher's performance, responsible for presenting the values and norms of scientific culture to students. The action of adopting a criterion established by the teacher and accepted by the group to validate the data indicates the existence of a public standard of analysis (Nascimento & Sasseron, 2019), which will be used in different episodes, and which will be fundamental in the distribution of power in the group, as discussed below.

CONSTITUTION OF MODERATE EQUALITY AND RECEPTIVITY TO CRITICISM

In general, the group dynamics was collaborative work, in which decisions about the different activities in the investigation involved all student people's participation, albeit in different ways. The explicit division of the tasks to be performed and the reading aloud to the science of the people who were part of the group are examples of dynamics adopted for collective decision-making.

Although everyone in the group participated, we noticed a difference in social roles between the two cis boys and the two cis girls during the work. In some episodes, the girls took on the task of executing the scientific report (producing the graph and writing the text), while the boys acted exclusively in proposing and evaluating ideas (Chart 2).

Chart 2. Interactions in Lesson 12 - Episode 12c

Turn	Person	Speak	Action
1	Student G	Come on, bro, help me put the () here.	Preparation of the inscription (graphic)
2	Student V	Help with what? You said you were going to make the graphic!	
3	Student G	But I have to... I need help!	
4	Student B	Go on, put it there... First day...	
5	Student L	Come on, let me help you...	
6	Student G	I already did...	
7	Student B	And the second day?	
8	Student G	The second day has not yet...	
9	Student B	151...	
10	Student L	I'm in the group too, oh...	
11	Student V	She's from the group... Our group is three and a half, and the half is her...	

In Chart 2, we have an interaction in which we can see how the boys commanded the situation, dictating what should be on the graphic prepared by the group and what should be written, while Student G performed the task. Situations such as this of differences in roles and social positions between boys and girls in the classroom show how the school reinforces normalized sex-generated performances in society in students' learning process (Carvalho, 2021).

The interactions of Episode 12C (Chart 2) indicate how sex-generated stereotypes can be reinforced in school organization (Santos & Gianella, 2021). Student G requested help from the group, obtaining Student V's denial as an answer, reinforcing her role as a task performer. In this unequal distribution of roles, we see a concrete example of how the school can reinforce gender stereotypes by attributing what is up to each of the bodies (Louro, 2000): the male cis body, intellectual activity, the female cis body, following what the male colleague dictates.

In the following turns of the same episode (Episode 12c, Turns 5 and 6), we also noticed that Student L sought to participate in the activity but had difficulties since Student G was already producing the graph and the male cis colleagues were in intellectual command. Throughout the interaction, Student L's silencing becomes more evident when she requests that her contribution be considered (Episode 12C, Turn 10), but Student V responded with an explicit speech that diminished the possibility of Student L contributing to the group's learning: *"She is from the group... Our group is three and a half, and the half is her..."*; thus, Student V exercised his position of power as a cis-masculine body (Louro, 2001) and reaffirmed the place occupied by his colleague in this space. We noticed that the silencing of cis-girl students does not appear in the difficulty in expressing themselves or getting a speech space in the group but in the fact that their contributions are not valued by the other members (Belenky et al., 1986).

We understand that these sex-generated roles can make it impossible to establish the norm of moderate equality since intellectual authority is considered an attribute of cis boys. The establishment of the norm of moderate equality in the classroom occurs when everyone is considered equally capable of contributing, a consideration that can be relativized by levels of expertise or knowledge but not by a vertical relationship of power (Nascimento & Sasseron, 2019) and, in this case, we see that there is a division of tasks and possibilities of participation that assigns different values to the ability of different sexes/genders to contribute. Cultural operations that indicate the constitution of moderate equality include turns by the teacher or students requesting contributions from peers and turns by students presenting contributions to the learning process (Nascimento & Sasseron, 2019). Although everyone participated in different turns of the interaction, cis girls are positioned as less able to contribute to group learning.

In Consensus Construction III (CCIII), we observed a different dynamic of student participation in the interaction. In the episode, the monitor was called to explain what should be placed in the “Interpretation” item of the report (Chart 3).

Chart 3. Interactions during Consensus Building III (Lesson 14 - Episode 1C)

Turn	Person	Speak	Action
1	Student G	Interpretation... What do we have to put?	Communicates to the monitor a doubt about what is expected for the item “interpretation” of the report.
2	Monitor	What have you seen? This is one thing to draw attention to ()	
3	Student L	We saw that [there was growth]	
4	Monitor	() Growing... Then, you will interpret why you thought it grew... And was the growth linear? Was it just the same day by day? So first, why did it grow up? What do you think made it grow up? It's a thing of analysis, of interpretation... Then there will be a day that it grew more, and there will be a day that it grew less... Why did it grow more that day and less the day after?	
5	Student L	Yeah, I don't know...	
6	Student G	And it... There was a day when it decreased...	
7	Student V	That's a hypothesis, isn't it?	
8	Monitor	These are hypotheses. That's the idea of the analysis. Raise hypotheses...	
9	Student V	Put it there B., that is interpretation...	
10	Monitor	So, but hypothesizing is a way of analyzing. I think it has grown. I think it has decreased this day because... I don't know, because it was a full moon... It is a hypothesis, yes, but then you will say: “Oh, just because it is a full moon”? And then you have to tell me, and the teacher, because the full moon would make it die... Got it? The analysis goes through ()	Report of observations and discussion of what is expected for the item “interpretation” of the report.
11	Student L	()	
12	Student B	Put the weather... It is obvious that [influenced]...	
13	Student L	But do you remember how the weather was?	
14	Student B	No...	
15	Student L	So, that is it...	
16	Student V	()	
17	Student L	Yes, that is obvious...	
18	Monitor	But could it be that the weather...	
19	Student G	You have to put... Light! All of this...	
20	Student L	Do you know the day? Do you remember? ((L. asks if B. remembers how the weather was at the time of data collection))	Construction of an interpretation for the data produced by the group.

When the monitor joined the interaction, Students L and G cooperated by communicating the patterns observed in the data (Turns 3 and 5) and were concerned with discussing the empirical data with the monitor. However, after his explanation, Student V guided the concept of hypothesis (Turn 7) and directed

the next speeches in the group. Here, albeit subtly, there was a silencing of cis girls not by the division of tasks, but by the way their concerns or interests were not considered relevant in the group.

In the continuity of the interaction, turning to the data themselves, student B suggested citing the influence of the weather to explain the population decline (something generic that would obviously influence population dynamics). Student L disagreed with Student B. To do so, she asked if he remembered how the weather was at the time of data collection (Episode 1C, Shift 13, Shift 20), that is, she demanded that he retrieve the data. Here, Student L used public standards of analysis (need for explanations to be based on empirical data or shared knowledge) to get her critique considered by the group. Student B could not support his explanation on criteria established by the group (students, teacher, and monitor) using theoretical or empirical evidence to support that the weather could explain population growth, so the group did not validate his idea. In this episode, public standards of analysis are important for redistributing power between cis girls and cis boys and the constitution of moderate equality in proposing explanations for population growth.

Later, in Consensus Construction IV (CCIV), we can see that the group gave up the idea of using the weather, and light became the explanatory factor for population growth (Chart 4).

Chart 4. Interactions during Consensus Building IV (Lesson 14 - Episode 4C)

Turn	Person	Speak	Action
23	Teacher	In general, the population... Grown up... Notice one thing: if I take this point and this point... How is the growth of this population? If we...	Interpretation of the produced inscription (graph) to construct explanations about population dynamics. The teacher places her finger on points outside the curve to show that, on average, the population showed growth.
24	Student G	Good?	
25	Teacher	What's good?	
26	Student L	Stable	
27	Teacher	It's almost stable... It's growing more or less... Now, here it starts ()... Yeah... So, this... I did it here just to see if there was an idea in your mind... So, this population is in conditions (has environments), suitable for it to grow, so much so that it has grown. How was this growth? Apart from this moment and this moment, this growth was...	
28	Student G	(Direct)	
29	Teacher	(Direct)	
30	Student L	In the end, I say, growth... But it (won't be) stable growth...	
31	Student V	Calm down, teacher... I will explain everything... So, our hypothesis is that the light was (hitting) directly in two groups, and one was ours. Then it could have... Facilitated the growth of our plants...	

In the previous episode (CCIII - Episode 1C), Student L criticized the absence of evidence (a public standard of analysis) and her questioning contributed to a new proposition of explanation by student V, a cultural operation that indicates the constitution of the norm of receptivity to criticism (Nascimento & Sasseron, 2019), which is quite associated with moderate equality.

ROLE OF SOCIAL NORMS OF KNOWLEDGE CONSTRUCTION TO MAINTAIN AND DISTRIBUTE POWER IN THE CLASSROOM

Different research in science education has defended the importance of establishing a learning environment where the teaching epistemic authority can be redistributed, and students can contribute to

constructing knowledge in the group (Ko & Krist, 2019; Stroupe, 2014). This proposition is related to the constitution of the public forum, a space for presenting and critically evaluating ideas, one of the norms for constructing scientific knowledge proposed by Longino (2020). However, the constitution of such a public environment of criticism depends on the full establishment of other social norms so that there is an equitable distribution of power among the people in the group.

Moderate equality is established when all people are equally capable of contributing to the group's knowledge construction (Nascimento & Sasseron, 2019). In the analysis carried out, we showed that, in some episodes, the contribution of student people is relativized by a power relationship based on sex/gender stereotypes: cis boys assume the place of decision, and cis girls perform the tasks dictated by male cis bodies. The reiteration of sex-generated stereotypes (Carvalho, 2021; Louro, 2001), evidenced by the different roles occupied in the group by cis girls and cis boys, impacts learning and participation in classroom practices since a specific social group (in this work, evidenced in cis girls, but which consists of all bodies that deviate from the cis-masculine normative) does not have the power to share ideas and contribute to the collective construction of knowledge.

However, in some episodes, we also evidenced another pattern of power distribution and the constitution of norms of moderate equality and receptivity to criticism when cis-girl students used public analysis standards to share or criticize ideas. The use of theoretical or empirical evidence (a public standard of analysis) by the female students proved to be a way of assuming a position of power and having their propositions considered in the group, thus contesting sex/gender stereotypes. Considering that, in the classroom, the public standards of analysis are established in the process of instruction of the activity (Ribeiro, Barcellos & Coelho, 2021), we highlight the importance of teaching action to share them and transform them into a tool for building equitable learning environments.

These data dialogue with Franco and Munford (2023), who showed that the conceptual knowledge of science was articulated with processes of reiteration/contestation of the sex/gender norm, which played a central role in learning the concept of sexual dimorphism. In this work, the sex/gender norm is reiterated and or questioned depending on how power is distributed among the people in the group.

In the case study of this work, we analyze how sex/gender influences the constitution of social norms of knowledge construction, but we know that other devices of normativity and inequality, such as race, class and sexuality can influence this social distribution of power in the classroom.

FINAL CONSIDERATIONS

This work dialogues with studies that propose the sharing of social norms of knowledge construction as an important aspect of science learning and with research that discusses how sex/gender stereotypes and inequalities can affect learning and, in this context, aims to contribute to the construction of an equitable environment in the classroom to enable the learning of people with different sex/gender performativities.

The social norms for the construction of scientific knowledge can guide actions for creating this equitable environment. However, our analyses highlight the importance of observing sex/gender-oriented power relations in classroom interactions since only promoting norms will not guarantee that different bodies engage in them. Besides, it cannot ensure that the socially prevailing exclusion does not also perpetuate itself in learning contexts. In addition to promoting the norms of scientific knowledge construction in classrooms, it is necessary, both in research and in teaching practice, to seek ways to mitigate existing inequalities, which can only be done when we are concerned with the distribution of power associated with sex/gender, even in situations where this concept is not an explicit content.

In this work, we point out a way to look at the social norms of scientific knowledge from the interactions of sex/gender, which we hope can stimulate new research in the area to consider sex/gender as a variable in

their analysis, as well as other devices of social control, whether race, class, or sexuality. Only by mapping these inequalities and how interactions reinforce them in the context of science classes will it be possible to think of actions that can reduce them in teaching practice. Because we believe that learning science depends on learning practices, it is relevant to bring this look at the distribution of power in the classroom, especially thinking about sex/gender, so that the norms, practices and values of science learned are not those that reinforce stereotypes and inequalities, exactly what we seek to combat in an education focused on social transformation.

Declaration on data availability

“The entire set of data that supports the results of this study was published in the article itself and in preliminary works cited. According to the approval of the project by the ethics committee, only the researcher and her advisor will have access to the data collected and will be authorized to publish articles using it.”

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