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Inquiry-based Science Teaching and Socioscientific Issues in the Classroom: Connections Based on the Analysis of Epistemic Practices

Ensino de Ciências por Investigação e Questões Sociocientíficas em Sala de Aula: Conexões a Partir da Análise de Práticas Epistêmicas

Enseñanza de las Ciencias Mediante la Indagación y Cuestiones Sociocientíficas en el Aula: Conexiones a Partir del Análisis de Prácticas Epistémicas

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Abstract

This paper analyzes continuities and changes in the constructing epistemic practices in two different instructional contexts: inquiry-based science teaching (IBST) and socioscientific issues (SSI). Based on Ethnography in Education, we followed students in an 8th-grade elementary school classroom for over a year in science lessons. We selected an event to analyze epistemic practices in discursive interactions. Considering other events over the year, the analysis of this event indicates reciprocal relationships between the IBST and SSI approaches. Inquiry-based activities fostered conscious and justified positioning by students in socio-scientific discussions. Socioscientific activities, in turn, catalysed the construction of more complex epistemic practices. Therefore, we defend the pedagogical advantages of articulations between IBST and SSI activities to support science education aims in the 21st century.

Keywords: epistemic practices, discursive interactions, Inquiry-based Science Teaching, Socioscientific Issues

Resumo

Neste artigo, analisamos continuidades e mudanças na construção de práticas epistêmicas em dois contextos instrucionais distintos: investigativo (EnCI) e sociocientífico (QSC). Baseados na Etnografia em Educação, acompanhamos estudantes de uma turma do 8° ano do Ensino Fundamental ao longo de um ano em aulas de ciências. Selecionamos um evento para análise das práticas epistêmicas a partir de interações discursivas. Os resultados da análise deste evento, à luz de outros eventos ocorridos ao longo do ano, indicam relações complementares entre as abordagens EnCI e QSC. Atividades em contexto investigativo favoreceram o posicionamento consciente e justificado pelos estudantes em discussões sociocientíficas. Atividades em contexto sociocientífico, por sua vez, catalisaram a emergência de práticas epistêmicas mais complexas. Defendemos, portanto, as vantagens pedagógicas de articulações entre o EnCI e as QSC, entendidas como complementares, tendo em vista os objetivos da educação científica no século XXI.

Palavras-chave: práticas epistêmicas, interações discursivas, Ensino de Ciências por Investigação, Questões Sociocientíficas

Resumen

En este artículo analizamos continuidades y cambios en la construcción de prácticas epistémicas en dos contextos instruccionales diferentes: Enseñanza de las ciencias mediante la indagación; Cuestiones sociocientíficas. Basándonos en la Etnografía en Educación, seguimos estudiantes de una clase de 8° grado de Educación Primaria a lo largo de un año en clases de ciencias. Seleccionamos un evento para analizar prácticas epistémicas en las interacciones discursivas. Los resultados indican que el desarrollo de actividades investigativas animó a los alumnos a adoptar una postura consciente y justificada en actividades de carácter sociocientífico. Actividades sociocientíficas, por otra parte, catalizaran la construcción de prácticas epistémicas más complejas que las desarrolladas en las actividades investigativas. Basándonos en estos resultados, abogamos por vincular Enseñanza de las ciencias mediante la indagación al debate sobre cuestiones sociocientíficas con el fin de apoyar los objetivos de la educación científica en el siglo XXI.

Palabras clave: prácticas epistémicas, interacciones discursivas, Enseñanza de las Ciencias Basada en la Indagación, Cuestiones Sociocientíficas

Introduction

A series of efforts have been made in recent decades to reform teaching in terms of a more *discursive*, *investigative,* and *argumentative* educational science (Carvalho, 2018; Duschl, 2008; Manz et al., 2020; Sasseron, 2019). In the present article, we address our analysis to two different teaching approaches that outstand in this context: inquiry-based science teaching (IBST) and socioscientific issues (SSI).

The inquiry-based science teaching is a didactic approach (Sasseron, 2020) that aims to approximate the practices of educational science to the scientific practices (Munford & Lima, 2007). Even if there is not a single structure to define the characteristics of this approach (see Franco & Munford, 2020; Rönnebeck et al., 2016), some elements have been considered as relevant in the preparation of activities in an investigative instructional context (Pedaste et al., 2015) such as the creation of opportunities to enable students to engage in the resolution of problems (Carvalho, 2018) using cognitive and discursive tools of science (Duschl, 2008).

Among the pedagogical advantages provided by the IBST, we emphasize the role of students in the teaching and learning processes, positioned as builders of the scientific knowledge in the classroom. In other words, students have the opportunity to propose explanations for natural phenomena or problem situations, by analyzing them based on data and by arguing to create consensus on the basis of evidence (Manz et al., 2020). The focus, in this case, entails the creation of opportunities so that students can make use of practices that are considered relevant in the scientific rationality.

On the other hand, the use of Socioscientific Issues (SSI) in science teaching aims to establish relations between science contents and interdisciplinary or multidisciplinary contents based on controversial and complex socioscientific and/or socio-environmental problematics (Conrado & Nunes-Neto, 2018; Nunes-Neto & Conrado, 2021).

Socioscientific issues are not restricted to explanations, arguments, substantiations, or reasoning in the scientific perspective. They go beyond the boundaries of several domains of human life (Mendonça & Vargas, 2022; Kelly & Licona, 2018). Therefore, its analysis involves knowledge from other areas, such as history and philosophy, besides the mobilization of values, skills and attitudes, consideration of cultural, economic, and political aspects in the issues being treated (Conrado & Nunes-Neto, 2018; Nunes-Neto & Conrado, 2021).

Socioscientific issues allow the contextualization of the knowledge about science, as they explore more complex visions about the scientific investigation (Zeidler et al., 2009). Under the perspective of STS (Sciences, Technology and Society) Education, the SSIs are understood as pedagogical strategies that can contribute to make the naive visions about science to be overcome in the school context, so that the science teaching becomes less technicist (Ibraim & Machado, 2022).

Both the approaches (IBST and SSI), even with the characteristics so markedly distinct, appear as complementary if we consider that sciences classes should provide opportunities for the students to understand the ways how science builds knowledge and how students should use cognitive tools to engage in the resolution of issues that involve science and other areas.

In this article, we propose a look in this direction, considering recent challenges that science education has been facing (Osborne et al., 2022). Science denialism movements have spread, with manipulation of data and information, aiming to privilege certain economic, political, and ideological positions. Considering the complexity of factors that are in the origin and in the maintenance of this kind of movement, including science itself (see Lima et al., 2019), the education in sciences has been facing challenges that are not well known and for which there are no answers yet (see Erduran, 2021).

Both IBST and the use of SSI seem quite promising to us in this context. Students that practice investigative activities and socioscientific discussions have to deal with different rationalities, with positions that depend on the learning contexts in which they are inserted. Despite this, the research that analyze the *in-situ* use of these approaches does not deal with the possible intersections in the routine of the classroom. There are few studies available that try to articulate within their reviews, somehow, the investigative instructional context to the socioscientific context (e.g., Ariza et al., 2021; Nam & Chen, 2017).

In this research, we developed analyses of a particularly interesting case for such discussions. We followed the everyday life of sciences classes of an 8th-grade elementary school classroom (Brazil). The class had experienced different teaching approaches and, more expressively, activities focusing on Inquiry-base Science Teaching. With relation to the Socioscientific Issues debate, the students had few opportunities. The positions presented by the students during one of these discussions were quite interesting (Ágar, 1994) for the research. To explore these points, we decided to use the reference of epistemic practices (Kelly, 2008), which propitiated analytical connections between Inquiry-based Science Teaching and the use of Socioscientific Issues.

Epistemic Practices in Sciences Teaching

In this article, we use the construct of epistemic practices proposed by Gregory Kelly. Based on epistemological studies such as those of ethnic speech schools of thought and feminist epistemology (e.g., Longino, 2002), Kelly understands that the subject who builds knowledge is placed in a social group and not in an individual connoisseur (Kelly, 2008). Under this perspective, a community justifies the knowledge produced through the social practices. A social practice entails "a standardized set of actions typically executed by members of a group, based on common purposes and expectations, with shared values, tools and meanings" (Kelly, 2008, p. 3, our translation). When these practices are related to the construction of knowledge, they are called **epistemic**.

Therefore, epistemic practices can be considered as specific manners through which the members of a community propose, communicate, assess, and legitimize knowledge propositions (Kelly, 2008). The author, while characterizing these practices, suggests that epistemic practices are *interactional*, *contextual*, *intertextual, and consequential* (Kelly, 2016).

Interactional because they are socially organized and executed (Kelly, 2008). The actions developed by members of a group have as main component ways of talking and being, including typical signs and symbols. The participation in the speech requires knowledge on how to properly take part in the group and includes not only functional aspects of the semantics used, but also aspects that are mostly implicit ones and that enable the conversation, such as the ways that are considered as adequate by the group as per how to act (Kelly, 2016). Discursive processes are central in the development of standards and expectations. They define the common knowledge for the group; they either limit or provide of access to the participation and they outline the knowledge made available.

The contextual nature of the epistemic practices, in its turn, is related to the fact that the epistemic practices are situated in norms that depend on the objectives and negotiations within a social group (Kelly, 2008). This means that the epistemic practices can be extended and revised, besides of assuming the specific characteristics of a local group or being expanded to several groups. Consequently, we do not have a fixed and immutable set of them (Kelly & Licona, 2018).

The intertextual nature of the epistemic practices indicates that they are communicated through speeches, signs and symbols that are historically articulated (Kelly & Licona, 2018). Written and spoken texts are referenced, resumed, adapted, and reinterpreted within the group. The analysis enables the comprehension on how the concepts reflect the assumptions created within a group based on the goals and needs (Kelly, 2016).

Epistemic practices are consequential also. This characteristic is deeply related to the previous ones, considering that the ways through which knowledge is built within a community legitimize some kinds of knowledge to the detriment of others. The agreed way on how the building of knowledge must happen in classrooms implies inclusion and exclusion of certain ways of doing science and, therefore, of certain people.

In addition to discussing the nature of the epistemic practices, Kelly is also concerned with the proposal of ways to insert such practices in the educational contexts, specifically in the education of sciences. The author indicates how the different social instances of knowledge production (proposition, communication, assessment, legitimation) can be arranged in the classroom.

The epistemic practices related to the instance of the *proposition* of statements of the knowledge, for example, have to do with the initial formulations made by the students about a studied phenomenon or debated issue, the planning of investigations, elaboration of hypothesis and predictions on phenomena (Kelly & Licona, 2018).

The epistemic practices related to the *communication* of statements of knowledge, on turn, have to do with the sharing of ideas through speech in the multiple audiences in which students participate (e.g., small discussion groups, discussion with the entire group, fairs). In such moments, students engage in activities like the development of a line of scientific reasoning, provision of justification for the statements proposed, written and/or verbal communication of scientific explanations and, also, they build scientific explanations based on evidence (Kelly & Licona, 2018).

The epistemic practices related to the instance of *assessment* are associated with the analysis of arguments and proofs and the way how they are presented, that is, if they meet the standards of representation and if they are in accordance with the proper language (e.g., evaluation of the merits of the presentation of evidence and scientific statements, evaluation of arguments holistically, interpretation of substantiations with different perspectives).

The epistemic practices related to the *legitimation* occur when students choose one point of view over another. Under the educational context, legitimation is the result of what the group recognizes as legitimate, which involves relation of power as well as cultural and social aspects. Through practices of legitimation, students recognize themselves as "learners of sciences that are able to participate and give sense to the scientific practices." (Kelly & Licona, 2018, p. 147, our translation).

These different social instances of the epistemic practices are shaped in the classroom in distinct ways, depending on the pedagogical approaches adopted, the specific characteristics of each group and the mediation methods used by the teacher. Kelly and Licona (2018) argue that different pedagogic approaches (investigative activities, socioscientific issues, education in engineering[1]) can promote the construction of different epistemic practices. Most of the surveys in the area of Sciences Education about epistemic practices emphasize the investigative instructional context (see Santana & Sedano, 2021). In other words, they analyze relations between the epistemic practices and the enquiry-based science teaching. More specifically, these studies intend to

1 This is a category that may look awkward under the Brazilian educational context. However, it is gaining space in international programs and constitutes a specific instructional context. Therefore, we decided to mention it. As indicated by the authors, "the engineering education focuses on the development of planning and analysis knowledge through approaches based on projects that require comprehension of sciences, mathematics and relevant cultural contexts" (Kelly & Licona, 2018, p. 5, our translation).

understand how this approach promotes the construction of the epistemic practices, since it puts students closer to an authentic scientific investigation and provides a space for discussion and reflection on the investigative actions in course (Silva, 2022).

However, we found few studies in the area that intended to analyze epistemic practices that value other instructional contexts, for example, in the use of socioscientific issues (SSI). Part of the studies which relate epistemic practices and socioscientific issues correspond to propositions in theoretical level (Ramos & Mendonça, 2021; Kelly & Licona, 2018). We have few works that discuss classroom data (Mendonça & Vargas, 2022; Casas-Queiroga & Crujeiras-Pérez, 2020; Nam & Chen, 2017).

The epistemic practices in socioscientific context are quite specific, since they implicate aspects related to "objects of borders" (Nielsen, 2013) around which multiple areas of human life have influence (e.g., scientific, economic, moral, religious, ecological issues). In this sense, although having links with science, they go beyond their reach, because they flow through social areas that often are immeasurable. Therefore, some distinctions are relevant. When practices are proposed as evaluation of evidence, for example, what counts as "good argument" in socioscientific context may be different from what counts as "good argument" in investigative context. In the same way, taking a stand or creating consensus are practices that assume different configuration in each instructional context (Kelly & Licona, 2018).

Despite this, consideration of this complexity in the classroom does not mean that the resolution of socioscientific issues is an "everything is allowed" situation. It is rather about considering the arguments and debating them, in face of the epistemic domain involved (Ramos & Mendonça, 2021). That is, in the approach of a socioscientific issue, each epistemic domain adopted by the students requires them to "construct, communicate, evaluate, and legitimate (or not) multiple and, most of the times, concurrent arguments" (Kelly & Licona, 2018, p. 156, our translation) looking for a better answer (or better answers) for complex problems under discussion.

Under this perspective, the construction of epistemic practices in SSI context generates relevant pedagogical implications. First, it can help students in the evaluation of the criteria to justify statements and in the development of a holistic reasoning with relation to the question (Ramos & Mendonça, 2021). In other words, based on the principle that the epistemic practices will "inform" about what counts as relevant knowledge for a community (Kelly, 2008), they can tell us about the merits of knowledge for the positioning of the students during the resolution of an SSI. Besides, the work with the epistemic practices during the resolution of an SSI can favor the comprehension of the epistemology of Science that go beyond the internalist aspects of Science. The internal social aspects refer to the fact that Science is governed, directed, and monitored by decisions taken within the community of practitioners. As to what concerns external aspects, it is important that students recognize that Science is not driven only by its own internal logic or by an endless search for the truth. Instead, it is financed by organizations, motivated, and shaped by the needs of the society, by political values and by personal needs, interests, beliefs, and attitudes of the scientists (Ramos & Mendonça, 2021).

Based on these theoretical propositions, this research intends to contribute to the discussions in the area of Science Teaching by characterizing *in situ* epistemic practices in socioscientific context and by establishing contrasts with epistemic practices in investigative context. We followed an 8th-grade elementary school classroom group in science classes throughout one academic year. In these classes, we observed an emphasis on activities oriented by the Enquiry-based Science Teaching. Specifically, in one of the classes monitored, the group was discussing a socioscientific issue, something that is not common in the group, and which led to conflicting ways of positioning in the discussion. Considering the analytical potential of the event, as well as other related events, we tried to answer the following questions of the research:

1. How do students construct epistemic practices in a socioscientific instructional context?
2. What continuities and changes are observed in these practices in contrast to the investigative instructional context?

Methodology

This research is qualitative in nature and was developed based on Ethnography in Education (Bloome et al., 2008; Green et al., 2005). Through this logic, we tried to bring visibility to the cultural meanings that are daily negotiated by the participants of the study, based on the analysis of discursive interactions in different time scales (Castanheira et al., 2001). Specifically, we associated ethnographic tools and assumptions to constructs of the Science Education field, as discussed below.

Participants and Instructional Context

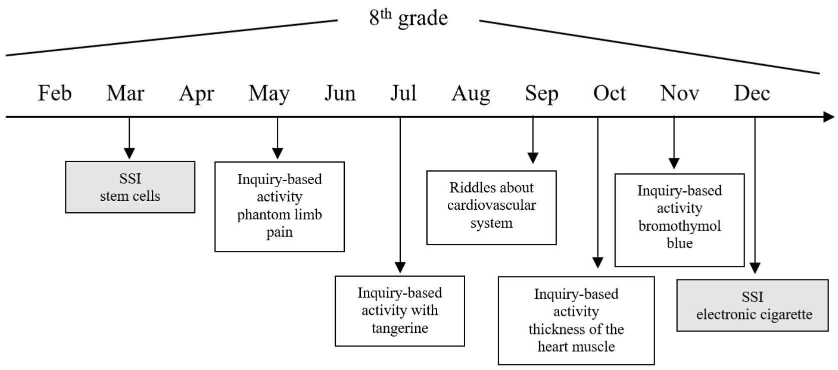
Data in this research were established based on the immersion in the daily experience of a group in the final years of elementary school in a public school at the Southeast region of Brazil. We followed this class throughout the period of three years (from 2018 to 2020) between the 7th and the 9th-grade. In this article, data are concentrated on classes of 2019, when the class was in the 8th-grade.

The group consisted of 26 students: 13 boys and 13 girls. The Sciences teacher, Sandro[2], followed the group for two school years (8th and 9th-grade). Sandro has a degree in Natural Sciences, with major in Biology, in addition to a sound academic education (master's and doctoral degree in Sciences teaching), and approximately twenty-year experience as teacher of Elementary School. Figure 1 displays the set of classes that were considered as basis for the data analysis in this article.

2 We used pseudonyms for protection of the identities of the persons involved in the research. The research was driven by the ethical criteria for research with human beings (Spradley, 1980), was authorized by the school board and relevant institution of ethics committee. We talked to the students about the research, its objectives and how data would be used. Adults involved — *parents, teacher, and interns* — signed a Consent Statement.

Figure 1

Activities in IBST and SSI context that were developed throughout the school year



Source: prepared by the authors.

With respect to the teaching methodologies, Sandro used expository and dialogic techniques in the classes, mainly in the first semester of 2019, focusing on the concepts of the contents discussed. From the end of the first semester and throughout the second semester, the teacher developed four investigative sequences, emphasizing the work with the IBST. The use of SSI, in its turn, even if occurring on some occasions, was not the predominant approach. We identified a discussion about stem cells in the first semester and a debate about electronic cigarette on the last day of classes in that academic year, as indicated in Figure 1.

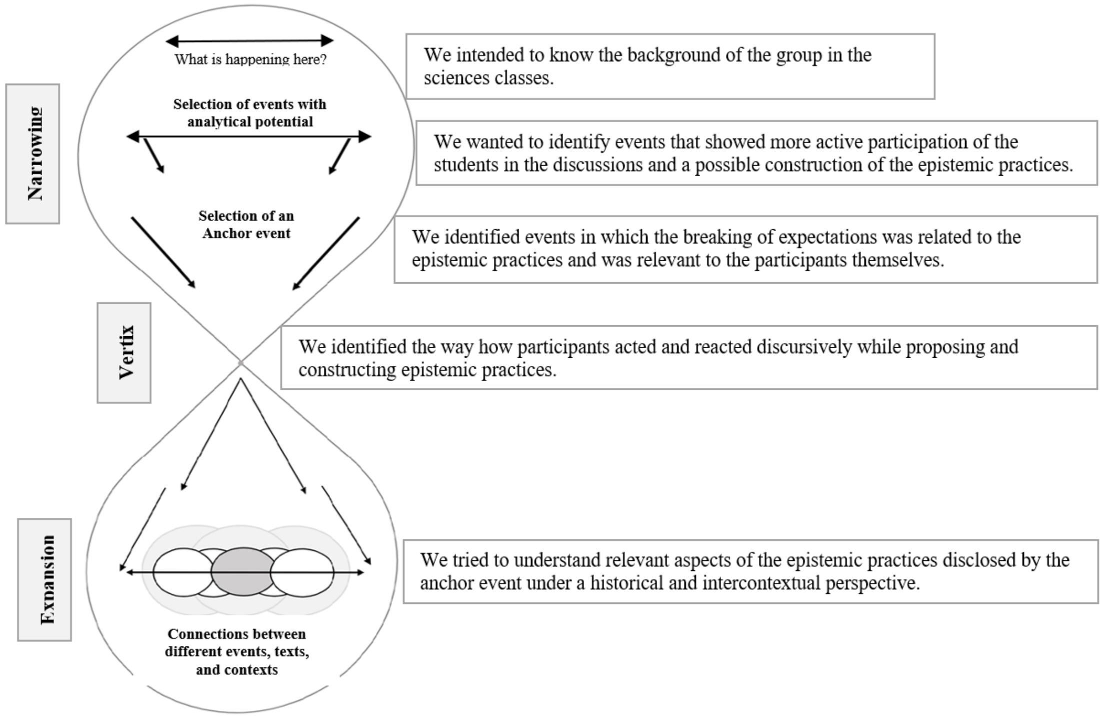
Construction and Analysis of Data

Our data were established using ethnographic tools, namely: participant observation of the sciences classes and registration of fieldnotes (Spradley, 1980), audio and video recordings, photographs, besides of collection of artifacts produced by the students (Green et al., 2005). Based on these data, we built a worksheet in Excel® called “Table of Lessons”, with general data from each class (description of the class, date, tasks, relevant observations, activities, photo records etc.). Such representations enabled us to have a holistic view of the daily routine in the sciences classes of the group (Green et al., 2005) and to look for more relevant events for the analysis.

To analyze the data, we used the analytical metaphor of the “Hourglass approach” (Franco & Munford, 2021). Through this metaphor, we articulated constructs of the Sciences Education area, specifically the proposals of Kelly (2008) about epistemic practices and assumptions of the Ethnography in Education (e.g., Bloome et al., 2005; Green et al., 2005). Figure 2 shows the hourglass scheme.

Figure 2

Representation of the research design



Source: adapted from Franco & Munford (2021).

This theoretical-methodological articulation was possible thanks to the alignment between Kelly's propositions and the analytical tools used from the ethnography. As observed by Milena and collaborators (2023), most of Kelly's work uses ethnography as theoretical-methodological perspective to "explore how students and teachers create what counts as sciences in their daily practices and build school scientific knowledge in an interactional mode, through actions and speeches" (Milena et al., 2023, p. 233). Under the ethnographic perspective, practices are built interactionally in the daily life of a social group. People act and react to each other through speech (Bloome et al., 2008) and this is the process that gives form to the practices. These actions and reactions depend on the characteristics of the group, on the connections that the members establish towards different events, texts, and contexts, which generates consequences for their future actions and reactions (Bloome et al., 2005). In this way, we understand that Kelly's propositions converge to the assumptions of Ethnography in Education, considering the interactional, intertextual, contextual, and consequential nature of the epistemic practices (Kelly, 2016).

The first phase of the hourglass scheme consisted of an analysis in macroscopic level, when we focused on the need to know the broader history of the group being observed. Using the Table of Classes as data source, while trying to learn about the group, we selected events with more analytical potential for our goals in the research.

The selection of these events took into consideration the possible relations with epistemic practices (Kelly, 2008). We built a timeline in which we could identify characteristics of the instructional context of each class and the epistemic practices related to such contexts[3].

We selected a set of events and performed a contrastive analysis for a new analytical profile, looking for an event that could anchor the analysis in microscopic level, vertex of the hourglass (Franco & Munford, 2021). To select this event, we used the contrastive perspective proposed by Ágar (1994). The author proposes the concept of relevant points (*rich points*) to identify situations with greater analytical potential for an ethnographic research. One of the ways to find these situations is by breaking expectations (*frame clash*). That is to say, situations that surprise the researcher and that break down the routine flow of everyday interactions of a social group (Ágar, 1994). In this kind of situation, the cultural sources or the previous knowledge of the researcher do not allow him to understand what is going on, from the perspective of the participants. A deepening in the analysis of these situations can bring comprehension of the everyday practices of a group, giving visibility to the perspective of their own members.

The contrastive analysis[4] performed led us to the selection of two events to anchor our analyses at microscopic level. From that, we passed to the second phase of the analysis, the hourglass vertex, which was the detailed analysis of the discursive interactions occurred in those events (Franco & Munford, 2021). In this process, we intended to understand how participants, teacher and students acted and reacted to each other while building epistemic practices in the sciences class (Kelly, 2008). For the analysis, we made the transcription of the discursive interactions into message units (Bloome et al., 2008), using the software InqScribe®. These units indicate the smallest unit of analysis of a conversation in one event. The limit is not indicated according to the grammar rules, but instead, by means of contextual clues used by the participants to sign each other what is going on in an interaction as well as to attribute meaning. Contextual clues can be any characteristics of the linguistic form that contribute to the indication of the contextual assumptions. They include verbal, non-verbal, prosodic signs, as well as manipulation of artifacts (Gumperz, 1982), whose meanings depend on the context of the interactions and through the interpretations attributed by the participants.

Finally, the third phase was to expand the analysis of the events by relating them to other events and contexts of the social life of the group being investigated (Bloome et al., 2008). Therefore, we tried to deepen our understandings on how the group was building epistemic practices over time.

3 This timeline can be consulted at Silva (2022).

4 The set of events analyzed throughout the hourglass first phase can be consulted at Silva (2022).

Results and Analyses

Our results are presented in three sections. In the first one, we contextualized the anchor events. In the second one, we analyzed the interactions that occurred in order to answer our first question of the research. Lastly, in the third section, we analyzed the relationship of the anchor events with other events and contexts to answer our second question of the research.

Contextualizing Anchor Events

The two events selected to anchor our analyses occurred in the second semester of the academic year of 2019, when the teacher was teaching the last content of the year — *Respiratory system*. The following figure displays a synthesis of these classes.

Figure 3

Classes about respiratory system in the 8th-grade. In gray, the class in which anchor events occur

Class	Date	Brief description of the class
1	11/18	In this class, the teacher provided research sources about electronic cigarette and asked the students, as a task, to gather information about the subject.
2	11/21	In this class, the students had an experimental investigative activity concerning the bromothymol blue color change, as a way to introduce the chemical reactions involved in breathing.
3	11/25	In this class, students had an investigative activity about the change in respiration rate while in relaxation and in intense physical activity.
4	11/28	Students and teacher discussed and ranged investigative activities of the class performed during the two previous classes.
5	12/02	In this class, the teacher discussed structures and functions of the respiratory system and respiration process through an expository and dialogic class with the students.
6	12/05	In this class, students were given a written evaluation activity about respiratory system.
7	12/09	Students presented the information gathered at home about electronic cigarette, took position about the legalization and, in groups, prepared the arguments for the class debate.
8	12/12	Students participated in the debate about electronic cigarette. The group in favor and the group against the legalization of the cigarette presented their standpoints and, after that, the jury asked questions to both groups and made a decision.

Source: elaborated by the authors.

At first, considering the predominance of investigative activities throughout the year, we expected some linearity in the occurrence of practices such as: construction of lines of scientific knowledge, use of evidence to supports statements, and communication of scientific explanations based on evidence. However, in class 8, last class of the academic year, some events dropped the expectations among the participants.

In that class, the class was organized in three groups to debate the legalization of the electronic cigarette. The favorable group that was formed counted on Marina, Yara, Vagner, Henrique, and Péricles. The opposition group was formed by Elen, Tina, Nara, and Bárbara. The rest of the group was formed by the undecided ones and, therefore, they formed the debate jury. The group that was in favor of the legalization of the electronic cigarette based their positions on personal opinions, which generated a discomfort and some reactions of the colleagues in the opposition group and in the neutral group.

This conflict is particularly relevant to our studies because it took place in face of a position that was not reflecting the epistemic criteria and communication demands that, apparently, were shared by the group at that moment. The colleagues of the opposition group insisted on demanding proofs considered as scientific and insisted on refusing personal opinion as a valid argument. Such a situation, differently from what we had observed in the group until that moment in investigative classes, generated a *frame clash* that provided us with a rich point for the proposed analyses.

The Anchor Events

Considering the flow of interactions of the debate about electronic cigarette, the events examined started when the class demonstrated dissatisfaction concerning the arguments elaborated by the group in favor of the cigarette. Until that moment, the debate was discursively dominated by the opposition group, that was presenting their view and correlated arguments. The contrary [group], however, despite of the explicit standpoint in favor of the legalization of the electronic cigarette, was not providing arguments. The epistemic practices, then, were more related to the proposition and communication of the knowledge (Kelly, 2008). To satisfy the demand of the class, Péricles, a member of the favorable group, proposed an argument (Figure 4):

Figure 4

Anchor event Part 1[5]

Line	Speaker	Message unit
1	Yara	Go Henrique I
2		Tell us why you are in favor
3	Henrique	Do you really want to know ↑ Laughs
4	Péricles	**I** am in favor because I think it is not bad for health I
5		That is it
6	Prof. Sandro	Why it is not bad ↑
7	Péricles	Ah+
8		Because I think it is not ▼ *lowering the head down*
9	Turma	*Laughs of the colleagues*

5 Symbols that represent contextual clues in the interactions: ↑ rise in the intonation; I short pause; III long pause; ▼ low speech volume; ▲ high speech volume; underlined: decrease in speech speed; **bold**: emphasis; "quotation marks" text reading; *italic*: non-verbal behavior; XXX unintelligible speech; - incomplete word; *asterisk* changed voice, tone, or style; + vowel lengthening; └ ┌ overlapping talk; ╡║ talk interrupted by next talk.

Figure 4

Anchor event Part 1 (continuation)

Line	Speaker	Message unit
10	Péricles	Because people use it for years and years that thing and nothing happens XXX
11	Tina	Do you know ↑▲▲
12		Checked out with these people to see whether something happened or not ↑
13	Péricles	Shut up ▲▲
14	Tina	Have you been there and checked it ↑
15		Went through these people to see if they have or not something bad ↑
16		Did you see it already ↑ XXX
17		Then, that is it ↑
18	Nara e Bárbara	*Nara and Bárbara hit the table*
19	Prof. Sandro	Which evidence do you have of people that use it for **years and years** ↑
20		And nothing happens ↑
21		Where did you get this from ↑
22	Bárbara	Is it just an impression ▲
23		Is it just an impression ▲
24	Péricles	From Internet ▼ *with the head down*
25	Nara	And just because it is on the Internet is it true ↑
26	Péricles	Huh ↑
27		Where did you get yours from ↑▲▲
28		┌From Internet ↑▲▲
29		└*Shouts and claps from some colleagues*
30	Péricles	┌XXX▲▲ *pointing with the hand to the group that is contrary*
31	Tina	└**Come on man** *Bárbara laughs and hits the table. Other students laugh too*
32		As far as I know |
33		This thing is <u>evidenced</u> research |
34		We took it from Websites |
35	Nara	From reliable Websites ▲
36		The sources I presented were taken from the link you indicated on Google Classroom *chest beating*
37		**I** did not take isolated ones |
38		My only source was there

Source: elaborated by the authors.

At the beginning of the event, Péricles stated that he was in favor because the electronic cigarette was not bad to health (L4–5). The laughs of the colleagues (L9) revealed an implicit evaluation of Pericles's argument and indicate that, for that group, argumentation based on personal opinion — "I think" — would not be considered as valid in a debate in sciences classes. The contextual clues in Péricles' speech — *lowering the head and reducing the voice tone* (L8) — indicate the insecurity of the student at that moment.

In face of the reaction of the colleagues, Péricles provided a new evidence, supposedly scientific: "Because people use it for years and years that thing and nothing happens" (L10). However, more than providing an evidence, colleagues indicated that the evidence had to be a valid one. The evidence used by Péricles was immediately assessed by Tina through an energic reaction: "Do you know↑ Checked out with these people to see whether something happened or not ↑ Have you been there and checked it ↑ (L14–17)".

Bárbara (L22–23), Nara (L25 and 35–38) and Tina (L31–34) reinforced the evaluation made by the teacher about the evidence brought by Péricles, when they stated that it was about a personal conclusion rather than something proposed by trusted agencies or obtained through experiments. On the contrary, the proofs brought by them had been collected from reliable websites and/or suggested by the teacher — two epistemic authorities as per the vision of the students.

In the sequence, other colleagues from the favorable group reiterated their position. However, they did not present arguments for justification. In this sense, by the end of the first event, we observed a repetition of what had already happened at the beginning: positions without the arguments demanded by the colleagues. Minutes later, at the beginning of the second event (Figure 5), Péricles started to act differently: he was analyzing the argument brought by the girls at the beginning of the class, when the groups presented their arguments. At that beginning, the students from the contrary group had mentioned data about the composition of the electronic cigarette, including the possible presence of THC (tetrahydrocannabinol), the main psychoactive substance of cannabis plant.

Figure 5

Anchor event Part 2[6]

Line	Speaker	Unit of message
1	Péricles	You said it does less harm │
2		But if it was+
3		Could use │
4		Would be even better │
5		Than conventional cigarette │
6		Remember the girls saying it has nicotine │
7		Bárbara │
8		Talked about THC │
9		Which is derived from cannabis and stuff and is harmful to health │
10		There are people who must use it to cure diseases.
11	Tina	W+ow │
12	Bárbara	W+ow │
13	Elen	But │
14		It is manipulated in the right way, Péricles │
15		In the case here of the electronic cigarette, it is in wrong way │
16	Prof. Sandro	Why is it not correct?
17	Elen	Because it is doing harm │
18	Péricles	Do you have evidence that it is doing harm ↑
19	Elen	Huh │
20		Yes │ *Pointing at the loose sheets over her desk*
21	Tina	Studies were carried out │
22		Guys │ *she puts the hands together with stretched fingers*
23	Henrique	Where is the source ↑
24	Péricles	Alright then │
25		The person died │
26		<u>But it is not saying that the death was caused indeed because she used XXX</u> ↑
27	Nara	Péricles │
28		We do not have studies that prove that the death was caused by the cigarette │
29		But │
30		We have studies XXX ╡
31		XXX

6 Symbols that represent contextual clues in the interactions: ↑ rise in the intonation; I short pause; III long pause; ▼ low speech volume; ▲ high speech volume; underlined: decrease in speech speed; **bold**: emphasis; "quotation marks" text reading; *italic*: non-verbal behavior; XXX unintelligible speech; - incomplete word; *asterisk* changed voice, tone, or style; + vowel lengthening; └ ┌ overlapping talk; ╡ talk interrupted by next talk.

Figure 5

Anchor event Part 2 (continuation)

Line	Speaker	Unit of message
32	Bárbara	I cannot explain why+
33		I don't know+
34		But I just think they are two sides of the scale |
35		There is the side, like Péricles said, that the THC is a derivative of cannabis plant that can help and can also harm |
36		So+
37		I don't know how to explain why it can help and it can harm |
38		But I only know that XXX can trigger a cause, like you said |
39		Of the disease |
40		Because it is proven, it says that there isn't |
41		It is not proven in the death result |
42		But it is said that people are having a lot of pulmonary diseases |
43		I think that+
44		I don't know+ *putting both hands up*
45		I cannot explain XXX

Source: prepared by the authors.

Péricles used a statement presented by the contrary group at the beginning of the debate expressing that a lot of people use electronic cigarette because it is better than the normal cigarette (L1–5). As per his perspective, it would be good to liberate the selling and to allow those who are users of conventional cigarette to use something that is less harmful. Péricles resumed the line of reasoning built by the colleagues to, then, deconstruct their arguments. As a result of this evaluation (an alternative interpretation for the proofs), he provided an argument for his standpoint.

After that, Péricles proposed an alternative interpretation once more (L6–10). He remembered another argument brought up by the contrary group, giving a new interpretation for the data, which culminated in a new argument. This time, the student stated that cannabis would also be medicinal and, therefore, something beneficial. Péricles had not mentioned these arguments for an initial positioning at the beginning of the debate. He did so based on the exposition of the arguments of the colleagues, who had mentioned the issue of THC, a component of cannabis.

Immediately after the pronouncement of Péricles, the opposition group evaluated his argument. For the colleagues, Pericles' argument had no coherence. The use of medicinal cannabis should be controlled by authorized people. This is why they, emphatically, expressed: "wow" (L11–12). Elen insisted it was the contrary (L13–15) and, answering to the evaluation of the merits of the evidence, she affirmed that the cannabis used in the electronic cigarette was not medicinal, for it was harmful to the users (L17). For Péricles, the evidence that the electronic cigarette was causing harm to the users, brought up by Elen, needed scientific corroboration as well (L18). Confirming the evaluation of Péricles, Henrique also questioned the merits of evidence presented by the colleague (L23).

In face of the failure of the initial arguments observed in Event 1, the group in favor of the electronic cigarette adopted a new strategy: evaluate the arguments of the colleagues in the opposition group. Epistemic practices of assessment became a solution through which the group tried to be properly positioned. Péricles had an expressive role in this process. The student did not provide any evidence to corroborate his positioning. However, as he could recognize the rules shared by the group, he found proper ways to participate. He started to use data already provided by the colleagues and elaborated alternative interpretations. In this way, instead of using data that could defend the use of the electronic cigarette, he tried to deconstruct the proofs that were substantiating the position against its use. Péricles, therefore, could create his arguments while evaluating the arguments of the others.

This new way of acting adopted by Péricles in the debate, originated consequences. The contextual clues of Tina on line 22 — she *puts the hands together with stretched fingers* — showed that she was trying to sustain her position, now threatened by Péricles. The words of Bárbara also showed that, after the evaluation of Péricles, she herself started to doubt the confidence in her own posture (L32–45). She began to consider the different lines of reasoning that potentially could answer the issue. These reactions differ from those observed in Event 1, when the students of the opposition group seemed to be quite convinced of their statements and concerns.

Based on the analyses of the hourglass vertex, we obtained elements to answer our first question of the research: *how do students build epistemic practices in socioscientific instructional context?*

Students, at first, built epistemic practices based on the use of evidence from the scientific domain to answer the debated problem. For part of the students, scientifically accepted data were required and were sufficient to answer the socioscientific question. For them, such evidence would be the way for the group to come to a plausible conclusion. Consequently, practices such as the presentation of evidence to support statements as well as the construction of the line of scientific reasoning were applied in this context.

However, other students positioned themselves in a distinct way, using epistemic practices that were focusing on other rationalities, such as personal opinion or specific experiences. This distinctive characteristic in the modes of participation in the socioscientific debate caused the use of other epistemic practices: the practices of evaluation of the knowledge. While at the initial moments of the debate we could see the predominance of practices for proposition and communication of the knowledge, the anchor events, in turn, indicated a significant change in the developments in terms of the participation of the students. Epistemic practices for assessment became a resource through which part of the students started to justify their position. It resulted in relevant consequences, particularly because these evaluations led to concerns about that rationality that, up to that moment, seemed to be shared and to be the prevalence in the group.

The construction of epistemic practices in socioscientific context, therefore, happened at the heart of a confrontation between different rationalities, which caused the participation of the students in more complex practices. Alternative interpretations to the evidence and the evaluations of arguments and lines of reasoning, practices promoted in the socioscientific context, intensified the debate which was, until then, based on the exhibition of points of view and the presentation of arguments.

Expanding the Analyses of the Anchor Event

To elaborate answers to the second question of the research, we expanded the hourglass diagram, seeking for connections between the anchor events and other events. In this case, we were interested in events in which the students participated of investigative activities (IBST), which provided us with elements for a contrast with the socioscientific instructional context (SSI).

The macroscopic analyses of the wide-ranging history of the group indicate the recurrence of the investigative approach from the end of the first semester to the end of the academic year. In these activities, there was engagement of the students in practices related to the instances of proposition and communication of knowledge in scientific context (Kelly & Licona, 2018), for example: proposition of questions, elaboration of hypotheses, observations, development of a line of scientific reasoning, scientific explanations in writing and communication of them verbally, construction of scientific explanations based on evidence and reasoning. We selected an event occurred in July, which illustrates the process. The students were learning about the nervous system with an investigative sequence of five classes about phantom limb pain, starting with the following problem question: why do people with amputated limbs feel pain in the missing part? First in small groups and afterwards with the entire class, the students elaborated hypotheses to explain the phenomenon. The selected event, called *Analysis Dynamics*, happened on 07/03/2019[7], date of the last class of the sequence. The instructional context entailed the consideration of the hypotheses elaborated in the first classes of the sequence according to a set of evidence that had been provided by the teacher. That was the first and more explicit contact of the class with the use of evidence to solve a problem in the school year of 2019.

There are some peculiarities that are relevant for the interpretation of the anchor events. Professor Sandro indicated that the set of evidence used in that analysis that was accepted by the scientific community, had been disclosed through publications in scientific articles and had been generated as result of experiments. To understand the phantom limb pain, therefore, it was required the use of scientific evidence to either discard or corroborate the hypotheses initially performed. This notion of evidence was

7 To see the transcription of the event, please access Silva (2022).

reiterated in events throughout the coming classes, in other investigations[8] (recapture Figure 1, e.g., the analysis of the taste of tangerine in July, the discussion about the cardiovascular system in September, the activity about the thickness of the heart muscle in October, the experience with Bromothymol blue in November, and the analysis of the relations between respiration and circulation in December). This process is important to explain the positioning of the students that were against the electronic cigarette, in the anchor events. The students in question used data obtained from experiments and provided by institutions that they considered as reliable ones. That is, the nature of the arguments raised by the students on 12/12/2019 was in accordance with what had been proposed by the teacher on the event of 07/03/2019 (*Analysis Dynamics*) and with what had been reiterated along the semester in other investigative activities.

We mapped, also, events that were closer to the anchor events and related to the debate that corroborate this interpretation. In the class dated 12/09/2019, the group prepared for the debate on electronic cigarette. During an event in that class, which was called *Argumentation of the Opposite Group*[9], the interaction between the students that were contrary to the [electronic] cigarette reveals the nature of their arguments: data concerning the chemical composition of the electronic cigarette, studies indicating diseases that could be developed by users, and studies related to the lack of efficacy of the product as alternative to the fight against tobacco use. The evidence brought by them was close to that shared by the class as being scientifically accepted in the sciences classes, initially proposed by the teacher, Sandro, in the classes about phantom limb pain and in other classes over the semester. The way how the scientific evidence is understood help us to apprehend the importance given by the students to their arguments, when they explained emphatically, during the anchor event 1: "This thing is <u>evidenced</u> research" (L33), "And just because it is on the Internet is it true ↑" (L25) or "**I** did not take isolated ones | " (L37).

The distinctive way with which some colleagues positioned themselves in the anchor events provide elements for a contrast between the investigative and the socioscientific contexts. Péricles was one of the students who made more use of personal arguments, which distanced him from the expectation of the group on how to communicate in a discussion in the sciences classes. In the class occurred before the debate, on 12/09/2019, we identified an event that we called *Previous Discussion*[10], when students initiated a discussion about the electronic cigarette. While not yet organized in groups, the students brought information gathered for a homework assignment. On that day, Péricles brought three pieces of information about the electronic cigarette: presence of nicotine in the composition, death of users, elevated price of the product. However, even if we could observe that the student had researched about the electronic cigarette and had brought information about the harms caused by its use, Péricles' position was not against its use, nor did he propose arguments implying his favorable positioning. The same thing was observed among the colleagues of the group.

8 The details of each of these activities can be seen in the experience reports published at: Carneiro and colleagues (2020).

9 To see the transcription of the event, please access Silva (2022).

10 To see the transcription of the event, please access Silva (2022)

The way how they position themselves and defend their ideas may imply, at first, that the students of the favorable group did not know how to argument in sciences classes or that they did not know how to use the epistemic practices required for that kind of discussion. The expansion of the analyses beyond the flow of interactions in both the events, however, indicates otherwise. Students like Péricles, for example, understood that they had a way to communicate their ideas that was not valid in that context. When we resumed the activities in the sequence about phantom limb pain (from June and July), we identified two texts produced by Péricles. The first one was produced during the first class of the sequence, on 06/26/2019, and had the initial hypotheses of Péricles to try to explain the phantom pain (*Text: Initial Hypotheses*[11]). The second one, in turn, was produced in the last class of the sequence, on 07/10/2019, and had the conclusions of the student at the end of the investigation (*Final Production of Péricles*[12]).

The contrast between both productions indicates that Péricles rejected the hypothesis initially elaborated to explain the phantom pain in view of scientific evidence. His new position, expressed in the conclusion activity, indicated that he based his conclusion on that set of evidence analyzed in the classroom and aligned with the consensus of the group in terms of the best explanation for the phantom limb pain phenomenon. This corroborates our interpretation that the student was aware of the relevance in the use of evidence in sciences classes, he knew how to mention them when required and he knew that he had to think about his positioning in face of the discussions in the collective sphere of the group. It corroborates, also, our perception that Péricles had a distinct position in the electronic cigarette debate and that it was not because he did not know how to argument in sciences classes. He, just like his colleagues of the class, was already constructing a repertory towards this. However, there is an aspect that is relevant for our analyses: the difference between the investigative context, characteristic of the classes about the phantom pain, and the socioscientific context, characteristic of the electronic cigarette debate.

In the sequence about phantom limb pain, there was not a socioscientific question at stake. The debate around legalization of electronic cigarette, on the other hand, generated a context in which other aspects, besides the evidence considered as scientific, had a relevant function. Péricles used other acquirements and experiences in addition to the scientific evidence that made him choose a favorable position towards the use of the electronic cigarette, despite the "scientifically accepted" positions of his opposing colleagues. The evidence considered as accepted was not sufficient to change the conclusions of the student.

In a later conversation with the teacher, we obtained the information that Péricles and other colleagues of the favorable group were indeed users of electronic cigarette. According to Sandro, those students had already talked openly about this in other occasions during the school year. The information was confirmed by Bárbara during

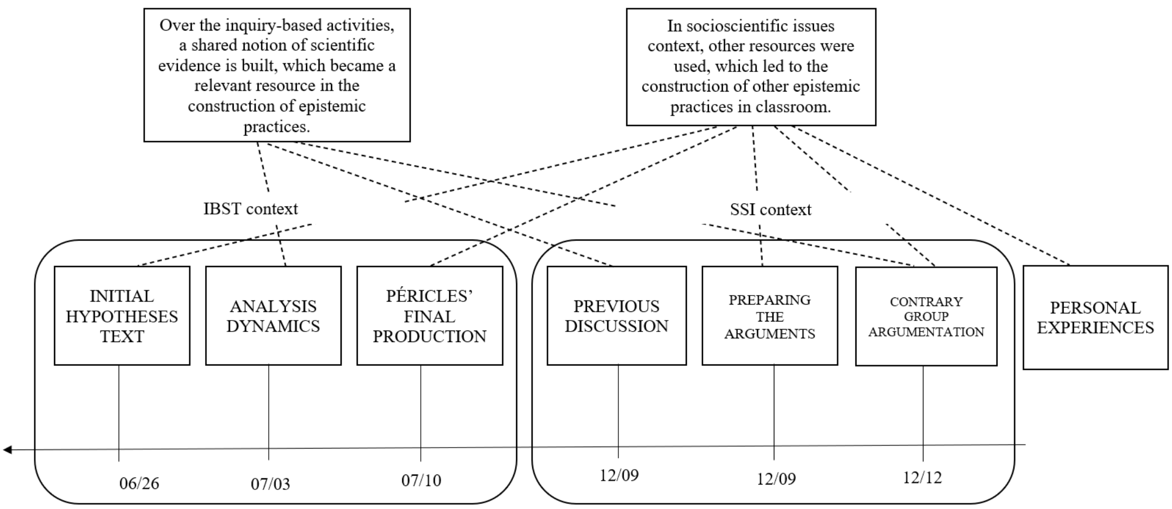
11 To see the artifact produced by the student, please access Silva (2022).
12 To see the artifact produced by the student, please accessSilva (2022).

an event occurred before the debate, on 12/09/2019[13], called *Preparing the arguments*. In this event, the students prepared their arguments in group. While n the discussion of the contrary group, Bárbara affirmed that her group had already "won" the debate, because the colleagues of the favorable group were all users [of the product] and would not be prepared for the activity. These experiences help us to bring light to some of the situations, such as when Péricles mentioned the high cost price of the electronic cigarette in the event called *Previous discussion* (12/09/2019), an information that was missing in the sources provided by the teacher, Sandro; or in the Anchor event 1, when Yara questioned Henrique by saying: "Go Henrique, tell us why you are in favor" (L1–2), to what the colleague answered: "Do you really want to know↑" (L3), with laughs around.

Figure 6 shows a condensation of the observed events:

Figure 6

Summary of the analyzes of expansion



Source: prepared by the authors.

The expansion of the analyzes provided elements for us to answer the second question of the research: *what continuities and changes are observed in the epistemic practices in the contrast between investigative and socioscientific instructional contexts?*

The instructional context of the sciences classes since the end of the first semester of the school year of 2019 was based on the investigative approach. Illustrative events of these classes indicate an emphasis in epistemic practices of proposition and communication of knowledge (Kelly & Licona, 2018). Despite that, it was not a concern to problematize the evidence in discussion, evaluate the quality of the relations between data and hypotheses, or bring information from other spheres of knowledge in addition to the scientific domain. With this, we can understand the indignation of the group, in Anchor event 1, when the students of the electronic cigarette favorable group used

13 To see the transcription of the event, please access Silva (2022).

arguments based on other sources other than those considered as scientific ones. In this way, the investigative instructional context shaped the use of scientific evidence to defend the ideas as a relevant epistemic practice at the social level of the group.

The socioscientific instructional context, in turn, expanded the opportunities for the students to take experiences and personal opinions to the social sphere of the discussions. Even recognizing the relevance in the use of evidence for construction of scientific knowledge in sciences classes, some students preferred to keep their beliefs even in face of the controverse. The socioscientific instructional context, moreover, opened space for other epistemic practices, not yet experienced in the group, to start to be constructed, which was the case of the practices of evaluation of the merits of evidence, the consideration of alternative explanations, and the use of other epistemic domains for the construction of holistic arguments. This result is substantiated by new debates about SSI, which started to be part of the repertory of the group in the future, throughout the 9th-grade, in 2020[14]. In that year, the evaluation practices identified in the anchor events were recurrent in discussions about questions such as: Covid-19, agrochemicals, and vaccination.

Discussion and Final Considerations

Our results indicate that the use of Inquiry-Based Science Teaching (IBST) and Socioscientific Issues (SSI) approaches provided the construction of distinct epistemic practices, which corroborates the theoretical propositions of Kelly and Licona (2018), as they indicate different practices connected to scientific and socioscientific context in sciences classes. There was a more expressive involvement in practices of proposition and communication of knowledge in the activities oriented toward the IBST. Under SSI context, on the other hand, it could be observed the involvement in evaluation practices, which then started to be part of the epistemic repertory of the group in other discussions about SSI over time.

This outcome, at first, can well suggest that the two approaches emphasize distinct social instances of the epistemic practices. It is as if the IBST favored the instances of proposition and communication, while SSI favored the instance of evaluation, which is not the case. We agree with Kelly and Licona (2018), when they indicate that both approaches can offer different epistemic practices in all the instances (propose, communicate, evaluate, and legitimize). The data we analyzed, however, give indication concerning two aspects still under discussion in the researches about epistemic practices: the pedagogical intentionality of the teacher and the role of the repertory of the students in the construction of these practices.

With relation to the pedagogical intentionality, we observed that the investigative activities, which were under recurrent work, favored practices of proposition and communication of knowledge. If we go back to the command of these activities and the ways of mediation of the teacher, there is emphasis on these dimensions. It does not

14 See interactions of these discussions at Silva (2022).

mean that the teacher was not valuing other practices, such as those aimed at evaluation, considering that throughout the 9th-grade year the same teacher encouraged such practices in a recurrent basis. Under the view of the pedagogical intentionality, this process can be interpreted by understanding the options of the teacher as a gradual construction path: from initial practices that support the construction of the scientific knowledge (e.g., proposing a hypothesis and finding evidence to corroborate it) to more complex practices (e.g., questioning the value of an evidence or interpreting it in different ways). This path could have been traced by means of investigative activities. For example, while the students were gradually beginning to acquire fundamental practices, the teacher could have proposed future investigations where other practices would be introduced, such as analyzing the quality of the evidence or evaluating the statements in a more critical manner than in the initial investigations. However, things did not happen in that way. When proposing an activity under SSI context, another aspect must be considered: the role of the repertories of the students in this kind of approach. The personal repertories of the students occupied a wider space than in the activities under IBST context, which resulted in consequences for the construction of the epistemic practices.

When discussing the socioscientific issue, a position based on the scientific evidence was not sufficient for the group to reach a consensus on how the investigative activities were occurring. When debating an SSI, some students left the "script" and used arguments that were not considered as scientific, which led colleagues to engage in practices that had not been experienced: epistemic practices of evaluation. In our interpretation, the introduction of an SSI catalyzed the engagement in these practices.

In this sense, the SSI instructional context was relevant by expanding the opportunities of epistemic learning of the group. Despite that, the investigative instructional context also played a core role. The engagement in more complex practices observed during the electronic cigarette debate, was only seen because the group had already constructed an epistemic repertory that substantiated these new practices. This becomes more evident when we add the analyses of Almeida (2022) to our results. The author analyzed the same class group investigated in this article, however focusing on the classes of the first semester of the school year. In that semester, the group did not go through investigative activities, but participated in a debate that discussed a socioscientific question about stem cells.

The debate of that issue was held during the correction of the assignment prepared at home. In the activity, the teacher had asked the students to explain stem cells and the difference between embryonic and induced stem cells. After that, he asked: "*The use of embryonic stem cells is very contentious. What is your position concerning the use of embryonic stem cells in the treatment of illnesses*?". As evinced by Almeida (2022), only few students took a stand in the discussion. In order to encourage more participation, Sandro proposed an activity in which the students who were already positioned had to convince the colleagues not yet positioned, by presenting arguments to support the point of view defended. However, they did not participate. Almeida (2022) indicates that even when the teacher asked the students to participate, there was no expectation that they would participate based on what a colleague said, that is, that they would consider the statement of a colleague while constructing their own position. If we look at the electronic cigarette event, we identify similarities in the way how the activity was developed, and still the participation of the students was different. As per our interpretation, the many activities under the IBST context that preceded the electronic cigarette debate provided the construction of a repertory for the emergence of new epistemic practices under SSI context.

In this sense, we are in accordance with those researches that have proposed methods of articulation between the IBST and SSI (e.g., Ariza et al., 2021; Levinson, 2018; Nan & Chen, 2017). According to our data, we suggest that this articulation should occur considering a balance between the positions of Tina and Péricles: science is not the absolute truth, but it provides a good source of information and is a good way for conceiving this information (Feinstein & Waddington, 2020). We align our argument with that of Sasseron (2019), stating that the development of epistemic practices in sciences classes allows the students to become more critical amid a profusion of information and an abundance of opinions, thus promoting the construction of "less egocentric perspectives and, therefore, wider and more complex ones" (Sasseron, 2019, p. 566). By taking the knowledge produced by the scientific community and knowing how it is conceived, students can assess other epistemic domains, seeking for arguments based on evidence to answer and act over the questions of their daily lives and those of the society (Ramos & Mendonça, 2021).

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