



## The Explicit Teaching Of Argumentation In The Approach Of A Socio-Scientific Issue About The Use Of Face Masks

### O ensino explícito da argumentação na abordagem de uma questão sociocientífica sobre o uso de máscaras faciais

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**Abstract:** In this article, we present, as an educational product, a teaching sequence based on a socio-scientific issue about the use of face masks in the context of the Covid-19 pandemic, aimed at teaching science to II elementary level of compulsory education. The teaching sequence was formulated based on the following methodology – articulation of the conceptual, procedural, and attitudinal contents in the approach of socio-scientific issues (SSI) (NUNES-NETO; CONRADO, 2018) and the explicit teaching of argumentation (JIMÉNEZ-ALEIXANDRE, 2010). We highlight how the explicit teaching of argumentation can be promoted depending on the characteristics of the activities and the role of the teacher. We aim to provide subsidies to the science teacher on teaching actions involving the explicit teaching of argumentation that can be transferred to the teaching of other curriculum topics and other educational approaches. In addition, we argue that the approach of SSI, specifically because of its dialogic and controversial nature, promotes an effective formative space for the development of students' argumentative skills.

**Keywords:** Socio-scientific issues. Argumentation. Covid-19. Masks. Science teaching.

**Resumo:** Neste artigo, apresentamos, como produto educacional, uma sequência didática baseada em uma questão sociocientífica sobre o uso de máscaras faciais no contexto da pandemia de Covid-19, voltada para o ensino de ciências para o nível fundamental II da

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educação básica. A sequência didática foi formulada com base na seguinte metodologia – articulação dos conteúdos conceituais, procedimentais e atitudinais previstos na abordagem de Questões Sociocientíficas (QSC) (NUNES-NETO; CONRADO, 2018) e o ensino explícito da argumentação (JIMÉNEZ-ALEIXANDRE, 2010). Destacamos como o ensino explícito da argumentação pode ser promovido, dependendo das características das atividades e do papel do professor. Nosso objetivo é fornecer subsídios ao professor de ciências sobre ações pedagógicas que envolvam o ensino explícito da argumentação e que possam ser transferidas para o ensino de outros tópicos curriculares e outras abordagens educacionais. Ademais, defendemos que a abordagem de QSC, especificamente por seu caráter dialógico e controverso, fomenta um espaço formativo profícuo para o desenvolvimento das habilidades argumentativas dos estudantes.

**Palavras-chave:** Questões sociocientíficas. Argumentação. Covid-19. Máscaras. Ensino de ciências.

## 1 Introduction

First reported in humans in December 2019, in the city of Wuhan, China, the outbreak of Covid-19 (short for Coronavirus disease 19), when crossing the geographic barriers of its country of origin and presenting alarming levels of contamination in global scale, was elevated to the category of 'pandemic' on 11 March 2020 by the World Health Organization (WHO, 2020b).

In the Brazilian context, in addition to the impacts on public health, the Covid-19 pandemic revealed structural problems in our social fabric, which contributed to its effects having different intensities in each context and social groups. As Matta (2021) and his collaborators explain, the virus, by itself, does not make a pandemic, as it performs and intensifies based on socio-sanitary, economic, cultural and political inequalities, in addition to collective or individual adherence to containment measures.

At the time of its emergence, as it was an unknown disease, there were no specific treatments to combat Covid-19. As a result, and given the transmissibility characteristics of SARS-CoV-2 - which end up in inhalation or in contact with droplets that infected people emit through coughing, speaking or sneezing - health authorities started to recommend non-pharmacological measures to reduce the spread of the disease, such as social distancing, hand hygiene and the use of face masks (BRASIL, 2022; WHO, 2020a, 2020b).

As scientific evidence has become more robust, masks have been elected as one of the main pillars of the designed package of Covid-19 prevention and control measures (WHO, 2020b). In this protocol, and in other studies (LIANG et al., 2020), the recommendation for the use of face masks is no longer restricted to health professionals and started to contemplate the general public, so that they reduce the possibility of contagion itself, as well as infecting others. This is because the physical barrier made possible by masks, when used correctly, limits the emission of pathogenic particles into the air, considerably reducing the possibility of infection of susceptible people.

Like other countries, Brazil, with the advent of Federal Law No. 14.019 of July 2, 2020, established the mandatory use of masks as Personal Protective Equipment (PPE) in spaces where there is the movement of people (public or private); on public roads; and in collective transport (public or private) (BRASIL, 2020). However, with the increase in vaccination coverage in the country, in the last quarter of 2021, the state of Rio de Janeiro and the Federal

District released the use of masks in open places, being noticeable that the former made optional the use of this PPE indoors as well (GOIÁS, 2021).

In view of the current epidemiological scenario, in which there is wide vaccination coverage, the low rate of new cases and the number of hospitalizations due to the severe form of the disease, the number of Brazilian states that have adopted more flexible measures regarding the use of masks, especially indoors, has grown (GOIÁS, 2022). However, there is a decline in some of them, as is the case of Belo Horizonte/MG, which, due to the increase in confirmed cases at the end of the first half of 2022, chose to resume the mandatory mask in closed places, especially in schools. (BELO HORIZONTE, 2022).

In a pandemic context, such as the one currently experienced, in which there is a profusion of information marked sometimes by conflicting and divergent opinions, sometimes by consensus and congruence, education, especially scientific, is relegated to the task of collaborating in the process of critical analysis of the information provided, in order to assist students in their decision-making process. To this end, we chose the Socio-Scientific Issues (SSI), from the perspective of Conrado and Nunes-Neto (2018), linked to argumentation (JIMÉNEZ-ALEIXANDRE, 2010), as a pedagogical strategy leading to the problematization of controversies arising from the current context.

The adoption of SSI for the discussion of controversial topics is relevant, as it allows students to construct the learning of scientific content in a contextualized way, the development of argumentative skills and critical thinking, since it requires the establishment of an investigative process, in which the student, mediated by the teaching proposal and the teacher, is responsible for analyzing, discussing and evaluating different information that support the discussions about the controversy under analysis (RAMOS; MENDONÇA, 2021). Depending on the nature of the SSI, their resolution may be driven by different perspectives and guided by justifications, for example, related to the well-being of society and human empathy, in economic aspects and supported by scientific knowledge (NUNES-NETO; CONRADO, 2021).

However, Dionor and collaborators (2020), when carrying out a research on teaching proposals based on SSI, highlighted that they have not always provided the opportunity for students to develop a conscious and justified positioning. In this sense, we reinforce the need to develop qualified arguments in the discussion of controversial topics. Argumentation is a social and linguistic process in which individuals, participants in the discussion, seek a consensus and adjust their interpretations, providing decision-making in a logical, reflective and evidence-justified way (DE CHIARO; LEITÃO, 2005; JIMÉNEZ -ALEIXANDRE, 2010)

Given the above considerations, the goal of this paper is to present, as an educational product, a Teaching Sequence (TS) guided by a SSI regarding the release of the use of masks in closed places with a view to promoting the scientific argumentation of students. We understand TS in the light of Zabala (1998), as being a set of activities systematically organized and articulated among themselves, obeying a logical sequence for the construction of knowledge about a specific theme. We believe that the proposal can contribute to science teachers interested in the development of critical thinking in science students and in actions to develop scientific argumentation in the classroom.

## 2 Pedagogical approach of SSI

A variety of socio-environmental problems are experienced in the modern world, such as those associated with diseases (dengue, coronavirus, and monkeypox), climate change, environmental disasters, social insecurity, racial segregation, economic and gender inequality,

among others. And given this scenario, it is important to consider the possible contributions of science education in the social contexts of a global or local nature in which it is inserted.

In this way, over the last decade, in order to prepare students to engage in speeches and decision-making related to relevant socio-environmental issues associated with global, regional or local contexts, SSI have become a prominent theme within the educational literature. According to Conrado and Nunes-Neto (2018, p. 87), SSI can be considered:

[...] problems or situations that are usually complex and controversial, which can be used in a contextualizing scientific education, by allowing an approach to inter or multidisciplinary content, with scientific knowledge being fundamental for understanding and finding solutions to these problems. However, in addition to scientific knowledge, in particular, knowledge of history and philosophy (especially ethics) are relevant and generally mobilized in addressing these problems.

Also according to the aforementioned authors, the SSI can be transposed to teaching, through teaching methods that enable students to build knowledge about certain contents, in a contextualized way, as well as to critically understand the nature of scientific knowledge and to develop skills related to critical thinking.

Hodson (2014) points out that teaching proposals based on SSI are an important step towards the formation of more participatory, autonomous, responsible and active citizens; however, for these goals to be achieved, it is necessary to break up with a science teaching that is neutral and decontextualized. In this way, it is recommended that the proposals take into account the interrelationships between the cultural and social knowledge of the context in which the students are inserted. Thus, the knowledge internalized by the students becomes significant, preparing them so that they can think and act critically in the face of real problems posed by the contemporary world.

However, if there is not a critical and in-depth reflection on the conception of school/academic content, it is possible that this more integral formation of the subjects as individuals effectively engaged in social participation gets jeopardised. Zabala (1998) conceives a typology of content to guide educational practice to achieve final objectives in the teaching and learning processes. The author emphasizes that, normally, they refer to content as merely concepts, theories or principles, which amplifies the cognitive dimension of the learning content to the detriment of others in educational processes. For the integral formation of the subject, as mentioned, the educational and pedagogical intentions must focus beyond the learning of concepts and theories, being able to cover everything that develops motor, affective, interpersonal relationship and social insertion skills. Therefore, for Zabala (1998), all this should also be considered as learning content. In this perspective, according to Conrado and Nunes-Neto (2018), the contents to be learned through the SSI are not restricted only to the conceptual understanding of the contents, but also include procedural and attitudinal learning. Zabala (1998) and Coll et al. (1992) distinguish and define, methodologically, based on cognitive and behavioral learning processes, three types of content dimensions: Conceptual, Procedural and Attitudinal (CPA). Thus, according to Conrado and Nunes-Neto (2018), for an integral formation of the individual, it is necessary that the learning objectives are aligned with the CPA.

The conceptual dimension considers three important categories: facts, concepts and principles. The procedural dimension of the contents can be understood through three categories: procedures, techniques and methods. The attitudinal dimension is directly related to

an axiological perspective and can be understood from three categories: values, norms and attitudes (CONRADO; NUNES-NETO, 2018). It is important to provide opportunities for learning in these three dimensions, as Martínez Pérez and Carvalho (2012) and Conrado and Nunes-Neto (2018) indicate that in this way the teaching processes involving SSI can be planned in order to explicitly consider activities that contribute to learning that goes beyond the memorization of concepts, but also favors the development of argumentative skills; understanding of the nature of scientific knowledge; the development of activism in favor of social, economic, educational, political and environmental changes, as well as the increase of moral sensitivity.

Conrado and Nunes-Neto (2018) proposed a structure consisting of three basic elements for the approach of SSI in the context of STSE education, with a view to training socially engaged subjects: the case or story, the guiding questions and the learning objectives.

The case or story is elaborated in order to introduce the SSI to the students, sensitizing them to a decision-making process in the face of conflict situations. The cases are accompanied by guiding questions, that is, problems related to the stories, capable of promoting argumentative interactions that allow students to mobilize scientific content, approach the nature of the problem and possible solutions. Finally, the learning objectives need to be directly related to the content in its conceptual (C), procedural (P) and attitudinal (A) dimensions (CONRADO; NUNES-NETO, 2018).

Within this perspective, teaching proposals based on SSI need to take into account the conflicts and controversies present in the cases and in the guiding questions as opportunities for inciting debates and critical reflections, with a view to the development of argumentative skills. Thus, students will be able to position themselves and make decisions based on conceptual, procedural and attitudinal learning internalized during the process, enabling them to engage in relevant social and environmental causes.

### **3 Argumentation in science teaching and the explicit teaching of argumentation**

For the occurrence of argumentative situations in the educational context, it becomes relevant to propose activities and problem situations that favor the exposure of controversial points of view (BAKER, 2009; MENDONÇA; IBRAIM, 2019). This is consistent with the pedagogical approach of SSI, since these are issues with a certain degree of openness, of a conflicting nature and that can admit different positions. However, as Dechiaro and Leitão (2005) point out, the teacher assumes a fundamental role in promoting the debatability of curricular themes, since it is not an intrinsic property of the theme, but a characteristic of the discourse, which emerges in the very situation in which this is produced. Therefore, the implementation of argumentation in the classroom depends on the possibility of the participants to create, in the course of their verbal interactions, a representation of the curricular themes that can be discussed (DECHIARO; LEITÃO, 2005). This implies the need for the teacher to approach the SSI as a controversial topic, to raise and legitimize the divergence of opinions, to present the problem as possible to be viewed from different perspectives (for example, in the scientific and ethical and moral domains) and to value the argumentation as a way to resolve differences of opinion in the search for consensus or plausible solution (DUSCHL; ELLENBOGEN, 2009; DUSCHL; OSBORNE, 2002; RAMOS; MENDONÇA, 2021).

This is because argumentation can be understood as a process through which people present reasons to support the thought (argument) (KUHN, 1991). Thus, arguing goes beyond the presentation of opinion, it consists of the minimum set of point of view and justification.

For Jimenez-Aleixandre (2010), the theses which we intend to defend must be justified, that is, supported by evidence. In the scientific context, Jiménez-Aleixandre (2010) highlights the element of evidence. They can be understood as information, facts, observations, experiments etc. that are used to evaluate a claim. Evidence is an important criterion in science because it can be used to indicate that a position is adequate or not, or even that a conclusion should be accepted or abandoned (JIMÉNEZ-ALEIXANDRE, 2010). Also, according to the author, justification is the element that relates the conclusion to the evidence. Thus, its role is to show that, taking the evidence as a starting point, it is legitimate or appropriate to accept or refute the conclusion (HENDERSON *et al.*, 2017; MENDONÇA; IBRAIM, 2019).

Argumentation is an intellectual activity of a social nature that can be accessed through discourse (VAN EEMEREN *et al.*, 2014), and from the externalization of reasoning and its self-regulation (JIMÉNEZ-ALEIXANDRE, 2010). With argumentation the teacher may have evidence of the students' way of thinking and access information considered relevant to the domain of knowledge in question (IBRAIM; JUSTI, 2018). In this sense, the argument is related to the epistemic sphere of knowledge, due to the focus on understanding the logic of the ideas defended (or refuted) by the students (JIMÉNEZ-ALEIXANDRE, 2010).

However, as Duschl and Osborne (2002) have already highlighted, there is traditionally focus on the rhetoric of conclusions in science teaching and learning processes as opposed to the raising of evidence-based arguments, that is, the emphasis on transmitting a corpus of established knowledge, as opposed to examining alternative theories, and a look at the status of given knowledge over time in science. On the other hand, considering the context of the current pandemic discussed in the SSI presented in this paper, the insertion of argumentation in the school context becomes even more relevant, because the constant development of argumentative skills contributes to students' critical thinking (JIMÉNEZ-ALEIXANDRE, 2010).

In current times, the objective of critical thinking has been highlighted by teachers and researchers due to the amount of information that students are faced with in everyday life with frequent access to social media. As the information disseminated on social media does not always pass through expert filters, students must be trained to assess the credibility of statements and to distinguish the specifics of that information with a scientific character (ALLCHIN, 2021). Due to our epistemic dependence on science experts, students need to be suspicious of information sources and question who talks about science (who is a relevant authority on certain topics or who is a fraud) (HOETECHE; ALLCHIN, 2020). Such capabilities are related to critical thinking, which can be related to structuring the argument and evaluating the consistency of a conclusion (GARCIA-MILA *et al.*, 2013). Critical thinking aims at the development of an independent opinion, due to reflection on reality and the critical analysis of discourses that justify inequalities, aiming at the social emancipation of the subject (DUSCHL; ELLENBOGEN, 2009; DUSCHL; OSBORNE, 2002; JIMENÉZ-ALEIXANDRE, 2010).

To promote argumentative skills and the development of critical thinking, we bet on the proposal of explicit teaching of argumentation. In this proposal, it is expected that the instructional material and the teacher highlight for students the central elements of an argument and the objectives of argumentation, in addition to the experience of teaching strategies that can promote argumentation (such as investigative activities and SSI). The explicit experience of argumentation by students can contribute to the reflection on the scientific practice of argumentation (a meta-knowledge about argumentation) (DUSCHL; ELLENBOGEN, 2009; DUSCHL; OSBORNE, 2002; HENDERSON *et al.*, 2017; MENDONÇA; IBRAIM, 2019), while the implicit approach, despite how much it requires the subject to argue for discussion

and resolution of problem situations, does not have as learning objective the reflection on the elements of the argument and the objectives of the argumentation in science and in the daily context. A reflection on the objectives of argumentation can make it possible for students to distinguish between fact and opinion; conclusions based on scientific evidence versus pseudo-evidence; and a notion of the weight of arguments to guide the processes of production, communication, evaluation and legitimation of knowledge in the scientific community.

The role-playing proposal, mock trial and public hearing (as discussed in the TS discussed in this article) are aligned with the explicit teaching of argumentation, because the teacher needs to negotiate with the groups and judges the criteria of what is considered a good argumentation (HENDERSON *et al.*, 2017; JUSTI; MENDONÇA, 2016; MENDONÇA; IBRAIM, 2019). The teacher must select materials (or guide their selection) to support a qualified argumentation by students, in addition to organizing the steps that will guide the argumentative activity. For example, in a simulated jury situation, students are divided into groups (by drawing lots, for example) so that each one represents a character or position related to the controversy raised by the teacher. They can assume different roles, such as defense, prosecution and judges (unlike conventional debate, in which students defend or refute propositions according to personal positions). In the explicit proposal of the argument, the teacher must establish norms for the social debate so that the students have space to expose the arguments (that support the position of their character), counter-argument (ideas that challenge the point of view of the proponent of an argument, making it less acceptable in the eyes of the opponent) and granting the right of reply (the speaker's immediate or remote reaction to the counter-arguments raised) (DE CHIARO; LEITÃO, 2005). The panel of judges does not participate in the presentation of arguments and rebuttals. It is up to this panel to create a rubric to judge the validity of the arguments presented according to the criteria established with the class (JUSTI; MENDONÇA, 2016).

We emphasize that the process of preparation for the jury, in which students prepare written arguments to be used at the time of role simulation, must be mediated by the teacher, not in the sense of building qualified arguments for the students, but of remembering and distinguish the criteria for the elaboration of quality arguments and clarify doubts about the consulted materials. The same is valid for the group of jurors, the teacher must mediate the process in order to make clear and consensual the criteria for evaluating the arguments in order to support the jury's verdict. For example, in the case of historical arguments, establish as a criterion for the validity of the evidence the fact that they are those that occurred in the historical period in question analyzed, instead of judging the facts with the view of the present (JUSTI; MENDONÇA, 2016; MCSHARRY; JONES, 2000).

Making available a set of central information to all groups is essential for the teacher to ensure that it is possible to propose arguments from both sides of the jury (or debate). This is because the objective is to evaluate the learning of the concepts as well as the argumentation, so it is not expected that a group will be favored in advance, since the result of the discussion will be evaluated by qualified argumentation. In the case of open-ended problems, such as SSI, this can be more easily agreed with students depending on the nature of the topic. However, even in discussions in which the problems are better defined or where we already know the current result (as in cases in the history of science) (JUSTI; MENDONÇA, 2016; MCSHARRY; JONES, 2000; MENDONÇA; IBRAIM, 2019), it is also necessary to clarify the rules to evaluate the argument in the sense that there is no a priori winner. Thus, the way in which the theme will be introduced by the teacher (the debatability of the theme generated by a problem question, for example) is an important element to encourage argumentation.



#### 4 Educational product

The TS that we present, consisting of six classes of 50 minutes each, is aimed at teaching science in the final years of II elementary school, given the proximity of the curriculum content of this level of education to the themes discussed in the proposal and its articulation with the fifth specific competence for the area of Natural Sciences at this level of education, defined by the Base Nacional Comum Curricular (BNCC), namely:

5. To build arguments based on reliable data, evidence and information and negotiate and to defend ideas and points of view that promote socio-environmental awareness and respect for oneself and for others, welcoming and valuing the diversity of individuals and social groups, without prejudices of any nature. (BRASIL, 2017, p. 324).

We structured the TS based on the pedagogical work with SSI proposed by Conrado and Nunes-Neto (2018), which is organized into three main elements: the approach of SSI in the form of cases or stories (Table 1); ii) the use of guiding questions; and iii) learning objectives. In the case elaborated (Table 1) we present dialogues and characters close to the sociocultural context of the students, as this enables affective and emotional involvement with the controversy, encouraging a more expressive participation in the discussions and in the resolution of the problem.

In this sense, it addresses a controversy about the use of masks in closed places during the Covid-19 pandemic, specifically on the premises of school institutions. This theme was chosen because it directly approaches the reality experienced by students in the pandemic context, especially in relation to the frequent questions about how long the masks would be used.

Table 01 - Case presented in the TS

<p>After all, is it time we stop wearing masks indoors?</p>
<p>With the return of presencial classes, the population of the municipality of Ouro Preto, in Minas Gerais, was divided over the decision of a private school - Colégio Inconfidentes - to make the use of masks optional on school grounds, that is, it would be up to each student to decide whether to use it or not. The decision had repercussions in the city, and as it is a case that involves public health, the councilors called a public hearing to, together with society, define whether or not to use masks in schools in the municipality.</p> <p>On the first day of the hearing, the councilors heard the arguments of the representatives of Colégio Inconfidentes, who said that with the increase in the number of vaccinated people in the municipality and the drop in the hospitalization rates of people contaminated with Covid-19, the school does not see need to demand that students remain wearing a mask at school, once these students, being over 5 years old, are already vaccinated.</p> <p>A group of parents, teachers and students from other schools, who were also present on the day, argued that:</p> <p>- “Even if the students at your school are vaccinated, it is important to remember that they have contact with people who have not been vaccinated yet, or, even having been vaccinated, due to advanced age, immunity is reduced, causing these people to suffer from the action of the virus, if they become contaminated”.</p> <p>The speech of this group continued pointing out other precautions to be taken from the flexibility of the masks, saying:</p> <p>- “The pandemic situation may be under control at the moment, but the use of masks in closed places, mainly, is necessary to avoid the circulation of the virus, because the more contaminated we have, the greater the chances of the emergence of new variants that escape vaccine and start a new wave of disease spread.”</p>





Based on this dialogue, Júlia, the Science teacher at Escola Vila do Saber, asks her students what their position would be regarding the continued use of masks in closed places. To this end, she encourages them to participate in the next session of the public hearing, presenting arguments that justify their decision-making on the question: should we continue to wear masks indoors or can we stop using them?

Source: Prepared by the authors (2022).

Notice that the case presented in Table 1 ends with a problem question that demands a position from students. We propose that this positioning be carried out in the format of a simulated public hearing at the end of this TS (in activity 3). We adopted the term 'simulated public hearing' because the situation under analysis simulates the processing of a matter of public interest, which must be dealt with in the City Council with the participation of representatives of civil society, and not in a jury that simulates the action of a judicial court. The dynamics of the activity consists of dividing the students into three groups: one that will argue against and another in favor of making the use of masks in closed places more flexible, and a third that will play the role of the councilors who will deliberate on the petition based on the arguments presented by the debaters. Ideally, in this first class, students should be informed about the holding of this hearing.

If possible, the case should be projected in the classroom or printed out for students so that reading and initial study can be done collectively. After reading, promote a discussion with the students, so that they share their impressions about the question posed. Ensure that all students who wish to speak out have the right to speak and that their views are respected. Next, ask the class to individually write their position regarding the release of masks in closed places.

The second guiding element of the work with SSI, for Conrado and Nunes-Neto (2018), is the discussion of guiding questions. These fulfill the function of highlighting and mobilizing the aspects inherent to the case, in order to provide elements for a deeper understanding and to achieve the defined learning objectives.

For this purpose, we list scientific argumentation as a pedagogical strategy to promote public hearing, since argumentation enables interaction among the subjects when they expose their positions based on scientific evidence, seeking to persuade an audience (JIMÉNEZ-ALEIXANDRE, 2010). These positions will tend to be evaluated by the other subjects, participants in the discussion, in the light of the scientific evidence available, becoming able to refute or agree with the exposed position.

In Table 2 we present the activities that make up the TS and their respective CPA learning objectives, as recommended by Conrado and Nunes-Neto (2018).

Table 2 - Systematization of the activities that make up the TS

Activity 1 - Practicing argumentation	Duration: 2 lessons of 50 minutes
Conceptual objective: to understand the constituent elements of an argument.	
Procedural objective: to develop a scientific argument to justify the position regarding a scientific controversy.	
Activity 2 - Virus and vaccine	Duration: 2 lessons of 50 minutes
Conceptual objectives: to understand the characteristics of viruses, especially SARS-CoV-2, in relation to their forms of transmission and prophylaxis; understand the mechanism of action of vaccines and their relevance to the control of infectious diseases.	
Procedural objectives: analyze graphs in order to obtain information on epidemiological data.	



Attitudinal objectives: to reflect, based on the knowledge of the forms of transmission of the viruses, on the attitudes and adequate measures for the prevention of diseases associated with them; reflect on the importance of individual actions to maintain the health of the population.	
Activity 3 - Mock public hearing	Duration: 2 lessons of 50 minutes
Procedural objective: survey, evaluation and analysis of scientific texts and scientific dissemination; to elaborate scientific arguments that justify the position; to argue, based on scientific evidence, about the controversies under analysis.	
Attitudinal objective: to develop skills related to teamwork and respect for differing opinions; develop skills to communicate their points of view and to take a stand on controversial issues.	

Source: Prepared by the author (2022).

The first moment of this TS that precedes the beginning of the activities elaborated is the reading of the case presented in Table 1.

In the first activity, called "Practicing argumentation", the focus is on the explicit teaching of argumentation. It begins with the reading of the text "Being or not being alive?" (Figure 1). In it, there are arguments proposed by the scientific community that defend the idea that viruses can be considered living beings, as well as other arguments that validate the idea that viruses should not be classified as living beings.

We suggest that during the reading, the teacher explains the terms (featured in the text) that may be new to the students. Terms such as: (i) acelular: organisms that do not have a cell; (ii) parasites: organisms that depend on other organisms to survive; (iii) host cells: those that are viral hosts due to the compatibility of both membrane proteins, both the viral membrane and the cell membrane; (iv) virions: inactive viral format, that is, when the virus is outside its host cell.

After that, students will be invited to build an argument that justifies their answer to the question: "Should viruses be classified as living beings or not?". Different answers are expected, since there is no single or definitive answer to the proposed question, especially because it is a controversy that still exists in the scientific community. However, we expect that students, when positioning themselves on the issue, present a valid argument, that is, one based on scientific evidence to justify the decision taken.

For this, it will be necessary to explain to the students that the argument to be elaborated must contain three elements, namely, the conclusion, the evidence and the justification. In the school context, we rely on Jiménez-Aleixandre (2010) to briefly define these elements that make up a scientific argument, namely: (i) conclusion: final position, the one you want to prove or refute. Generally, the argumentative process begins with the analysis of a hypothesis that will or will not be confirmed; (ii) evidence: element that the arguer uses to refute or affirm the hypothesis (or the claim) being evaluated. It can be an observation, an experiment or a scientific fact and (iii) justification: reflection that the arguer makes to relate the evidence to the conclusion.

The act of justifying the argument consists of showing that, based on the available evidence, the conclusion presented is the most coherent (JIMÉNEZ-ALEIXANDRE, 2010). During the correction of the activity, it is essential that the teacher checks if the students elaborated the argument observing the three basic elements, as the activity aims to work on argumentative skills as a way of preparing them for the public hearing.




Figure 1 – Being or not being alive?

## Being or not being alive?

### The role of the Viruses in current Biology

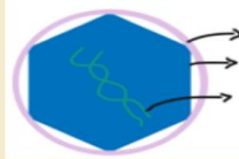
Viruses are present in all ecosystems and are the most abundant organisms on planet earth, accounting for a total of more than  $10^{31}$  organisms. Despite this, they were discovered only in 1892, and since then these beings have been puzzling many scientists.

At first, they were believed to be a type of poison, as they were found in tobacco leaves. Later, a debate would arise that continues to this day: **would viruses be living beings?**



But to answer that, we first have to understand **what viruses are**.

Viruses are acellular beings (not formed by cells) made of nucleic acids (DNA or RNA) covered by a protein coat called a capsid and, in some cases, a lipid envelope.




Viruses are obligate intracellular parasites, as they are dependent on a host cell for their multiplication. Its life cycle can be divided into two phases:

**Extracellular phase:** the virus is inactive and outside the cell. at that moment he called her **VIRION**.


**Intracellular phase:** the viral genome can be inactive or actively expressed (producing molecules necessary for its multiplication). When replication is active, it leads to the production of new virions, which will leave the cell to infect other cells.

**Due to their design and function, viruses are considered organisms on the edge of life!**




#### NOT ALIVE

- organisms must be made up of cells, and viruses do not have cells.
- viruses do not have the ability to capture and store free energy and do not have autonomy from metabolic activities.
- viruses do not self-replicate. They require host cell metabolism.
- viruses do not evolve. they are evolved by host cells.



#### ALIVE

- The term **VIROCELL** was suggested by a scientist, which would be a cell at the time of infection, where the entire cellular metabolism is altered due to the presence of the viral genome, causing this host cell to transform into another completely different organism.
- In the virocell period, the only active genome is that of the virus.
- This concept causes viruses to become cell-like organisms, due to the virocell stage of their life cycle.
- With the concept of virocell, m viruses also have a metabolism and their evolution occurs at this same stage.



Source: Adapted from Aschidamini, Pereira e Mourmann (2019).

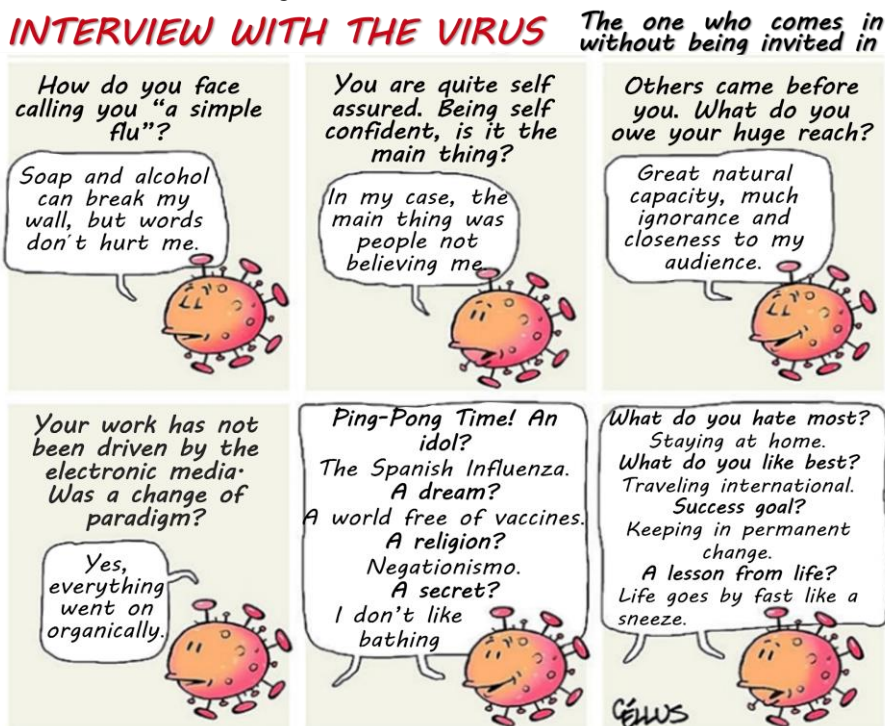
The Activity 2 “Virus and Vaccine” is divided into two parts. In the first, part A of this activity, we present a cartoon (Figure 2), in the form of an interview, discussing specific aspects about the SARS-CoV-2 virus, the etiological agent of Covid-19. From the reading of the cartoon, the following questions are asked: (i) in the sixth scene of the cartoon, the virus mentions that its worldwide reach is due, among other factors, to its proximity to the public. Thinking about the ways of transmission of SARS-CoV-2, what are the possible justifications for this specific factor of viral success? and (ii) in the ping-pong part, in the fifth scene, the virus responds that its dream would be a world without vaccines. Propose an explanation for this virus response.

In the first question, we hope that the justifications presented by the students address the direct nature of the contagion of the disease, being able to discuss the forms of transmission of Covid-19, especially those that result from contact with infected people (ex.: the handshake, followed by touching the eyes, nose or mouth) or respiratory droplets expelled when a person who is infected with the virus speaks, coughs, sneezes etc., highlighting the importance of the mask.

In the second question, we aim for students to indicate vaccines as the most effective method of immunization against a given disease. Therefore, they must be able to explain the mechanism of action of vaccines, which, from the inoculation of an inactive virus or a fragment of a virus, stimulates the immune system to produce specific antibodies to neutralize the infectious agent in question. In parallel with these antibodies, memory cells are also produced, which store information about the respective pathogen and the antibody produced; this process makes the body's immune response faster in future contacts with the pathogen. We suggest the teacher's mediation in solving alternative B of this activity, in order to encourage students to hypothesize what is in vaccines that develop an immune response in our body. As support material for this discussion, we indicate the video “Why vaccines protect?”, produced by Butantan (POR..., 2020).



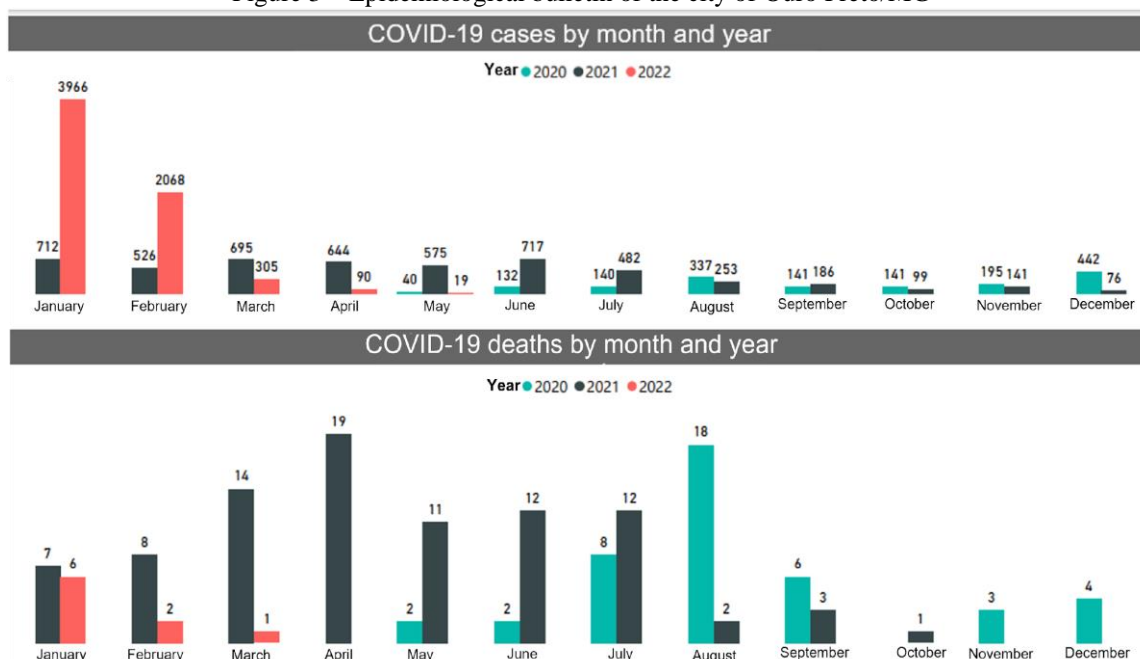
Figure 2 – Interview with the Virus



Source: Oliveira and Gomes (2020). Purely illustrative representation and fantasy colors.

In part B of this activity, we added a graph (Figure 3) relating the number of Covid-19 cases and the number of deaths in the years 2020 to 2022. For the purpose of exemplifying how the activity can be developed, the graph presented corresponds to the data from the city in which the authors' home university is located. Therefore, we believe that these data can be extracted, and the graph adapted to the reality to the student who will pass through the TS.

Figure 3 – Epidemiological bulletin of the city of Ouro Preto/MG



Source: Ouro Preto (2022).

Regarding the graph, we ask the following questions: (i) Note, from the graph, that there was an increase in the number of Covid-19 cases in January 2022. To what would you attribute this increase? and (ii) Knowing that vaccination in Ouro Preto/MG started on January 19, 2021 and analyzing the data presented in the graph, is it possible to establish any kind of relationship between the death rates and new cases of Covid-19 with vaccination in the municipality? If yes, how? If not, why?

There is no single or definitive answer to the first question. In this sense, we conjecture that students can point out different reasons, such as: the fact that January is the period after the end-of-the-year parties and thus people and, consequently, the virus circulate more; (ii) the existence of the movement for the release of masks in the country; and (iii) proliferation of the Omicron variant in Brazil, which conferred greater transmission capacity to SARS-CoV-2. The possibility of different points of view opens space for argumentation, however, we emphasize the need for the teacher to direct the discussions to the scientific sphere.

In the second question, we hope that the students understand that, even with the advance in the vaccination rate, the numbers of new cases can grow substantially, since the vaccine, by itself, does not prevent the transmission of the virus, being necessary the use of other prophylactic methods, such as masks. However, as a direct action of the vaccine, we can see the considerable reduction in the number of deaths in the municipality, since the vaccine's function is to prevent Covid-19 from evolving into serious cases and, consequently, the death of those infected and overcrowding of the health service.

Prior to activity 3, called "simulated public hearing", we provide students with scientific articles, newspaper and electronic magazine reports so that they can extract evidence in order to justify their arguments. For that moment, we suggest the bibliographic materials presented in Table 3. This is so because they were carefully thought out in order to provide plausible information for the different groups to argue.

Table 3 - Support material for the simulated public hearing

Machado (2021)	Study proves the effectiveness of wearing a mask and social distancing in combating the pandemic
Alecrim (2022)	Wearing a mask is no longer mandatory in all Brazilian states
Santos Filho and Vieira (2022)	Covid-19: easing the use of masks in open areas - update
Souza and Farias (2020)	Covid-19: On the (in)effectiveness of using masks: a brief review
Nishioka (2020)	Does wearing a mask decrease oxygen levels and increase carbon dioxide levels in the blood?
Biernath (2022)	What happened in countries that ended restrictions against covid
Magalhães (2022)	Minas does not record deaths from COVID-19 for the second day in a row

Source: Prepared by the authors (2022).

At the beginning of this activity, we propose that the initial case of the TS presented in Table 1 be resumed, as well as informative notes related to the immediate context of the students, for example, related to the state and/or the city where the TS will be developed, which discuss the exemption from the use of masks in closed places. This moment, prior to the simulated public hearing, is important to situate students in the face of controversy. The teacher can ask questions such as: (i) What does Science say about the use of masks, especially in closed places? (ii) Are there indicators that must be observed to allow the use of masks? If yes, what

are they? (iii) Why in some closed places, such as health establishments, public transport and schools should the use of masks continue and in other closed spaces their use is no longer mandatory?

These questions can place students in the face of the controversy and direct the reading of the material available to create their arguments (against or in favor). We suggest that only those that address scientific knowledge and contain the three main elements (evidence, justification and conclusion) are considered valid arguments for the simulated public hearing.

From these discussions, students will be guided on the structure and dynamics of the simulated public hearing that they will hold, being clarified that this will be composed of three groups of participants, who will deliberate on the following question: "Should we continue to wear masks indoors or not?". The participants and their respective attributions are: (i) councilors: coordinate the holding of the simulated public hearing and write the final opinion based on the arguments presented by the debaters; (ii) favorable part: formulates and offers arguments in favor of the continued use of masks in closed places; and (iii) opposing party: formulates and makes arguments against the continued use of masks in closed places. We suggest that the role of each student be defined by drawing lots. We believe that this can contribute to the development of argumentative skills due to the fact that students have to mobilize arguments to defend theses that may not be defended in a personal way. Such action can contribute to a deeper and more careful reading of the references indicated by the teacher and even to changes in point of view due to the detailed analysis raised by the task.

The teacher must organize the public hearing in order to previously explain to the students the moments and the time available for each one of them in order to negotiate the social norms for the debate, which we consider as the attitudinal sphere of school contents. That is, the time available for the initial exposition of arguments by each party, the moments of reply and rejoinder, the importance of listening to and respecting the ideas of others, and of the arguments being directed to the ideas and not as an attack or confrontation with the people. The teacher must point out to the students that all groups will have the same work demand, since they will have to read all the texts available. However, the councilors, responsible for the verdict of the public hearing, must present it in a class after the event, because they must show the rubric of analysis of the arguments and the synthesis of the quality of the arguments of the groups in order to define the result. To favor the work of councilors and the evaluation of the task by the teacher, it is suggested that the arguments of all parties that make up the hearing be delivered in writing. The teacher must point out to the students that the outcome of the hearing depends on the quality of the argument, even if this represents a divergent result from the conduct of the school or city at the time.

As forms of evaluation, we suggest the teacher to evaluate the participation and engagement of students in all activities, evaluate the written part of all activities and even the written arguments developed by students (in order to understand if all sources were consulted and how students appropriated the elements of the argument), as well as evaluating the oral part of the students in the public debate, including observing the respect for the agreed norms and the group work.

## 5 Final remarks

In this article, we present a teaching sequence aimed at teaching science for II elementary school and discuss it according to the theoretical references of SSI (CONRADO; NUNES-NETO, 2018) and argumentation (JIMÉNEZ-ALEIXANDRE, 2010) and we highlight

teaching actions for the development of activities, aiming at the objectives of conceptual, procedural and attitudinal learning and the explicit teaching of argumentation. Thus, in this article, we seek to provide subsidies for science teachers interested in promoting argumentative skills.

The TS presented here stands out in relation to other teaching proposals based on SSI and based on Conrado and Nunes-Neto (2018) due to the focus on the explicit teaching of argumentation. The approach of SSI, in science education, demands that students develop decision making, seeking to base their arguments on scientific evidence, given that the debates and discussions that permeate the SSI are constituted from issues of controversial nature and social impact. This implies that students must be judicious when analyzing scientific data, with a view to encouraging critical reflection, the construction of reasoned arguments, and collaborative dialogue.

We have gathered here the main information for the science teacher interested in promoting argumentation in the school context in activities such as debates and role simulations, based on this educational proposal and on other works that we have developed in the initial training of teachers on argumentation (see OLIVEIRA; MENDONÇA, 2019; MENDONÇA; IBRAIM, 2019): promoting the debatability of school topics; explanation of the main elements of the argument in the context of the activities; presentation of texts and other resources for the elaboration of qualified arguments by the students; and explanation of the criteria for analysis of arguments via consensus with the students.

By the time the reader has contact with this article, it may be that the issue of the use of masks is already well resolved due to the virus not escaping to existing vaccines and the expansion of vaccine coverage (at the time of writing, we were surprised by the excellent news regarding the approval, by Anvisa, of vaccination for babies from 6 months of age on). However, mutations of the virus can happen, in addition, in the next Brazilian winter there may be increases in cases of flu and Covid-19, which may make it necessary to use masks as a mandatory prophylaxis measure. In this sense, the discussion on the use of masks can be raised in different ways by the teacher, either for scientific understanding of what happened in the Covid-19 pandemic or as a practice to be adopted in other situations with greater circulation of viruses.

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