Intersectional pedagogy in nursing education
A study of HIV/AIDS

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Résumé : Le thème de l'infection par le virus du VIH/SIDA dans les cours d'immunologie n'est encore traité que sous l'angle du contenu biologique. Cependant, cette question englobe une variété de thèmes qui passent par des dimensions sociales, politiques et scientifiques qui sont importantes dans les processus d'enseignement-apprentissage, et dans la formation et la culture scientifique des professionnels de la santé dans une perspective d'éducation scientifique de transformation sociale contre les préjugés. Ici, nous construisons et étudions une séquence d'enseignement par apprentissage par problèmes (APP) sur le VIH/SIDA pour l'expérience des étudiants avec une pédagogie critique et intersectionnelle dans les classes d'immunologie. L'analyse des résultats a montré que les étudiants universitaires du cours de santé ont mobilisé d'importantes connaissances sociales et scientifiques ainsi que des pratiques épistémiques spécifiques lorsqu'ils ont réalisé l'apprentissage par problèmes en ligne. En conclusion, notre étude a mis en évidence une perspective d'enseignement intersectionnel et scientifique de l'immunologie pour les cours d'immunologie dans le cadre de la formation des professionnels de la santé.

Mots-clés : Pédagogie intersectionnelle ; éducation au VIH/SIDA ; questions de sciences sociales ; éducation à la santé pour les infirmières ; méthodologie PBL ; enseignement de l'immunologie.

Abstract : The theme of infection by the HIV/AIDS virus in immunology classes is still treated only in the dimension of biological content. However, this issue engages in a variety of themes that go through social, political, and scientific dimensions that are important in the teaching-learning processes, and in the formation and scientific literacy of health professionals in a perspective of scientific education of social transformation against prejudices. Here, we construct and study a teaching sequence by Problem-based learning (PBL) on HIV/AIDS for student experience with a critical and intersectional pedagogy in immunology classes. The analyses of the results showed that university students of the health course when performing the PBL online mobilized important social, scientific knowledge and specific epistemic practices. In conclusion, our study pointed to a perspective of intersectional and scientific immunology teaching for immunology classes in the training of health professionals.

Keywords : intersectional pedagogy,HIV/AIDS education,social scientific issue,health education for nurses,PBL methodology,immunology teaching

1 Introduction

The HIV/AIDS pandemic has been a major global public health problem since the 1980s of the 20th century (WHO, 2020). Unlike other diseases, the issues surrounding HIV infection go beyond the dynamics and complications of the virus' interaction with the human body but reach a multidimensional spectrum (social, gender, sexual, political, and racial-ethnic) of an individual's life that is called the domains of intersectionality (Watkins-Hayes, 2014). The concept of intersectionality (Collins & Bilge, 2016) and intersectional pedagogy is part of a theory that gained momentum in the mid-20th century and sets out to expose, critique and problematize societal issues through the categories of social class, gender, racial-ethnic, and sexual that intersect and intertwine in any social issue and catalyze inequalities between individuals (Hooks, 1994 ; Hooks, 2005 ; Case, 2017 ; Hsieh et al., 2022). The training of science teachers and health professionals to prepare for social, political, and scientific issues that involve the practices regarding the dynamics of HIV infection is important for the realization of health education from a perspective of transformation and social justice (Valladares, 2021 ; Moreno, 2018 ; Ah-King, 2010 ; Powell & Ah-King, 2013 ; Westberg & Powell, 2015). Science education is an important mechanism for the transformation and pursuit of social justice against prejudice, discrimination, and dissemination of misinformation in societies (Dimick, 2012 ; Dimick, 2016 ; Valladares, 2021).

The subject of immunology classes involves a range of specific and complex knowledge that can be stimulated during higher education training by inquiry-based learning in practical classes (Manzoni-de-Almeida et al, 2016 ; Mello et al, 2019 ; Manzoni-de-Almeida et al, 2021), in historical-philosophical approach (Manzoni-de-Almeida et al, 2019 ; Pradeu, 2020) and in the goal of the processes of the dynamics of language and specific concepts of science by engaging the teaching-learning of scientific argumentation in the individual or collective construction of knowledge in immunology classes (Pereira et al. 2017 ; Manzoni-de-Almeida et al, 2016 ; Mello et al., 2019). There are still few articulations and studies between specific immunology knowledge associated with intersectional themes in science education. The subject of HIV/AIDS presents a social demand linked to all classes of society, in particular, of groups in situations of vulnerabilities, social inequalities, and prejudices (LGBTQIA+, women, and populations with racial-ethnic markings) (Silverstein, 1989 ; Dowsett, 1996 ; Cohen, 1999 ; Millett et al, 2006 ; Merritt et al., 2017 ; Moreno et al., 2018). In this way, proposing pedagogical activities in the training of health professionals, such as nurses, that can articulate scientific knowledge with social and political knowledge about HIV/AIDS can engage these future professionals in professional practice in a more critical, humanized, and empathetic way with patients.

Science education for critical thinking is a form of education for citizenship, justice, and social transformation. This critical posture implies the development of both cognitive and socio-political elements (Puig & Jiménez-Aleixandre, 2022). Problem-based learning (PBL) is a methodology that approaches scientific topics in class through a problem, which can be a clinical or a social case study, which engages students in mobilizing practices to solve the proposed problem in science and health education (Millett et al, 2006, Wang, 2010 ; Urrutia, 2011 ; Mansur, 2012). Epistemic and scienti-

fic practices are important markers of student engagement and participation in scientific culture in science classes (Trullàs et al., 2022 ; Kelly, 2008 ; Jiménez-Aleixandre, 2017 ; Kelly & Licona, 2018). In this way, evaluating the mobilization of categories of epistemic/scientific practices by students during pedagogical activities can be a good marker of scientific literacy processes in teaching-learning processes. Thus, the articulation between problem-based learning goals and social scientific culture is an important mechanism in order to understand scientific literacy critical aspects and teacher decision-making for health education classes.

How can issues of intersectionality be present in immunology classes ? Our objective was to construct a teaching sequence using PBL methodology that involves sociopolitical and scientific aspects of the HIV/AIDS theme. Also, to describe the experience and mobilization of intersectional and epistemic/scientific practice markers in the dynamics of the students' writings in carrying out a teaching sequence with these complex characteristics on the HIV/AIDS theme.

2 Theoretical framework

The theoretical framework to which our work is affiliated is in the field of identity studies and science education with the aim of scientific literacy with perspectives on processes of emancipation, social transformation (Valladares, 2021), and social justice (Dimick, 2012 ; Dimick, 2016), especially in oppressed and marginalized populations in educational processes (Freire, 1970).

Identity studies in the field of science education have been gaining ground in the last decades of the 21st century. This interest is linked to the objective of understanding how the processes of knowledge construction in science education are closely linked to the identities of researchers or teachers involved in these science education processes (Varelas, 2012 ; Avraamidou, 2014 ; Avraamidou, 2016 ; Avraamidou, 2020). In addition to this objective, there are other interests in understanding how the dynamics of identities, access to educational processes, and the construction of representations in science education take place, as ways of understanding and proposing public policy projects that can address issues and people in situations of marginalization and vulnerability (Avraamidou, 2020). This issue involves studies in the field of identity, the definition of which that identity is constructed as part of social practices and not just as an individual process of construction (Wenger, 1998). In this way, these social practices in the construction of an identity touch on important ethical, social, and political categories that intersect in the formation of an individual ; however, the social dynamics of this intersection can lead to inequalities between individuals. This device for analyzing these categories is called intersectionality, which originates within the construction processes of feminist theories and can be an important device for critical analysis in various fields of society (Collins & Bilge, 2016). Intersectional pedagogy is part of a theory that gained strength in the mid-twentieth century and sets out to expose, criticize, and problematize issues in society through the categories of social class, gender, ethnic-racial, and sexuality that intersect and intertwine in any social issue and catalyze inequalities between individuals (Hooks, 1994 ; Hooks, 2010 ; Cabrera, 2014 ; Case, 2017). Several studies have shown the problems caused by sexism, racism,

and inequalities in the scientific field and classrooms, especially involving teaching-learning processes in science classes (Brickhouse, 2001 ; Bowleg, 2008 ; Arnold, 2012 ; Bullock, 2018 ; Avraamidou, 2019). Brown et al (2005) examined the discourse of identity in examining the discourses delivered by students in science classes and how these discourses were linked to scientific literacy. Dimick (2012), constructing a teaching activity on the environment with students from a popular high school in the USA, showed the process of the participation of identities in the political, social, and academic empowerment of students in the engagement and construction of knowledge in science.

The lines of research into identities, intersectionality and science education can be divided into three main areas of interest (Danielsson *et al.*, 2023) : i) macro studies with a psychological perspective. These studies are affiliated with quantitative methodologies and are mainly linked to participation and gender equality in science teaching studies or the performance of student inclusion processes in science classes. These studies occupy a large part of intersectionality studies in science education. One example is the study by Means *et al.* (2016) which carried out a statistical comparison between several inclusive and non-inclusive schools on attendance, interest and aspiration of students in science classes. The results showed that the STEM attendance of inclusive schools increased the interest and aspiration of students in science and math classes ; ii) macro studies with a sociological perspective. Not far removed from the first perspective, these studies are linked to quantitative methodology on the social relations established in large target groups on gender, ethnic-racial origins, and social class in dialogue with sociological theories. For example, Archer et al (2012) showed, *via* an ASPIRES project study, the engagement, adherence, and career aspirations of young students aged 10-19 for science using survey research and interviews. The criticism of these first two lines of research is the effect of generalization that conclusions can be drawn without sufficient attention to the particularities in which issues involving intersectionality present themselves ; and iii) micro studies with traditional interpretative perspectives. These studies are linked to the use of qualitative methodologies to study intersectional issues of small groups or the performance of individuals in a specific and limited social context. An example is Brickhouse & Potter (2001), who show a qualitative study of the journey and identity of two black women and their relationship with STEM. On the other hand, the criticism of this block is centered on the specificity of the situations presented, which may not generate conclusions that can be taken as a general phenomenon that supports the making and creation, for example, of public policies.

These various studies show that scientific literacy processes, to exercise citizenship, do not only involve the acquisition of scientific concepts.

Scientific literacy is understood as a process of developing the appropriation of social practices of scientific culture to exercise critical citizenship (Bybee, 2016). Studies on scientific literacy processes point to approaches that go beyond just scientific content in science or health classes. For Hodson (2014), the objectives of science teaching can be classified into four categories. The first is to learn science, i.e. that scientific content and concepts are transmitted to students in the classroom. The second is to learn

about science, i.e. that in addition to transmitting the content and concepts of science, the history and philosophy of science are incorporated into this, so that students can experience how science works. The third is learning to do science, i.e. that science classes, through teaching methodologies, can give students the experience of doing science, of producing knowledge. The fourth is to learn socio-scientific content, in other words, to relate scientific concepts to social issues in the teaching-learning process. Valladares (2022) brings up an important criticism of this format of closed objectives for science teaching, as they do not include the ethical and political dimensions that involve the process of scientific literacy and citizenship. The author criticizes this process in light of the COVID-19 pandemic and the post-truth era. For Valladares (2022), the idea of an "epistemological vaccine", adopted by many authors as an idea of scientific literacy through the insertion of scientific epistemologies in teaching-learning processes, has shown little efficiency in the face of the challenge of the covid-19 pandemic. The author's proposal states that science teaching in the 21st century needs to go beyond being linked not only to socio-scientific issues but also to political knowledge, for example, intersectionality (Valladares, 2021).

Thus, Valladares (2021) puts forward a proposal on the current visions of education and scientific literacy. Vision I focus on the objectives of science teaching regarding technical knowledge and information about scientific concepts. The criticism leveled at this vision is the limitation provided by a science that is detached from social reality and enclosed in hermetic and abstract concepts. On the other hand, Vision II focuses on the objectives of science teaching regarding scientific content, knowledge, needs, and the importance of social demands, such as environmental issues. However, the criticism of this vision is linked to the utilitarian limitation of science as just an application tool for solving technological problems in society. For the author, the vast majority of proposals fall into the first two visions. Vision III, on the other hand, contemplates science teaching that addresses the intrinsic knowledge of scientific culture, social applications, and the addition of a political perspective involving issues of intersectionality. The argument for this approach is that science teaching is the dialog between identities and scientific knowledge that can promote processes of engagement and processes of scientific transformation. To this proposal, activities for science classes should contain intersectional approaches.

The advent of the COVID-19 pandemic has brought many more challenges to the teaching and training of health professionals and to scientific literacy. However, the HIV/AIDS epidemic since the 1980s can provide us with important knowledge for proposing classes in Vision III, according to Valladares (2021).

The issue of the HIV/AIDS epidemic has been part of science and health teaching since the middle of the 20th century. Various methodological approaches to health teaching and education, especially in higher education, have already been produced that address this issue, promoted by various public policies around the world (McGinty and Mundy. 2009; Holderness, 2012). One example is South Africa's "Policy and Strategic Framework on HIV and AIDS for Higher Education" (HEAIDS. 2008). Woold & Pillary (2016), conducting a survey of studies on education and health in higher education for the issue of HIV/AIDS in the world, make an interesting point

about the approach and insertion of HIV/AIDS themes in school curricula around the world. The authors found that developed countries in the northern hemisphere (Canada, USA, Western Europe), where the incidence of HIV/AIDS is still lower, take a technical-rational approach to the subject linked to preventing students from becoming personally infected, rather than addressing the HIV/AIDS epidemic as a social issue.

Woold & Pillary (2016) cite several theoretical-pedagogical approaches, which are based on the principle that technical knowledge leads to behavioral changes, for example, the AIDS risk reduction model (Fisher and Fisher 2000), the diffusion of innovation model (Bertrand 2004), the Health Beliefs model (Obregon 2000), the social cognitive theory model (Bandura 2004) ; the Stages of Change model (Munro, Lewin, Smart, and Volmink 2007) ; the Rationalized Action theory (Montano and Kasprzyk 2002) (Woold & Pillary, 2016), but which ignore individual, collective, social and political issues in the HIV/AIDS epidemic. This view is limiting for teaching about HIV/AIDS, as it conditions the issue only in the biomedical field and does not encourage the engagement of other socio-political perspectives that involve the HIV/AIDS epidemic. On the other hand, the authors found that in African countries, where the issue of the HIV/AIDS epidemic is recognized as a social problem, other critical pedagogical approaches are taken to understand the HIV/AIDS epidemic as a multidimensional, dynamic socio-political problem that requires a break with socio-political ideological paradigms (Baxen and Wood, 2013 ; Francis, 2010 ; Morrel 2003 ; Madeira, 2012).

Thus, for this approach to HIV/AIDS health education in the training of health professionals, teaching methodologies that can contemplate the connection between the scientific world and the social world are essential. Valladares' (2021) proposal suggests methodological teaching approaches that enable critical thinking involving scientific, social, and political issues. The Problem Based Learning (PBL) methodology is a teaching methodology, developed in 1969 at McMaster University (Canada), based on inserting the student into a concrete problem in which the student is engaged in solving a problem and the learning process is student-centered (Neville, 2009). The central idea behind PBL is that, based on a problem, students can develop a working hypothesis and identify learning needs, so that they can solve the problem. Thus, PBL is a teaching methodology that has been well accepted, received, and adopted in health education in the training of professionals as a way of developing skills and competencies, especially critical decision-making skills, in professional practice (Neville, 2009 ; Trullàs, 2022). Several studies have shown the integration of PBL with the theme of HIV/AIDS in the training of doctors and other health professionals (Solomon, 2003 ; Curran, 2005 et al ; Gandhi *et al.*, 2014), especially for the development of skills beyond the technical-scientific, but social and political. One of the major problems in socially and politically vulnerable populations who are undergoing treatment with antiretroviral therapies is adherence and discipline in treatment (Bezabhe, 2016). For example, Zang et al (2019) showed that the PBL teaching approach helped health and medical students in the teaching-learning processes on HIV/AIDS and adherence to antiretroviral therapy

3 Methodology

This study of qualitative research methodology is a descriptive ethnographic case study. Ethnography is a qualitative methodology that consists of observing, collecting information, and interpreting a specific cultural situation The ethnographic method may or may not involve the participation of the researcher concerned. In this study, the first author was a teacher in the target. classes for approximately four and a half months, thus characterizing the study as action research in which the main researcher participated in the study process in study design, application, observation, data collection, analysis, and interpretation (Denzin & Lincoln, 2005 ; Rian, 2009 ; Harwati, 2019 ; Mills, 2013). At the time of the study, classes were administered remotely and online, due to the health issue of social distancing imposed by the covid-19 pandemic (2020), using the "Blackboard platform" provided by the institution. Classes were administered online and live. The written material produced by the students was collected through Word and PDF files submitted electronically *via* the platform. Previously, the study was submitted and approved by the ethics committee (CAAE : 03191018.8.0000.8054/protocol number : 5.113.647) and participants signed a voluntary consent form for participation in the study. There was no hesitation or withdrawal of students participating in the study.

3.1 Characterization of the field of study

The study was carried out on the subject of Immunology for the first year of the Nursing course when in the second semester of the course they are taking the subject of Basic Immunology, which consists of basic content from the areas of microbiology, parasitology, and immunology. The time spent on the subject is, in fact, far too little for the density of the scientific content that needs to be covered. For example, in four and a half months the student needs to have basic knowledge of the biological mechanisms of how the immune system works, and how these mechanisms are articulated to carry out defenses against bacteria, viruses, protozoa, and fungi. On the other hand, the structures, classifications, life cycles, and infection mechanisms of microorganisms and parasites need to be presented so that students can learn about the morphologies and functions of these organisms. In addition to all these objectives that support the foundations of technical-scientific knowledge, students also need to be encouraged to articulate this knowledge with important social issues in public health and with their realities as future nurses, for example, with issues of diversity and inclusion in public health care. In these situations, building classes that articulate socio-scientific themes can be important pedagogical actions in education and social justice in science teaching. Especially when the work is carried out in popular education spaces and with working-class students, in situations of social vulnerability, health vulnerability, or who are important citizens in the fight against and treatment of the masses of diseases caused by the COVID-19 pandemic, for example, health professionals, the so-called "front line" who risk their lives every day with cases of the disease. Most of the students who graduate from this private and popular university are trained and can work in the single health system and more popular hospitals, especially in the city of São Paulo, Brazil. One class was held in the morning and another in the evening. The morning class consisted of 17 students (7 men and 10 women) and the

evening class of 63 students (52 women and 11 men) aged between 18 and 50 who already work as nursing technicians (non-higher education) in hospitals. The nursing course in question at this university has been running for more than twenty years, with more than 2,000 students enrolled in classes in three shifts, morning, afternoon, and evening. The university's campus is spread out over various regions (noble or peripheral) of the city of São Paulo. However, the nursing course is offered in the central region of the city, as it is easily accessible to students by bus and subway.

3.2 The development and application of the PBL teaching sequence

The teaching sequence was proposed in 7 steps, during online/remote classes. Each stage corresponds to one day of class meetings corresponding to 3 hours/classes each (a total of 5 meetings and 1 inverted class) (Table 1).

Briefly, *Step I* students received orientation and a link to watch the movie "*And the band played on*" (1993). The movie, based on the work "*And the band played on politics, people, and the AIDS epidemic*" by Randy Shilts (1987), narrates the social, political, and scientific events of the beginning of the HIV pandemic and discovery in the world, especially in the USA. This film was chosen because it presents a historical narrative of the discovery of the HIV epidemic based on scientific evidence. For example, there are interesting elements in the film for nursing students of how the science of epidemiology was important in characterizing and mapping the forms of transmission of HIV/AIDS cases in the 80s. The film's narrative shows how researchers have investigated and characterized HIV/AIDS cases to discover how the virus is transmitted. Although the film is considered old for today's times, it has elements of the history and logic of science, especially HIV/AIDS, which are pedagogical for understanding how science works and builds knowledge, one of the objectives of science teaching (Hodson, 2014) and how science can be in everyday life important in scientific literacy processes (Valladares, 2021).

Step II consisted of students reading a book that addresses the implications of vulnerabilities, intersectional, social, political, and economic (gender, sexuality, class, and racial/ethnic) that permeate the issue of HIV infection and the development of AIDS (Parker & Aggleton, 2001). The objectives of these steps were to develop students' awareness of the scientific, political, and social dimensions of HIV/AIDS infection. The book in question was selected because it was a classic work and a pioneer in scientifically explaining intersectional, social, and political relations in cases of HIV/AIDS infection. Recent studies show that these intersectional issues still persist today in HIV/AIDS public health for populations in situations of exclusion and vulnerability (Dowsett, 1996 ; Cohen, 1999 ; Millett *et al*, 2006 ; Merritt *et al.*, 2017 ; Moreno *et al.*, 2018).

Step III, in class, consisted of *Problematization I – What is the social dimension of a sexually transmitted infection ?* For this step, students were given a problem situation and two questions to evaluate and develop individual responses to the problem. The objective of this step was to stimulate intersectional discussion about HIV infection. Subsequently, *Step IV* consisted of a theoretical and expository lecture, given by the subject teacher, about the main concepts and scientific knowledge of HIV virus bio-

logy (classification, structure, and forms of reproduction) and the immune response developed by the host to the virus (innate, acquired/adaptive immune response). This step was based on chapters 16 "Immunity to microbes" (p. 351) and 21 "Congenital and acquired immunodeficiencies" (p. 459) of the international basic immunology teaching manual proposed by Abbas, Lichtman & Pillai (edition, 2018) (*Abbas, Lichtman & Pillai, 2018)*. This step aimed to present and discuss with students the main knowledge already established in microbiology and immunology about the HIV virus and the development of AIDS.

Tab. 1 : Steps (I-VII) in the teaching sequence problem based on HIV/AIDS

Step	Action	Activity
I	Flipped Classroom: movie "And the band played on" (1993)	
II	Discussion of the text: "Estigma, Discriminação e AIDS", de Richard Parker e Peter Aggleton" (2001)	
III	Problematization I: "*A hospital performed a test for the presence of the HIV virus in a serum sample from human blood. The result was positive for the presence of HIV in the sample*"	Question 1: What is the possible person in the sample? Justify your answer
		Question 2: How could this person have come in contact with this virus?
IV	Lesson on HIV biology and immune response	
V	Problematization II: "*Look at the graph with results from a blood sample from a person diagnosed with HIV infection. It shows the curve of HIV infection and the development of AIDS in that person*"	Question 1: Explain the dynamics of the relationship between viral particle number and the number of TCD4+ cells/lymphocytes in the peripheral blood of this person.
		Question 2: Explain what would happen to the dynamics of the relationship between the number of viral particles and TCD4+ cells/lymphocytes in this person's peripheral blood if he or she uses antiretroviral drugs
VI	Problematization III: "*Researchers conducted a study on the sexual behavior of a certain population. The data are results from the article. Analyze the results and answer the questions*"	Question 1: Which group is most vulnerable to contracting the HIV virus? Justify your answer
		Question 2: In which situation are people in the survey most vulnerable to contracting the HIV virus? Justify your answer.
		Question 3: In which situation are people in the survey least vulnerable to contracting the HIV virus? Justify.
VII	Final Discussion of the Activity	

Step V consisted of *Problematization II – What is the scientific dimension of a sexually transmitted infection*? Students were provided with a graph showing the dynamics of HIV infection through to the development of AIDS in an infected person. The graph provided was translated and based on Figure A-21.8 (p. 481) from Chapter 21 (Abbas,

Lichtman & Pillai, 2018). The graph consists of one axis that shows the life span of a person infected with HIV in months and years. On another axis, the number of viral particles (viremia) developed over months/years of the person's life is shown. On another axis, the number of TCD4+ cells in the individual's peripheral blood over this time (immunodeficiency). The purpose of this graph is to show the relationship of the dynamics of infection by the HIV/AIDS virus, inversely proportional to the increase of viral particles and the decrease in the number of specialized cells of the immune system (TCD4+) that are the target of infection by the virus. This step is an opportunity to mobilize scientific knowledge, especially biological/immunological knowledge, presented to students in the previous step.

Step VI consisted of *Problematization III – What is the intersectional dimension of a sexually transmitted infection ?* In this step, students received the abstract and Figure 1 of the article (Pereira, 2018) for reading and analysis. This study reported the results of a survey conducted on the vulnerability of people to HIV infection in the face of the issue of sexual practices, gender, and social conditions. Students were encouraged to answer two questions after the analysis of the results in which issues of gender, sexual practices, and social contexts and vulnerabilities are discussed. This step aimed to stimulate the mobilization of scientific knowledge in triangulation with the intersectional issues of students in the HIV/AIDS theme. *Step VII* consisted of a final discussion with the students about the teaching-learning process in the proposed teaching sequence. This step aimed to allow an evaluation and disclosure, among the students, of the knowledge circulated during the process of the teaching sequence.

3.3 Data Analysis

The written answers produced by the students to the questions proposed in stages III, V, and VI of the teaching sequence were analyzed in 3 ways. Each analysis of the students' writings was carried out by two researchers and later compared :

i) *lexical analysis* : the individual writings of the students were analyzed in the linguistic program AntConc for determination of the corpus of greater expression of words in the writings of the answers (Anthony, 2005). This stage aimed to assess which words occurred most frequently in the students' writings ;

ii) *analysis of the dimensions of knowledge in the answers* : the individual responses were analyzed based on the construction of the category table (Tables 2, 3, and 4). This stage aimed to differentiate and evaluate physical, chemical, and biological scientific knowledge from social knowledge in the students' writings. Each of the students' writings was evaluated for the presence of scientific (physical, chemical, and biological) and social content, as illustrated in the following examples. For the words in Table 2, it is the construction of a group of terms on scientific or social/intersectional knowledge, especially in immunology and infection by the HIV/AIDS virus, for the analysis of the writings produced by the students as shown in Tables 3 and 4.

Tab. 2 : Analysis tool with word classes that refer to ideas of intersectionality and specific knowledge of immunology and microbiology about HIV/AIDS infection

Group	Words	Reference
1	Male, female, homosexual, heterosexual, sexual orientation, gender, race, ethnicity, religion, social class, work class, sexuality, age	Collins, 2015 ; Collins & Bilge, 2016 ; Viveros, 2016 ; Collins 2019 ; Case, 2017
2	drug use, condom ; vaginal intercourse, anal intercourse, under effect, fixed partner ; T-lymphocyte, CD4, virus, virus number, drug, cells, immune defense, immune system, AIDS, HIV, drop, increase, white blood cell, comparison, quantity, consequence, due, grows, decreases, large, small, effect, stabilization, passing of time, multiplication, division, proportion, curve, undetectable, continuous, becoming, viral load.	Chapters 16 and 21 (Abbas, Lichtman & Pillai, issue, 2018)

For Table 3, 3 categories were constructed based on the fields of interest for knowledge : scientific or social/political. Scientific knowledge was considered in the writings when in the answers that present only knowledge involving the natural sciences such as physics, chemistry, and biology ; for knowledge of social fields in writings when in answers that only present knowledge involving social and political issues. Some students' writings presented a mixture of scientific and social knowledge. Therefore, the answers that simultaneously present knowledge involving scientific and social topics were classified into these categories.

Tab. 3 : Instrument for the analysis of the knowledge categories

Categories	Meaning	Example
Nature knowledge	answers that present only knowledge involving the natural sciences such as physics, chemistry, and biology	Q5- S61 -Once the HIV virus has a membrane protein that can bind to the lymphocyte receptor CD4, the virus particles can bind and enter the cells, but they are retroviruses, that is, the genetic material is RNA within the capsule, there is a type of reverse transcriptase. The enzyme can transcribe RNA into DNA, incorporating it into the DNA of the host cell, causing to produce other equivalent viral particles, the virus multiplies and then releases the cell. Q5- S62 By using medications correctly, viral replication is inhibited, so the patient can have an undetectable viral load, the medications act as inhibitors in 5 phases : A fusion inhibitor : blocks virus to merge into the cell ; Reverse transcriptase inhibitor : blocks transcription of DNA into RNA, thus it cannot incorporate itself into the host cell's DNA. Integrase inhibitors : prevent the DNA of the transcribed virus from incorporating into the host cell's DNA Protease inhibitors : inhibit the manufacture of viral particles Virus maturation inhibitors : prevent viral particles from multiplying."
Social knowledge	answers that only present knowledge involving social and political issues	Q1- S33 - It may be any person because it's a virus that attacks men and women -being a democratic illness- from different ages, social classes, and social specters. Q1- E21 - It may be men or women, there is no age, it may be rich or poor, and any person is susceptible.
Nature/ Social knowledge	answers that simultaneously present knowledge involving scientific and social topics	Q1- S4 - The Acquired Immunodeficiency Syndrome (HIV/AIDS) as the name implies, affects the individual's immune system, which can be male or female, as there is no gender distinction. Q1- S23 - It can occur in anyone, be it men, women, or children, without differentiating social class, or sexual option, it can be transmitted by blood, semen, vaginal secretions, milk, maternal vertical transmission to baby, unprotected sex.

For the analysis in Table 4, categories were constructed based on the main axes of intersectionality : biology, genders, sexualities, social class, and racial-ethnic issues Collins, 2015 ; Collins & Bilge, 2016 ; Viveros, 2016 ; Collins 2019 ; Case, 2017) and biology/immunology (Chapters 16 and 21 [Abbas, Lichtman & Pillai, issue, 2018]). In this way, the writings classified in the category of biological knowledge as answers that present biological knowledge about HIV, the human body, and ways of transmitting the virus ; for those of gender, the answers that refer to the gender issue ; for those on sexuality answers that refer to the question about the types of sexualities ; for those of social class the answers that refer to the issue of social classes ; for those of ethnic-racial the answers that refer to the ethnic-racial issue

Tab. 4 : Instrument of analysis of the categories of specific knowledge

Categories	Meaning	Example
Biological	answers that present biological knowledge about the HIV virus, the human body, and ways of transmitting the virus	Q5 -S58 : When a person affected by this virus uses antiretroviral drugs, it increases the multiplication of the viral load, generating a stabilization in the number of lymphocytes, so there is a gradual increase in symptoms and a better quality of life. Q1 – S10 : Through unprotected sex, blood transfusions with contaminated blood, sharing needles or syringes, contaminated sharps, and vertical transmission (from mother to child) can be transmitted during pregnancy, childbirth, and breastfeeding
Genre	answers that refer to the gender issue	Q2 – S25 : Group of men who practice vaginal sex under the influence of drugs, due to the numbness of the senses, people end up taking more risks without thinking about the consequences. Q2 – S49 : [transmission] can occur through your fluids not only through ejaculation, but the anus is also at even greater risk by not containing its natural lubrication. Q3 – S44 : 64.14% of women use condoms, apparently in general they show more care about the disease
Sexualities	answers that refer to the question about the types of sexualities	Q1 – S62 : The sample can be represented by men or women, as this virus affects both sexes. Q2 – S57 : In analysis, it is more likely to contract the virus the man who has anal intercourse while using drugs, as he is not fully aware of his actions.
Social class	answers that refer to the issue of social classes	Q1 – S45 : We cannot say who contracted the virus from the doctor to the janitor. As long as it's a living being, anyone can. Q1 – S1 : There are numerous biological and social factors that make some people more exposed and prone and at a greater risk of contracting the virus than others.
Ethno-racial	answers that refer to the ethnic-racial issue	Q1- S69 : According to studies, HIV is a disease that can affect both sexes (male or female), in addition to being able to spread at any age that the person is, in any ethnicity, in any stereotype, it can be said that such a virus does not respect people. Q1 - S86 The (possible) person who tested positive can be anyone, regardless of gender, color, bank account, and sexual orientation. The virus has no distinction between people, it affects any organism that has contact with it.

iii) *analyses of the epistemic practices* : the individual written responses of the students were analyzed for evaluation of the occurrences of the categories using the tool and definitions table (Mello, 2019). The objective of this phase was to qualitatively characterize the mobilization of epistemic/scientific practices in the students' writings. This characterization of the types of epistemic/scientific practices mobilized by students can help us understand the dynamics of literacy and scientific culture present in students participating in science activities, as we have done in previous studies (Manzoni-de-Almeida, Marzin & Trivelato, 2016 ; Manzoni-de-Almeida, 2016 ; Mello et al, 2019 ; Natale *et al.*, 2021). Briefly, the units of analysis for classifying epistemic

practices were defined as used in Manzoni-de-Almeida, Marzin & Trivelato (2016) in which each "Brand" was defined as a text executed forming a paragraph considering a brand as a structure of one sentence and paragraphs. After classification, each brand was analyzed for categorization along the lines of epistemic practices summarized by Mello *et al.* (2019) (Table 5 – Table extracted from Mello *et al.*, 2019). These results express the differences in the types of epistemic practices/operations in each student response.

Tab. 5 : Epistemic practice framework tool for analysis. Table extracted from Mello et al (2019)

Epistemic practices	Definition
Making questions	Create an experimental question related to the problem posed or other questions generated after data analysis. Corresponds to the motivation to start a discussion.
Developing Hypothesis	Elaborate a possible explanation for a question or problem.
Making predictions	Predict results to each sample related to control and experimental groups based on the explanatory hypothesis.
Explaining the scheme of investigation	Explain the use of instruments and equipment, as well as the procedural steps mobilized over experiment performance.
Making literary inscriptions	Elaborate different forms of representation of raw data to shape the phenomena.
Mentioning inscriptions in the text	Make explicit reference to literary inscriptions into the written text.
Describing data	Discuss a system, object, or phenomena, in terms of its characteristics.
Comparing data	Establish a relationship between two or more samples while explaining the data.
Interpreting data	Establish the meaning of the data obtained from the investigation.
Explaining data	Establish a causal relationship between observed phenomena and theoretical concepts, or between observed phenomena and some experimental event
Making inferences	Devise claims based on data or theoretically derived premises.
Monitoring anomalous results	Select and discuss anomalous data generated by execution errors by unexpected experimental events or by errors in the hypothesis, which can influence the results.
Accessing consistency of data	Define which evidence is valid for each specific claim established.
Relating data and theory	Present data and relate them to the theoretical statements.
Conceptualize	Assign meaning to an explicit concept.
Making conclusions	Find a solution for the proposed problem or question.
Considering data sources	Mobilize more than one type of data to develop a line of reasoning.

4 Results

The results will be presented in two parts. The first refers to the participation and interpretation of the main researcher in this study of the application of the teaching sequence. The second is the qualitative and interpretative analysis of markers of scientific culture and intersectionality in the writings produced by the students during their participation in and experience with the proposed teaching sequence.

4.1 Part 1 : Report and interpretation of the application of the teaching sequence and participation in the research

The research period of seven lessons, i.e., meetings with the classes, went smoothly and the students were very engaged with the topic and the activities. The interpretation of this student engagement can be explained in two ways :

- The teaching sequence was applied by the first author – who is a professor of immunology and didactics of science/biology – and who is involved in studies of the teaching-learning processes of immunology in the classroom as a way of working with the culture and politics of science. The professor explained the theme of the teaching sequence and the motivations behind this approach. One of the first author's engagements with the teaching of immunology came from his own story, as reported in his doctoral research in autoethnography (Manzoni-de-Almeida, 2021) for scientific literacy in immunology against the prejudice of the LGBT+ population. In short, the science of immunology grew mainly from the 1980s with the emergence of HIV/AIDS (Silverstein, 1989 ; Pradeu, 2020). At the beginning of the epidemic of this disease in the world, a lot of fake news circulated, bringing the stigma of the "gay plague" (Sontag, 1988 ; Earnshaw *et al.*, 2012). The first author and teacher of the subject told the groups of students that this experience of prejudice is still a major stigma against LGBT+ people. The first author also said that he was a member of the LGBT+ community. This movement of declaring one's sexual identity is an important mechanism for intersectionality in science classes (Koedel, 2017 ; Gibney, 2019). At the time, there was an important reception of the professor's identity, with a show of support, and identification by some students of their identities and layers of intersectionality's, such as gender, social class, and origin. As described in the methodology, most of the participating students declared themselves to be female and the university where the study was carried out caters for a popular and working-class audience in the city of São Paulo. This movement was important in creating a welcoming, empathetic, democratic, and safe space for learning about a delicate topic at a unique and insecure time such as the social distancing in online classes caused by the COVID-19 pandemic, a pedagogy focused on human values, as proposed by Paulo Freire (1970) ;

- The students were highly motivated by the importance of immunology content circulating in the media due to the COVID-19 pandemic. In this context, the pandemic in Brazil had already caused more than 600,000 deaths from the infection, not counting the deaths caused by the breakdown of Brazil's social and political system. Discussions about vaccines, immunity, and infectious diseases

permeated the whole of Brazilian society at the time. Many health professionals, such as nurses, were represented in communities as the main characters fighting the Covid-19 pandemic. In this way, understanding the dynamics of teaching scientific knowledge, especially Immunology, is fundamental for the engagement and empowerment of these professionals in society and with collective health.

4.2 Part II : qualitative and interpretative analysis of markers of scientific culture and intersectionality in the writings produced by the students

Students mobilized intersectional and scientific markers together in conducting the teaching sequence

The analyses of individual responses in *Problematization I* there was a greater occurrence of words from the intersectional group in the responses (person, man, sexes, women, gender, age, social class) than words from the other groups (Figure 1A).

Qualitative analyses of the responses as a whole suggest that students did not associate suspected HIV infection with a specific gender, sexual practice, age, or social class, but according to students' responses, all social groups may be vulnerable to contracting the virus in the absence of adequate protective measures (Table 2 and 3). This point becomes clearer in the analyses of the answers to question 2 of this dimension of the teaching sequence where the problematization is it is problematized how this person could have contracted the infection (Figure 1B). The analyses of these responses showed the occurrence of the following words (Groups 1 and 2) (virus, blood, contact, transfusion, contamination, sexual, drugs, and person) that are associated with the types of student responses that justify HIV infection to the care of adequate protective measures rather than to specific groups of people in society, e.g., gender, social class, and sexuality practices (Table 2). Further analysis of student responses to the problematizations showed mobilizations of scientific knowledge (social and natural sciences) (Figure 2 A and B) with higher percentages of intersectional markers occurrences in question 1 (about gender, primarily) (Figure 3A) and natural-biological knowledge occurrences in question 2 (Figure 3B). This phenomenon in the mobilization of responses may be related to the nature of the problems posed to students in each of the questions. Question 1 required students to think about defining the gender of who was the "person" that could have the infection. However, according to the analyses of the answers, the students did not apply the definition to a gender – male or female – directly related to a higher probability of infection, opting for the definition that vulnerability to HIV infection would not be linked to a defined gender, sexual practice or class (Figure 3A), but to the vulnerability of people to the non-use of sexually transmitted infection prevention methods, as suggested by the analyses of higher percentages of biological content – related to the routes of contamination of the virus – when solving the problem of how the "person" could have come in contact with the virus (Figure 3B). The mobilization of this pattern of answers by the group of students in the class may be related to the processes of reading and accessing the material in stages I and II of the proposed teaching sequences. This set of analyses suggests that an important critical awareness of steps I and II of the teaching sequences may have occurred with an intersectional approach to the issue of HIV contamination.

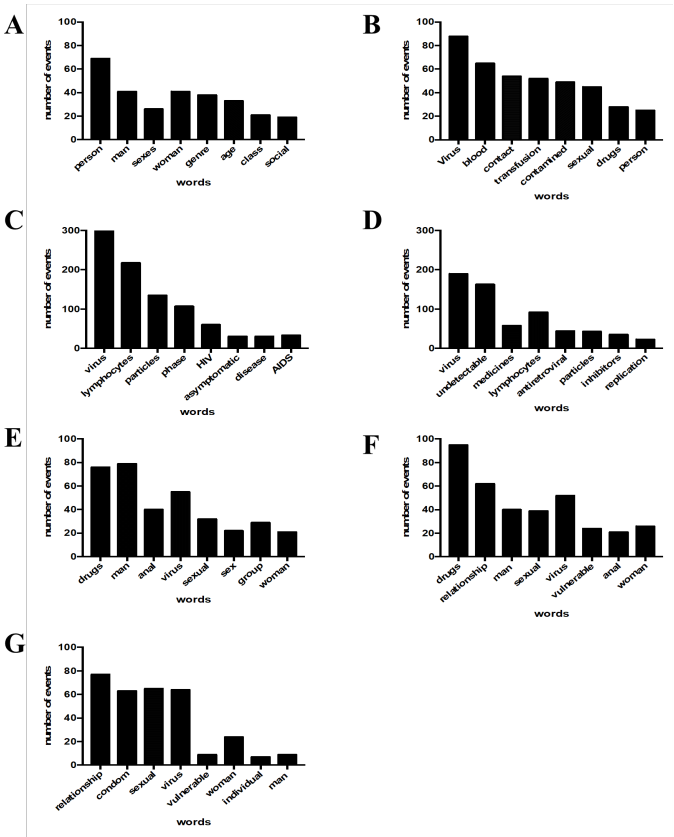


Fig. 1 : Analysis of the most prevalent linguistic occurrence in the students' answers in the three stages of the teaching sequence. In A and B is the number of events in the answers to questions 1 and 2 of step III of the teaching sequence; in C and D is the occurrence in the answers to questions 1 and 2 of step V of the teaching sequence; and E, F, and G is the occurrence in the answers to question 1, 2 and 3 of step VI of the teaching sequence.

The analyses of individual responses in *Problematization II* showed higher percentages and prevalence of mobilization and occurrence of group 2 words (Table 2) (virus, lymphocytes, particles, symptoms, detection, drugs, retrovirus, replication, disease, AIDS) (Figure 1C and 1D). The analyses of the set of responses showed that students mobilized specialized scientific knowledge of microbiology and immunology in the construction of the problem-solving answers for questions 1 and 2 of this dimension. The analyses did not detect the presence of words from group 1 and of related intersectional knowledge. The analyses of the knowledge mobilized in the students' answers showed a prevalence of scientific content from the natural sciences when compared to the contents from the social sciences (Figures 2C and D), with the biological contents being the most prevalent (Figures 3C and D). This phenomenon can be explained by the nature of the problem questions offered to the students, which required the mobilization of immunology-specific knowledge (immune responses, T cell function, and HIV infection dynamics). The set of analyses of responses in this dimension suggests

that students appropriated and mobilized scientific knowledge covered in step IV of the teaching sequence to solve the specialized scientific problems.

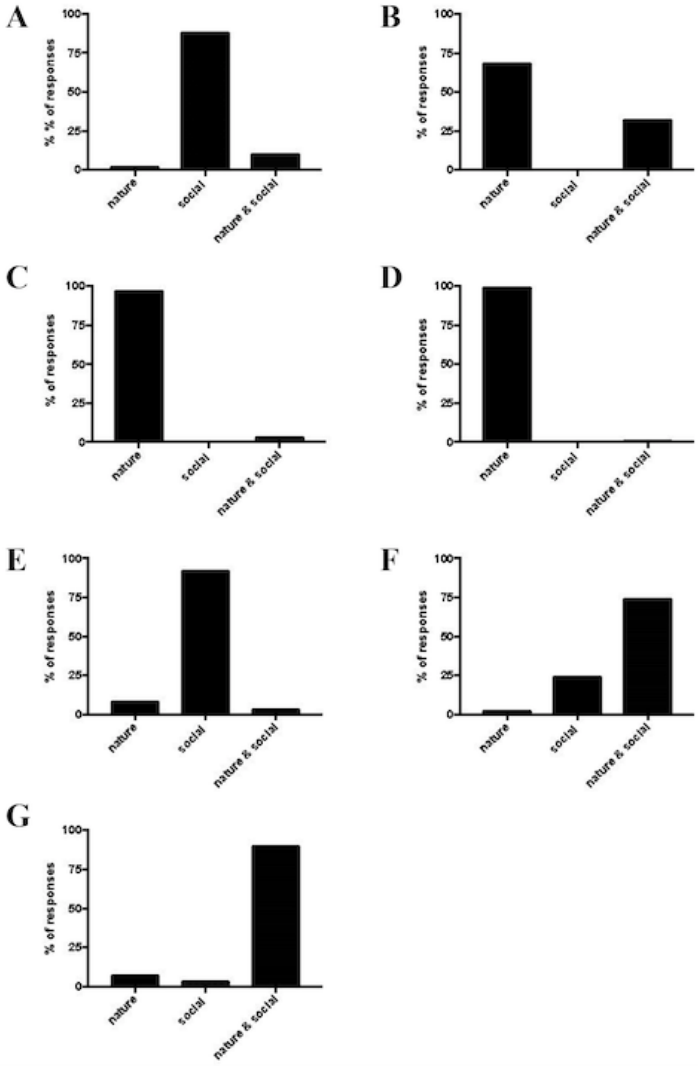


Fig. 2 : Analysis of the nature of the knowledge mobilized by students in the three stages of the teaching sequence. The students' answers were analyzed and categorized into 3 (three) types of knowledge present in the writings : nature, social, and nature/social knowledge. Subsequently, the percentage of each category of knowledge present in the answers was calculated. In A and B is the number of events in the answers to questions 1 and 2 of step III of the teaching sequence ; in C and D is the occurrence in the answers to questions 1 and 2 of step V of the teaching sequence ; and E, F, and G is the occurrence in the answers to question 1, 2 and 3 of step VI of the teaching sequence.

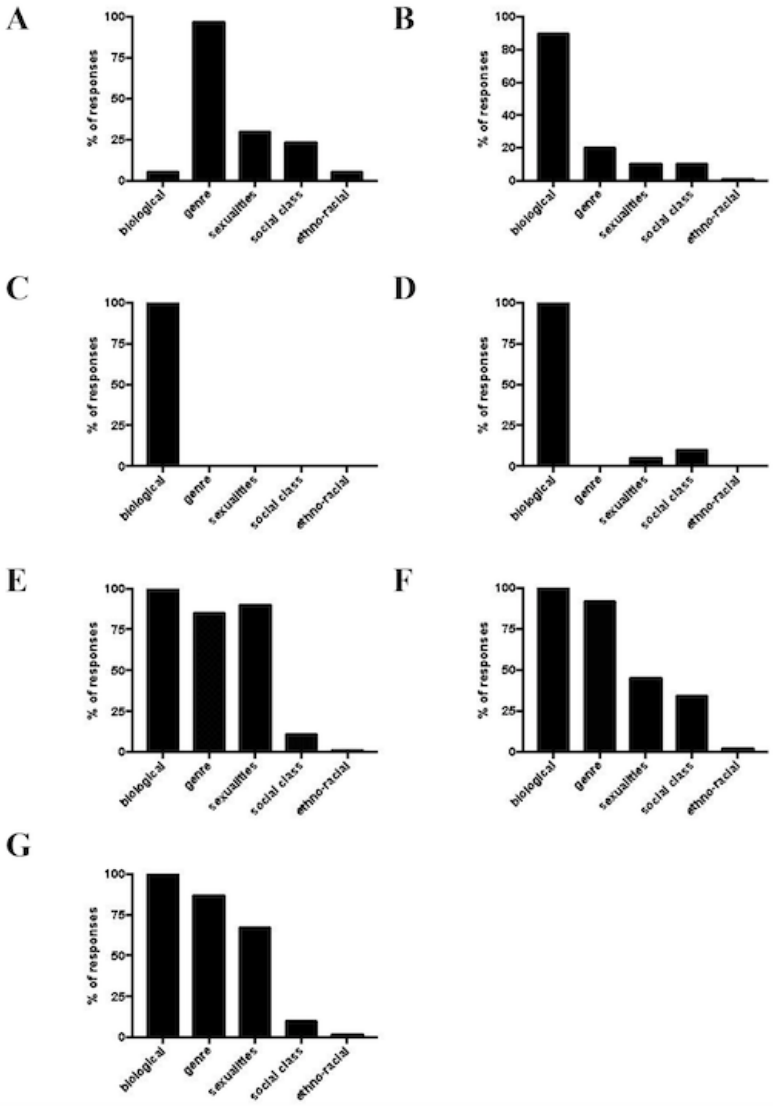


FIG. 3 : Analysis of the types of specific knowledge mobilized and presented in the answers of the students' activities in the three stages of the teaching sequence. The students' answers were analyzed and categorized into 5 (five) types of knowledge present in the writings : biological, gender, sexuality, social class, and racial-ethnic knowledge. Subsequently, the percentage of each category of knowledge present in the answers was calculated. In A and B is the number of events in the answers to questions 1 and 2 of step III of the teaching sequence ; in C and D is the occurrence in the answers to questions 1 and 2 of step V of the teaching sequence ; and E, F, and G is the occurrence in the answers to question 1, 2 and 3 of step VI of the teaching sequence.

The analysis of the responses in the dimension of *Problematization III* showed the appearance and occurrence of words from both groups 1 and 2 (virus, drugs, sexual, man, woman, condom, forms of sexual practices) (Figure 1E, 1F, and 1G). The analysis of the responses showed that students mobilized scientific concepts, about the forms of prevention and transmission of the HIV virus, to explain the vulnerabilities of groups involving genders, social class, and practices of sexualities to explain the results observed in the problem questions from the data (graph) in the article provided for this step of the activity. These findings in the responses can be correlated to the analyses of the types of knowledge mobilized by the students, which showed significant percentages of social science content and natural and social content together (Figure 2 E, F, and G). However, unlike the analyses of the responses to the activities in the social and scientific dimensions above, there are higher percentages of a plurality of biological knowledge, gender, sexuality, social classes, and the racial-ethnic issue, in a smaller percentage, in the answers presented by the students (Figure 3E, F and G) (Table 2 and 3). This phenomenon can also be explained by the nature of the problem design presented to the students. In this dimension of the teaching sequence, students were challenged with a problem that required the mobilization of social and scientific aspects in the responses. This set of analyses of the answers to the problems proposed in this dimension shows that the students performed a critical and scientific analysis of the situations with the help of the contents worked in stages I, II, and IV of the teaching sequences.

4.3 Students mobilized epistemic practices markers from scientific culture to solve the activities in the PBL sequence

The analyses showed the presence of epistemic practices markers occurrence for the answers to questions 1 : *i) considering different sources, ii) relating data with theories, iii) making inferences, iv) interpreting data, and, v) making conclusions* (Figure 4A) ; however, for question 2, there was only the appearance occurrence of the categories markers : i) making inferences, ii) interpreting data and iii) making conclusions (Figure 4B) (Table 6 and 7). This phenomenon of greater mobilization of this set of epistemic practices in solving this problem in this dimension of the teaching sequence can be explained by the nature of the proposed problem that requires an epistemic movement of data collection and interpretation – even if theoretical – to solve scientific problems (Kelly & Licona, 2018 ; Natale et al, 2020). These findings can be correlated to the findings on the nature of the knowledge mobilized by students in the responses where the “data”, interpretations, and conclusions mobilized by students in the responses to problems in this dimension are, in a substantial percentage, social in nature or in conjunction with scientific knowledge from the natural and social sciences together. This suggests that the mobilization of this set of epistemic practice markers was important in solving a social dimension problem of a sexually transmitted infection.

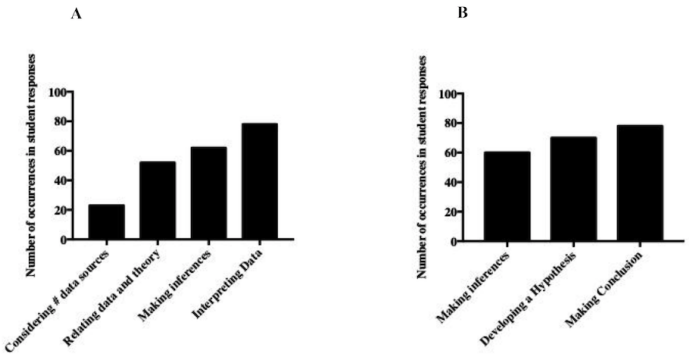


FIG. 4 : Analysis of the epistemic practices presented in the answers of the student's activities in the three stages of the teaching sequence. In A is the occurrence in the answers to question 1, in B is the occurrence in the answers to question 2 of step III of the teaching sequence

TAB. 6 : Analysis of the epistemic practices presented in the answers of the student's activities in the three stages of the teaching sequence : examples of occurrence analysis in the answers to question 1

Epistemic practices	Example
Considering # data sources	Q1 - S78 : "We cannot say who it was that contracted the virus from the doctor or janitor. As long as it is a living being it can be anyone"
Relating data and theory	Q1 - S1 : "Anyone can contract the AIDS virus, regardless of any factors. All it takes is for HIV to enter the bloodstream and become lodged in the body for infection to occur, regardless of color, creed, sexual orientation, or age" Q1 - S6 : "The Acquired Immune Deficiency Syndrome (HIV/AIDS) as the name implies, affects the immune system of the individual, and can be man or woman, because there is no gender distinction. It is also a disease that the person acquires, in the most common case, through sexual intercourse without the use of condoms"
Making inferences	Q1 - S1 : "there are numerous biological and social factors that make some people more exposed and more prone and at higher risk of contracting the virus than others" Q1 - S40 : "The possible sample person, without a doubt, could be anyone. Considering that the virus has the ability to contaminate any human organism, regardless of sex, age group, social class, or sexual option. So, everyone is a possible protagonist of this sample"
Interpreting Data	Q1 - S7 : "It can be both men and women of different ages, different social classes, different generations, the virus is not linked to a specific class, anyone is susceptible. Q1 - S16 : It can infect both men and women, of different ages, because the virus is capable of infecting any human organism"
Making Conclusion	Q1-S79 : "Both men and women, there is no difference between the sexes, nor age or social class. This virus can infect anyone" Q1 - S75 : "The person can be female or male because the HIV virus can affect both sexes, this virus is spread through sexual intercourse, sharing infected sharp objects, etc"

Tab. 7 : Analysis of the epistemic practices presented in the answers of the student's activities in the three stages of the teaching sequence : examples of occurrence analysis in the answers to question 2 of step III of the teaching sequence

Epistemic practices	Example
Making inferences	Q2 - S70 : "HIV can be contracted through sharp objects, sexual intercourse without the use of male and female condoms, blood transfusion, breast milk, vaginal fluids, transmission through semen, and others" Q2 - S68 : "The individual can be exposed to the virus through unprotected sexual intercourse with an infected individual, receiving a blood transfusion of contaminated blood, through accidents with an infected needle, sharing needles for intravenous drug administration, or even transmitted from the mother during childbirth or breastfeeding"
Developing a Hypothesis	Q2 - S82 : "There are several ways of being infected by the virus, and they are : By sex without the use of a condom ; by direct contact with the carrier's blood or any sharp or piercing object that has been used by the carrier ; by vertical contamination" Q2 - S86 : "Probably because he had sexual intercourse without the use of adequate protection, shared a needle that had already passed through other people, may have been caught through his parents, contaminated blood transfusion, breast milk"
Making Conclusion	Q2 - S79 : "Through sexual intercourse without the use of condoms, syringe use by more than one person, blood transfusion, vertical transmission, vaginal fluids, and semen" Q2 - S65 : "Through syringes/needles, sexual intercourse without a condom, among others"

The analyses showed the presence of epistemic practices markers for the responses to questions 1 : *i) relating the data and theory, ii) conceptualizing, iii) accessing the consistency of the data, iv) explaining the data, v) interpreting the data, vi) comparing the data, vii) describing the data, vii) mentioning literary inscriptions* (Figure 5A). In question 2, the analyses showed an occurrence of the epistemic practice categories markers : *i) making inferences, ii) explaining data, iii) interpreting data, and iv) comparing data* (Figure 5B) (Tables 8 and 9). The occurrence profile of the epistemic practice markers sets of the problem-solving responses in this dimension is distinct from the previous dimension of the teaching sequence, especially for problem question 1 of this dimension. The mobilization of a set of epistemic practices, in particular, those comparing the data, describing the data, and mentioning the literary inscription can be explained by the fact that students use scientific "data" provided in the problem question (the graph) to compare, explain, interpret the results using the literary inscription (the graph) (Manzoni-de-Almeida *et al.*, 2019) showed the greater mobilization of this special set of categories when students participated in investigative teaching sequences with hands-on activities using data collected from experiments and requiring the construction of literary inscriptions, explanations, interpretations, and conclusions from this movement of scientific culture. These findings can be correlated to the findings on the nature of the knowledge mobilized by students in the responses where the "data", interpretations, and conclusions mobilized by students in the responses to the problems in this dimension are predominantly biological science knowledge. This suggests that the mobilization of this set of epistemic practices was important in solving a scientific dimension problem of a sexually transmitted infection.

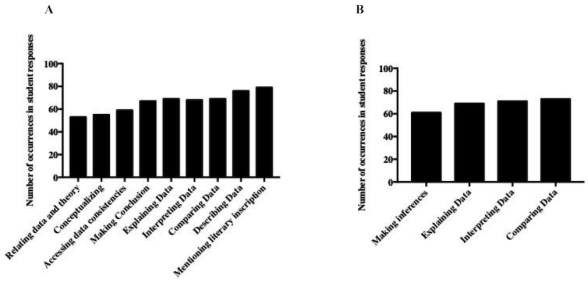


FIG. 5 : Analysis of the epistemic practices presented in the answers of the students' activities in the three stages of the teaching sequence. In A is the occurrence in the answers to question 1, in B is the occurrence in the answers to question 2 of step V of the teaching sequence.

TAB. 8 : Analysis of the epistemic practices presented in the answers of the students' activities in the three stages of the teaching sequence : examples of occurrence analysis in the answers to the question is the occurrence in the answers to question 1.

Epistemic practices	Example
Relating data and theory	Q3 - S12 : "Because the HIV virus has membrane proteins that have the ability to bind to receptors on the TCD 4 lymphocyte cell, so the viral particles are able to bind and enter the cell, but because they are retroviruses, that is, the genetic material is RNA, inside the capsid has an enzyme called Reverse Transcriptase, which has the ability to transcribe the RNA into DNA, thus incorporating into the DNA of the host cell, causing it to produce other viral particles equal, the virus multiplies and then is released from the cell" Q3 - S72 : "TCD4 lymphocytes are the cells in which HIV has tropism, the hiv virus enters the cell"
Conceptualizing	Q3 - S14 : "The HIV virus has membrane proteins that have the ability to bind to receptors on the TCD4 lymphocyte cell" Q3 - S23 : "The virus binds to a TCD4 defense cell receptor and when it sticks it loses the envelope and only the capsid enters the cell"
Accessing data consistencies	Q3 - S49 : "The more the person has viral particles the fewer TCD4+ cells he/she will have, this means that the HIV virus attacks the defense cells and destroys this group of TCD4 cells, causing the person to go through phases : the first being the acute asymptomatic phase, where the viral load proliferates in great quantity, then the chronic asymptomatic phase, characterized by the increase in years, consequently, the last phase called AIDS which is given by the loss of immunity when there was drastically a decrease and elimination of TCD4+ cells due to the greater viral replication that led to the development of the acquired immunodeficiency syndrome. Q3 - S52 : "In the middle of the first year of contamination, it is possible to notice the high viral load in the body followed by a slight increase in tcd4+ lymphocytes in the second half of the first year, there is a drastic reduction in the viral level until the end of the first year (characteristic of the acute phase), After this period, the chronic period begins, in which the lymphocytes gradually reduce while the viral load increases over the years, until it enters the AIDS phase when the lymphocytes are at drastically reduced levels and the load is higher"
Making Conclusion	Q3 - S14 : "The HIV virus has membrane proteins that have the ability to bind to receptors on the TCD4 lymphocyte cell, so the viral particles can bind to and enter the cell" Q3 - S18 : "The more viral particles you have in your body, you will have less TCD4+. Because the viral particles destroy the TCD4+. So the individual in the symptomatic phase loses immunity"

Explaining Data	Q3 - S24 : "The greater the number of viral particles, the fewer TCD4 cells you will have" Q3 - S25 : "As soon as an individual becomes infected, the virus multiplies inside the cell, wherein the acute phase the lymphocytes are low, and in the chronic phase the virus multiplies silently and consequently the lymphocytes fall more and more, then comes the symptomatic phase, which is the AIDS phase, in which there is a lot of virus circulating and few CD4 cells"
Interpreting Data	Q3 - S47 : "Because the Hiv virus has proteins in the membrane that are able to bind to receptors on the TCD4 lymphocyte cell, so the particles are able to bind to and enter the cell, via transcriptase" Q3 - S63 : "When infected with the HIV virus the defense cells are infected and destroyed. As a result, the viral load is increasing and the number of TCD4 cells is decreasing"
Comparing Data	Q3 - S-36 : "The graph expresses a high amount of viral cells, on the other hand, we also have an increase of our body's defense cells, the TCD4+ lymphocytes, in the acute phase (asymptomatic), causing the virus particles to fall in the chronic phase (asymptomatic) and at the end of the graph we notice an increase of the HIV virus that decreases our defense cells, AIDS phase (symptomatic)" Q3 - S19 : "On one side the lymphocytes and on the other side the number of viruses, the person gets infected, the viral particles increase and, in the sequence, the number of TCD4+ cells will drop. If there is no treatment, opportunistic diseases may develop"
Describing Data	Q3 - S52 : "In the middle of the first year of contamination, it is possible to notice the high viral load in the body followed by a discrete increase in tcd4+ lymphocytes in the second half of the first year, there is a drastic reduction of the viral level until the end of the first year (characteristic of the acute phase), After this period, the chronic period begins, in which the lymphocytes gradually decrease while the viral load increases over the years, until entering the AIDS phase, when the lymphocytes are at drastically reduced levels and the load is higher" Q3 - S49 : "The more the person has viral particles the less TCD4+ cells he will have, this means that the HIV virus attacks the defense cells and destroys this group of TCD4 cells, causing the person to go through phases"
Mentioning literary inscription	Q3 - S76 : "In the graph, we observe that the more viral particles, the lower the number of TCD4 lymphocytes, this is because in the acute asymptomatic phase, there are many viruses, but there are also in the same proportion TCD4" Q3 - S61 : "In the graph, you can see that at the beginning of the infection, there is a high level of lymphocytes and virus, and due to the normal immune response, the amount of virus drops dramatically, but as time goes by, the virus curve starts to rise, causing the amount of lymphocytes to drop. This occurs because while there is an infection the body can fight back, but after a while the viruses adapt and manage to infiltrate good cells that no longer do their job as they should, and at this point immunodeficiency occurs, where the body's system can no longer defend itself from the HIV virus, which continues to reproduce and weaken more and more the immune system of the infected person"

TAB. 9 : Analysis of the epistemic practices presented in the answers of the students' activities in the three stages of the teaching sequence : examples of occurrence analysis in the answers to question 2 of step V of the teaching sequence

Epistemic practices	Example
Making inferences	Q4 - S75 : "With the right use of the drugs, the amount of viral particles will decrease and the TCD4+ lymphocytes will return to the normal amount in the blood since the viral particles that destroy the lymphocytes will almost completely disappear from the blood" Q4 - S68 : "The right use of antiretroviral drugs helps to inhibit virus replication, the viral load in genital secretions drops to the point of undetectability, and the amount of lymphocytes stabilizes in correspondence with the decline in viral load in the peripheral blood. The residual risk cannot be scientifically excluded, but it is very low"

Explaining Data	Q4 - S63 : "With the use of the viral retros the defense cells are in stability, consequently the viral load is falling until with this decline in the amount of viruses the viral load becomes undetectable" Q4 - S60 : "There is an increase in cd4 cells controlling the multiplication of the virus cells where the viral load becomes undetectable because the medication does the cell control replicating the cd4 and killing the virus keeping the cd4 higher in level than the HIV virus where the immune system is in almost normal activities"
Interpreting Data	Q4 - S66 : "In the case of the patient who uses the proper and correct medications, in the asymptomatic chronic phase, the TCD4 will remain in high proportion and the number of HIV virus will steadily decrease until it becomes undetectable" Q4 - S54 : "The TCD4 lymphocytes would have a considerable increase, being able to control the virus where the peak of the disease would not exist and it would have an imperceptible viral load, that is, there is virus inside the cell, but it is such a small percentage that it cannot be detected"
Comparing Data	Q4 - S77 : "In the case of the patient who uses the proper medications correctly, in the asymptomatic chronic phase, the TCD4s will remain at a high proportion and the number of HIV virus will decrease steadily until it becomes undetectable" Q4 - S81 : "The number of viral particles would drop and may become undetectable on testing, and the amount of TCD4+ lymphocytes would increase"

Figures 6A and B are the analyses the presence of epistemic practices markers in questions 1 and 2 that showed a higher prevalence of the categories : *i) making conclusions, ii) making inferences, iii) explaining data, iv) interpreting data, v) comparing data, vi) describing data, and vii) mentioning literary inscriptions.* Figure 6C expresses the analysis of the occurrences in the answers to question 3 that showed a different profile of the categories of epistemic practices : *i) relating data and theories, ii) conceptualizing, iii) accessing data consistency, iv) explaining data, v) interpreting data, vi) comparing data, vii) describing data, and viii) mentioning literary inscriptions* (Tables 10, 11, and 12). The profile of the occurrence of epistemic practices markers in the responses to the questions in this dimension differed from the other dimensions with a "mixture" of the mobilization of the categories of epistemic practices found in the social and scientific dimensions predominating. These findings can be correlated to the analysis of the knowledge mobilized, which is a "mixture" of knowledge from the social and natural sciences with knowledge about gender, sexuality, social class, ethnic-racial, and biological knowledge. This phenomenon can be explained by the fact that the proposed problem question requires the mobilization of social and scientific knowledge in the interpretation, explanation, and conclusion based on the proposed graph about the vulnerabilities and sexual practices of the subjects who participated in the research conducted by the students in the activity. Other work we have conducted suggests that the mobilization of epistemic practices may be important in judging, analyzing, and making decisions in the face of knowledge in students in activities in immunology and biochemistry classes (Manzoni-de-Almeida *et al.*, 2016 ; Mello, 2019 ; Natale *et al.*, 2020). This suggests that the mobilization of this set of epistemic practice markers was important in solving the problem of an intersectional dimension of a socially stigmatized sexually transmitted infection such as HIV.

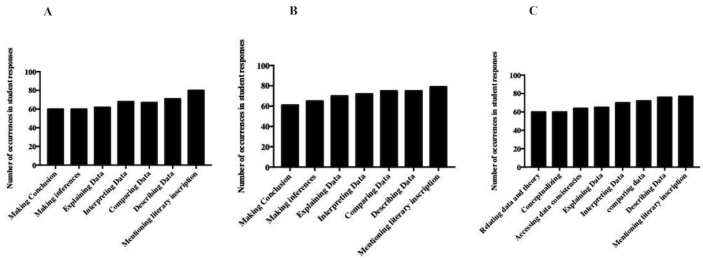


FIG. 6 : Analysis of epistemic practices mobilized and presented in the answers of the students' activities in the three stages of the teaching sequence. In A is the occurrence in the answers to question 1, in B is the occurrence in the answers to question 2, and in C is the occurrence in the answers to question 3 of step VI of the teaching sequence

TAB. 10 : Analysis of epistemic practices mobilized and present in the answers of the students' activities in the three stages of the teaching sequence : examples of occurrence analysis in the answers to question 1.

Epistemic practices	Example
Making Conclusion	Q5 - S34 : "Are men having anal sex under the use of Drugs" Q5 - S22 : "Men, by the use of drugs in vaginal and anal intercourse"
Making inferences	Q5 - S26 : "74.5% Men who have anal intercourse under the effect of drugs. Usually because of drug abuse and alcohol abuse they may not pay attention to safety through condoms and may also share sharp objects where there is a great possibility through infected blood" Q5 - S54 : "74 % of men ; anal sex under the influence of drugs, the potentiator for infection is drugs"
Explaining Data	Q5 - S56 : "According to figure 1, the probability of contracting the HIV virus is higher in men, due to all the risk factors that they are exposed to, having as examples, the higher percentage of casual relations, lower adherence to condom use and higher incidence of sexual intercourse under the influence of drugs" Q5 - S82 : "Everyone is susceptible to contracting the disease, but according to the survey, men are 74.5% more vulnerable to contracting the virus in anal intercourse under the effect of drugs"
Interpreting Data	Q5 - S27 : "Men, under the influence of drugs because they lose their sense of responsibility and reasoning for the risks" Q5 - S15 : "Men who have anal sex under the use of drugs. They have no sense of the necessary care that should be taken, such as the use of condoms"
Comparing Data	Q5 – S25 : "The groups that are most vulnerable in contracting HIV virus are : vaginal intercourse under the effect of drugs and the group of anal intercourse under the effect of drugs. Both groups are subject to contracting the virus because they are on drugs and end up having sex without condoms" Q5 – S18 : "Men in anal intercourse under the influence of drugs. Also depending on the situation between men and women. But according to the chart men are more prone"
Describing Data	Q5 - S47 : "In this case men with 74.5% because of drug abuse and not being careful about condom use and often having homosexual relations" Q5 - S51 : "According to figure 1, the probability of contracting the HIV virus is higher in males, due to all the risk factors that they are exposed to, having as examples, the higher percentage of casual relations, lower adherence to condom use and higher incidence of sexual intercourse under the influence of drugs"
Mentioning literary inscription	Q5 - S56 : "According to Figure 1, the probability of contracting the HIV virus is higher in males, due to all the risk factors they are exposed to. Q5 - S40 : "As shown in figure 1, the most vulnerable group are men, they contract more the virus, higher percentage of casual relationships, lower adherence to condom use, and higher incidence in sexual performance under the influence of drugs"

Tab. 11 : Analysis of epistemic practices mobilized and present in the answers of the students' activities in the three stages of the teaching sequence : examples of occurrence analysis in the answers to question 2.

Epistemic practices	Example
Making Conclusion	Q6 - S47 : "Men, in drug abuse" Q6 - S71 : "Men and women, with any kind of sexual intercourse under the influence of drugs"
Making inferences	Q6 - S32 : "All situations have a certain level of vulnerability, but men who are under the effects of drugs increase the risks even more and become more exposed to the virus" Q6 - S82 : "Everyone is susceptible to contracting the disease, but the survey evidences a high percentage of sexual intercourse with drug use, being vaginal, oral, and anal"
Explaining Data	Q6 - S20 : "The least vulnerable group is the female, according to the graph they use condoms since the first sexual reaction and have a steady partner" Q6 - S37 : "In all situations, there is a different risk, but vulnerability is greater when drugs are used, because at this moment the person under the effect loses his/her senses and notions, acting irresponsibly when having sex"
Interpreting Data	Q6 - S7 : "With the use of drugs. Because they bring about psychological changes that give rise to a "loss of control", with unconscious acts and actions" Q6 - S9 : "People on drugs are more susceptible to contracting HIV. Because when under the effect of some narcotic drug people become more inconsequential, making them think that it is not necessary at that moment"
Comparing Data	Q6 - S43 : "Both groups are vulnerable to contracting the virus, however, there is an aggravating factor in this table that is related to the use of condoms, in which women use more in the 1st relationship than men) and in relation to the effect of drugs during the act of coitus. these cases men are more susceptible because there is no protection and still adds with the use of drugs, which alters levels of discernment and acts" Q6 - S72 : "In all cases where there is sexual intercourse without the use of condom can occur the situation of vulnerability regarding the obtaining the HIV virus. However, making a comparison, according to the groups, vulnerability is greater in cases where the individual has sexual intercourse under the effect of drugs because the individual under the effect of drugs is less susceptible to making correct decisions, such as, for example, the use of condoms, these being fundamental for the prevention of HIV"
Describing Data	Q6 - S74 : "In all cases where there is sexual intercourse without the use of a condom, there may occur a situation of vulnerability as to obtaining the HIV virus. However, making a comparison, according to the groups, vulnerability is greater in cases where the individual has sexual intercourse under the influence of drugs because the individual under the influence of narcotics is less susceptible to making correct decisions, such as, for example, the use of condoms, these being fundamental for the prevention of HIV. Q6 - S43 : "Both groups are vulnerable to contracting the virus, but there is an aggravating factor in this table that is related to the use of condoms, in which women use more in the first intercourse than men) and in relation to the effect of drugs during coitus these cases men are more susceptible because there is no protection and still adds the use of drugs, which alters levels of judgment and acts"
Mentioning literary inscription	Q6 - S26 : "As shown in the graph, the situations that leave people more vulnerable to contracting the virus are : anal intercourse under the effect of drugs with a higher percentage for men, because when a person is hallucinating under the effect of drugs, he does not think about preventing himself by using condoms or in many cases the person acquired the virus by sharing needles when injecting drugs" Q6 - S60 : "Analyzing the figure, the most likely to contract the virus is the man who has anal intercourse under the use of drugs, because he is not fully aware of his actions"
Epistemic practices	Example
Making Conclusion	Q6 - S47 : "Men, in drug abuse" Q6 - S71 : "Men and women, with any kind of sexual intercourse under the influence of drugs"

Making inferences	Q6 - S32 : "All situations have a certain level of vulnerability, but men who are under the effects of drugs increase the risks even more and become more exposed to the virus" Q6 - S82 : "Everyone is susceptible to contracting the disease, but the survey evidences high percentage of sexual intercourse with drug use, being vaginal, oral, and anal"
Explaining Data	Q6 - S20 : "The least vulnerable group is the female, according to the graph they use condoms since the first sexual reaction and have a steady partner" Q6 - S37 : "In all situations, there is a different risk, but vulnerability is greater when drugs are used, because at this moment the person under the effect loses his/her senses and notions, acting irresponsibly when having sex"
Interpreting Data	Q6 - S7 : "With the use of drugs. Because they bring about psychological changes that give rise to a "loss of control", with unconscious acts and actions" Q6 - S9 : "People on drugs are more susceptible to contracting HIV. Because when under the effect of some narcotic drug people become more inconsequential, making them think that it is not necessary at that moment"
Comparing Data	Q6 - S43 : "Both groups are vulnerable to contracting the virus, however, there is an aggravating factor in this table that is related to the use of condoms, in which women use more in the 1st relationship than men) and in relation to the effect of drugs during the act of coitus. these cases men are more susceptible because there is no protection and still adds with the use of drugs, which alters levels of discernment and acts" Q6 - S72 : "In all cases where there is sexual intercourse without the use of condom can occur the situation of vulnerability regarding the obtaining the HIV virus. However, making a comparison, according to the groups, vulnerability is greater in cases where the individual has sexual intercourse under the effect of drugs because the individual under the effect of drugs is less susceptible to making correct decisions, such as, for example, the use of condoms, these being fundamental for the prevention of HIV"
Describing Data	Q6 - S74 : "In all cases where there is sexual intercourse without the use of a condom, there may occur a situation of vulnerability as to obtaining the HIV virus. However, making a comparison, according to the groups, vulnerability is greater in cases where the individual has sexual intercourse under the influence of drugs because the individual under the influence of narcotics is less susceptible to making correct decisions, such as, for example, the use of condoms, these being fundamental for the prevention of HIV. Q6 - S43 : "Both groups are vulnerable to contracting the virus, but there is an aggravating factor in this table that is related to the use of condoms, in which women use more in the first intercourse than men) and in relation to the effect of drugs during coitus these cases men are more susceptible because there is no protection and still adds these use of drugs, which alters levels of judgment and acts"
Mentioning literary inscription	Q6 - S26 : "As shown in the graph, the situations that leave people more vulnerable to contracting the virus are : anal intercourse under the effect of drugs with a higher percentage for men, because when a person is hallucinating under the effect of drugs, he does not think about preventing himself by using condoms or in many cases the person acquired the virus by sharing needles when injecting drugs" Q6 - S60 : "Analyzing the figure, the most likely to contract the virus is the man who has anal intercourse under the use of drugs, because he is not fully aware of his actions"

Tab. 12 : Analysis of epistemic practices mobilized and present in the answers of the students' activities in the three stages of the teaching sequence : examples of occurrence analysis in the answers to the answers to question 3 of step VI of the teaching sequence.

Epistemic practices	Example
Relating data and theory	Q7 - S4 : "People who use condoms, because it is the most known, accessible, and effective method to prevent HIV infection" Q7 - S33 : "Condom use at first intercourse, condom use will always be the best option for sexual intercourse, because the condom is the most effective method to prevent against sexually transmitted infections such as HIV/AIDS, some types of hepatitis, and syphilis, for example. In addition, it prevents unplanned pregnancy"
Conceptualizing	Q7 - S8 : "The use of condoms protects against the virus and when used from the first relationship the risk of infection is lower preventing the same contract the virus in the first relationship and pass the virus on to other partners in successive relationships after that" Q7 - S29 : "By using condoms, people are less vulnerable to contracting the virus"
Accessing data consistencies	Q7 - S38 : "The people in the research, shown in the graph, are : 35.86% of men and 64.14% of women using a condom in the first vaginal sexual intercourse, because the virus is not transmitted through the air but through contact. Therefore, using a condom puts them at a clear advantage before the possibility of non-contamination. Social behavior is the focus of contamination" Q7 - S64 : "In view of the figure, the individual is less vulnerable when a condom is used in the first sexual intercourse, that is, unlike others, by using a condom there is a considerable decrease in the spread of this virus, which is especially correct. The transmission of the virus is understood when we understand the behavior of the society where the HIV virus can spread, which is the function of epidemiology, an indispensable thing"
Explaining Data	Q7 - S71 : "With the use of a condom on the 1st sexual intercourse, because by performing the prevention methods the contamination rates are reduced" Q7 - S55 : "Women with the use of condom, this is because the condom prevents the transmission of the virus when having a sexual intercourse"
Interpreting Data	Q7 - S78 : "Women are less vulnerable because they take more precautions in the use of condoms in the first sexual intercourse" Q7 - S82 : "Those who use condoms for the first vaginal intercourse, because even with steady partners there are several ways to contract the disease in a non-sexual way, so of the behaviors surveyed, the one that shows more care is the use of condoms"
Comparing Data	Q7 - S17 : "Those who use condoms in the first vaginal intercourse, because even with steady partners there are several ways to contract the disease in a non-sexual way, so of the behaviors surveyed the one that shows more care is with the use of condoms" Q7 - S62 : "The least vulnerable people are men who use condoms at first vaginal intercourse, according to the data"
Describing Data	Q7 - S20 : "The least vulnerable group is the female group, because in face of the information, it is the group that protects itself the most during sexual intercourse and has a fixed partner compared to the male group" Q7 - S13 : "The research shows that the group that is least likely to contract the virus is the group of women who use condoms during their first vaginal intercourse (64.14%), so by having this responsibility, the chances of contracting the virus are very low, as well as any other STD"
Mentioning literary inscription	Q7 - S75 : "According to figure 1, the situation in which individuals are at a lower risk of contamination is in the case where there is the use of condoms in the first vaginal intercourse, because, in this situation, individuals used a barrier against the HIV virus, this being the greatest prevention against the disease" Q7 - S38 : "The people in the survey, shown in the graph, are : 35.86% of men and 64.14% of women with condom use at first vaginal intercourse, because the virus is not transmitted by air but by contact. Therefore, using a condom puts them at a clear advantage before the possibility of non-contamination. Social behavior is the focus of contamination"

5 Discussion and conclusion

Our main objective was to contribute to the construction of a teaching sequence proposal that gives health students the opportunity to relate scientific content, on the HIV infection, to issues of intersectionality for immunology online classes according to Vision III proposed by Valladares (2021). This engagement is in line with Paulo Freire's pedagogical proposal, which takes as its starting point the dialog and relationship between teacher and student as central to the teaching-learning process in which stories, social realities, and the experiences of students and teachers are involved in building a space of experiences so that students can see purpose in their studies. The construction and application of the teaching sequence with the theme of HIV/AIDS and intersectionality promoted a learning experience with the theme of science and intersectionality when : i) provided students with contact and engagement with this content, which is reflected in their acceptance of the teaching proposal, adherence to the teaching sequence. The PBL teaching strategy for HIV infection was challenging in two main aspects. The first was related to the construction and development of material for the approach to the theme that contemplated intersectional and biological science aspects of HIV infection ; ii) and mobilization of a variety of epistemic practices – important markers of scientific culture. Studies have shown that the mobilization of epistemic practices by students is linked to their engagement with the topics covered in class (Cunningham & Kelly, 2017 ; Antink-Meyer and Arias, 2022 ; Agustian, 2023). The second aspect was linked to developing a scientific culture environment in online immunology classes so that students could establish important social interactions in the learning process and scientific culture literacy. The analysis of the students' writings showed the mobilization of a variety of epistemic practices that mark scientific literacy when carrying out activities in science classes. This mobilization of a variability of epistemic practical categories of scientific culture is in conjunction with the mobilization of terms and categories related to issues of intersectionality (genders, sexualities, social class) in their writings when carrying out the activities proposed in the teaching sequence. This set of results suggests that the creation of this type of teaching sequences can mobilize important evidence of vision III of scientific literacy.

Our results showed that the dialogue between the knowledge of social and political fields is articulated with the scientific knowledge of natural sciences specific to HIV immunology. The proposed and applied teaching sequence presented three distinct dimensions that, when articulated, provided health students with an important intersectional path and experience to address the issue of HIV and its infection. In the first dimension – the social dimension – the social and political aspects that affect the HIV pandemic, through contact with artistic works and journalistic literature are important areas in the processes of awareness and engagement in scientific culture for science classes (Hallowell, & Holland, 1998 ; Miele, 2010 ; Polman *et al.*, 2014), which suggests an important impact on the resolution of the problematization that addresses possible prejudices (of gender and sexualities) in the view of health professionals in the care of vulnerable population related to sexually transmitted infections. In the scientific dimension, the sequence in problematization II provided the experience of the articulation of biological concepts with a routine situation in the practice

of health activity through interpretation and conclusions from laboratory results of the course of HIV infection. The last dimension of the teaching sequence – the intersectional path – allowed the experience of joining the other two previous dimensions in which students could articulate social and scientific data through the analysis of an intersectional aspect's situation in HIV infection research. This set of data suggests evidence of a process of scientific literacy on the topic of HIV/AIDS, articulating a technical-rational approach to the topic linked to the prevention of personal contamination, based on the principle that technical knowledge that leads to behavioral changes in prevention, with the social and political issues surrounding the disease (Woold & Pillary, 2016)

In conclusion, we believe that the teaching sequence proposed and studied can contribute to the discussions of science education in science classes, especially immunology, for undergraduate nurse courses, especially in online and remote modalities. In addition, we believe in the contribution of the teaching sequence and our study to reinforce science teaching with intersectional approaches in delicate themes that involve discriminated populations, in processes of inequality and exclusion. In addition, we believe in the contribution of the teaching sequence and our study to reinforce science teaching with intersectional approaches in delicate themes that involve discriminated populations, in processes of inequality and exclusion.

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