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ARTICLE

Epistemic and Political Confrontations Around the Public Policies to Fight COVID-19 Pandemic

What can Science Education learn from this episode?

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Abstract
Our purpose in this article is to discuss the roles for HPSS in Science Education considering the crisis of COVID-19, as well as to think what Science Education could look like beyond the pandemic. Considering the context of a pandemic as a starting point, we defend in this article the thesis that contours of public controversy involving COVID-19 bring elements that allow us to argue that Science Education needs to embrace perspectives that highlight politics as co-constitutive of science, and not in a subsidiary role to it. To defend this thesis, we begin with a theoretical framework based on arguments of science studies and from exemplary cases from history of science. Then, we analyze some of the public controversies surrounding COVID-19, in its most central aspects, trying to interpret how intertwining between science and politics took place. Brazilian case is analyzed in more details. Finally, based on educational scholarship and considering the previous discussions, we propose some implications for Science Education research and practices, both concerning the role of HPSS in its teaching and discussing critically boundaries of this research field.

Keywords COVID-19 · Science education · History and philosophy of science · Science studies · Public controversies

1 Introduction

Early in 2020, perhaps the biggest health and economic crisis of modern times materialized. What apparently started as a local epidemic in the Chinese city of Wuhan quickly became an unimaginable global pandemic of major proportions and profound health and economic

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consequences. Since the Chinese authorities announced the first death on January 11, those infected by the SARS-CoV-2 virus have surpassed 44 million, and the dead are more than 1.1 million to the present date (October 28, 2020), with the pandemic affecting more than 180 countries. At the moment, the most important action to control the spread of the virus is so-called social distancing, in which people are recommended—or, in some locations, forced—to stay at home to avoid contagion from other individuals; after all, the new coronavirus is characterized as highly contagious (Wang et al., 2020). This recommendation sits alongside other recommendations from the scientific[1] community, such as the use of masks in public, sanitization of environments and surfaces using alcohol-based solutions, and constant handwashing with soap and water or with the alcohol-based hand sanitizers themselves, among others. Still, we are witnessing real task forces at a global level, acting both in the dissemination of these actions to fight the coronavirus, as well as in the production of inputs to be distributed to the population. In Brazil, universities have engaged in the production of alcohol hand sanitizers, for example, to be distributed in hospitals and needy communities, as the increase in demand has also increased the sale price of these items.

Actions to control the spread of the virus, recommended by the scientific community—represented by several infectologists around the world and the World Health Organization (WHO)—have as direct consequence reducing (or pausing) economic activity, with the temporary closure of stores, markets, and restaurants, decreased demand for consumer goods and in people's mobility, which in itself also impacts economic activity. This last aspect, related to economic activity, promotes the case of the COVID-19 pandemic as a challenging arrangement for the Science Education community. The movement of the scientific community to recommend social distancing (and quarantine for a large part of the population) was followed by the position of some leaders around the world who were against this recommendation. They capitulated to pressure from large business people for activities to be normalized and social isolation rules to be relaxed (Fernandes, 2020). As examples of this position contrary to experts' recommendations, we can mention the case of the UK, in which its Prime Minister Boris Johnson initially indicated only mitigation measures that would not remove a good part of the population from the streets. He ended up having second thoughts, facing the projections of a massive number of deaths. In Italy, Prime Minister Giuseppe Conte declared that the media was inflating the severity of the virus; in an even more serious case, the mayor of Milan promoted the "Milan doesn't stop" campaign, encouraging people to continue their lives normally. Shortly thereafter, Italy became the great epicenter of the crisis on the European continent, generating horrifying headlines in the world press, with countless deaths and a sample of all the chaos the virus could cause. The mayor of Milan has publicly apologized for the reckless action (Piano, 2020). The case of Brazil, which we will also explore here, is quite emblematic on the world stage of the pandemic[2]. These and other cases will be examined further in the following sections.

The point we want to address here is that the actions of several governments around the world, showing great denial about the scientific recommendations, point to a type of public controversy that forces us to emphasize some aspects (notably, political) of these

[1] As we will explain in Section 2, whenever we use the term "scientific" in this text, except the instances in which the context speaks on the contrary, we are considering that epistemic practices are never apolitical, that is, despite this term, we are always considering political-scientific networks.

[2] Being one of the three most affected countries, standing at the center of the controversy around the use of cloroquine/hydroxychloroquine for COVID-19 treatment and with a polemic leader, Brazil (country of the three authors) seems to be an exemplary case to see more closer the interplay between political and scientific issues.

controversies. These aspects have been more present in recent perspectives of the Science Education literature (see some in Bencze et al., 2020). This is not a scientific controversy along the lines that generally work in the field of history of science and teaching, for instance. In examples in the literature, Braga et al. (2012) explored the debate between Biot and Ampère related to different interpretations for Ørsted's experiment. Niaz (2009) also explored diverse historical controversies in the formation of chemistry teachers seeking to address aspects of nature of science and, thus, contribute to a better understanding of chemical science. Another field that has been dealing with controversies has been that of socio-scientific issues (SSI), which has been exploring, in addition to scientific controversies and their social, cultural, and political contexts in the STSE Education field, also the moral consequences of socio-scientific decisions and the development of students to deal with these decisions (Zeidler et al., 2005). In this sense, there seems to be two major tendencies or curriculum emphasis when it comes to controversies: one of a more reductionist and rationalist view of scientific practices and another with a more sociological view that tries to grasp complex relationships between science and society.

Without highlighting the political and social implications of these controversies in a central way, the current COVID-19 crisis exposes the inadequacies of treating this case as a socio-scientific controversy (whether historical or contemporary). We emphasize here that, although many of these proposals for the analysis of controversies involving science entail these political aspects, they are not always relevant to the other aspects of these controversies. In this work, we intend to compare arguments that give strength to the thesis that the complexity of topics such as the public controversy involving COVID-19 poses, as a community of Science Education, the challenge of deepening and continuing to develop the perspectives in our field that are already emphasizing the entanglements between science and politics[3].

Here it is worth pointing out that when we refer to political factors in science, we demand the interpretation that advocates the co-construction between nature and society, between science and politics (Harding, 2015; Jasanoff, 2004, 2015; Latour, 2016). According to the arguments that we will defend ahead, it is not possible to maintain that science can be placed on a more important plane in relation to the other elements of public controversies around COVID-19 because such an analysis would eclipse important aspects of such controversy.

In view of this complex scenario, we raise the possibility that, in Science Education research field, perspectives of analyzing controversies that ignore or put the political factors of public controversies involving the sciences in a less important position are not able to account for the complexity of these debates and, therefore, may not achieve their goal of empowering students to deal with complex and controversial issues. As we propose a greater emphasis on political issues in Science Education, one could ask: what could be at the center of Science Education if not science? Put another way: can Science Education go beyond the (already complex) frameworks created to approach science in a critical, social, and contextualized perspective? In what ways would it be possible to reimagine Science Education to consider the complex issues we present? Seeking to create subsidies that allow reflecting on these issues and in a way to answer the editorial calls of Erduran (2020a, b), in this article, we will deal with how History, Philosophy, and Sociology of Science (HPSS) can contribute to

[3] Here, we consider politics according to the philosopher Marilena Chauí (2001), when she proposes politics as a government, that is, as the direction and administration of public power, in the form of the State. In this sense, it refers to government actions in order to direct the collective, as well as the actions of the community in support of or contrary to governmental authority or even to the form of the State.

Science Education in the era of the COVID-19 pandemic, and at the same time, we will present reflections on what counts as science and Science Education in the midst of a pandemic (and potentially beyond that). In this sense, we intend to defend, in line with other authors (Gutiérrez, 2013; Hodson, 2003, 2010; Tolbert & Bazzul, 2017), that the field of Science Education ought to consider the need for a socio-political turn to deepen complex issues such as those of COVID-19, and that this can mean a reconfiguration of what we mean by Science Education.

To this end, we organize this article in the following movements: first, we present some ideas brought from science studies that reinforce the inseparability between epistemic and political domains, through different lenses and approaches. Then, we will analyze the case of COVID-19 in the global context and, subsequently, in Brazil. Due to the wealth of analytical elements that give empirical support to our theoretical considerations, the Brazilian scenario will be detailed from various data that allow us to map this connection between the epistemic and political domains, tracing the consequences for education in sciences. Finally, we build on some theoretical arguments and defenses in the field of Science Education to advocate for a socio-political turn and what this can mean in terms of Science Education practices and the very way we understand what it is to educate in science in the current context.

2 Science Studies and Political Epistemology

The birth of modern science is often associated with the Renaissance period and the beginning of the modern era (Weinberg, 2015). In fact, the factors that mark the rupture of the scientific tradition in relation to other traditions or in relation to a pre-scientific past are the subject of dispute between different historical narratives.

In general, however, it can be said that the first historical narratives about science were written by scientists themselves as a way of legitimizing the institutionalization of science, its values, and methods of obtaining the truth in opposition to theological and philosophical approaches (Videira, 2007). In particular, development of positivist philosophy and its classification as a theological, metaphysical, and positive state inspired several narratives about a linear and rational evolution of science (Comte, 1830), such as what is found in the conception of scientific spirit by Bachelard (1996). According to this view, scientific thought is constituted in the epistemic field, moving away from social, cultural, and political influences (Latour, 1993, 2016). The advent of the industrial revolution and the consequent production of wealth at the end of the nineteenth century reinforced the conception of science as a promoter of a modern, rational, just society, in which production of knowledge and technology would be the source of social well-being.

At the beginning of the twentieth century, however, reports that characterize social aspects of science began to be developed, such as the works of Robert Merton and Boris Hessen. Despite this, it is only after the Second World War that a turning point can be seen in the way history of science is told (Videira, 2007). In particular, consequences of the Second World War and first studies on environmental impacts arising from modernity (Carson, 1994) created favorable context for works that place the epistemologically privileged status of science under suspicion.

Thomas Kuhn's (1996) work in particular had great influence on this period of development of the history of science. Although some authors distinguish between post-positivist (1945-1970) and post-modernist (1970-) periods (Videira, 2007) or between critical and

deconstructive aspects (Latour, 1993), it is possible to say that cultural studies of science (Lightman, 2016), the Strong Sociology Program (Bloor, 1991), Laboratory Anthropology (Knor-Cetina, 1981), and post-colonial studies (Santos & Meneses, 2009) point to the conception that scientific knowledge and practice are not justified by epistemic factors alone, but also through political disputes. In this sense, objectivity of scientific knowledge is also a cultural product (Daston & Galison, 2007).

This does not mean recognizing only that scientists and scientific communities are subject to socio-cultural and political factors as in the psychology of science, for instance. It also means recognizing that knowledge itself, the objects and products of science, and their discoveries and conclusions are also politically forged (Latour & Woolgar, 1986). Politics, in these terms, naturally also encompasses economic and social aspects. The inseparability of these areas is precisely a property of the neoliberal capitalist political-economic regime present in many countries around the globe. Despite originating in the seventeenth century, capitalism has been operating at an accelerated rate since the mid-1970s with the rise of its varied neoliberal form. This sophisticated version has contributed to the spread of capitalist ideals on a global scale, such as competitiveness and individualism (Springer et al., 2016). This complex network is an arrangement of material-semiotic relations, it is a *dispositif* (Foucault, 2008), capable of assimilating new elements and constantly changing, being resilient and very difficult to dismantle. For example, recent questions about the neoliberal regime in Europe have led to emergence of right-wing populist leaders, who have transformed popular demands with highly nationalistic and xenophobic discourses (Mouffe, 2018). Calling themselves the saviors of the people, these charismatic leaders (like Donald Trump and Jair Bolsonaro) take advantage of crisis moments to enact the so-called states of exception (Agamben, 2005), as recently seen in Brazil, when the Environmental Minister stated in a meeting that it was necessary to take advantage of the COVID-19 pandemic to change the entire environmental regulation, to make the country's laws and regulations more flexible (Spring, 2020).

Perhaps, one of the seminal works that allowed one to think about the social (and political, economic) aspects of science was presented by Shapin and Schaffer (1985). The authors discuss the intellectual clashes between Boyle and Hobbes. In doing so, they show that Hobbes' political conception, with the proposition of the State in the form of Leviathan, was also committed to a defense of a specific method of legitimizing knowledge, that is, the apodictic method. Through reason, one arrives at the truth, in an absolute, impersonal, and universal way. There is no space, in this proposal, for a democratization of the production of knowledge, and thus, the State can hold, at the same time, a monopoly of power and truth. It should be noted, therefore, that Hobbes' effort meets the stabilization of power, overcoming the conflicts that would arise from a deregulated society. Political views give rise to certain epistemologies.

On the other hand, Boyle "inaugurates" the so-called empirical method. A set of Sirs get together at the Royal Society and verify what is true. Supported by the legal system of the time, according to which two testimonies would be enough to condemn a man, Boyle uses the testimony of his peers about the result of an experiment built in the laboratory to draw conclusions about nature. Not only is a new method of validating the truth founded, but also Hobbes' centralization project is at risk. The epistemic view gives rise to a certain political result. Therefore, the clash between the two thinkers occurs on both levels, which cannot be dissociated. Each of them defends his own political and epistemic vision.

One could imagine that these connections between knowledge production and political dispute would still be a remnant of the pre-modern period. Contrary to this view, Latour (1999) discusses the case of the French nuclear program, in which Joliot needs to mobilize the

interests of the Minister of Defense and the neutrons in the laboratory at the same time. His ability to win support from the minister directly affects his ability to mobilize neutrons, and symmetrically, his ability to mobilize neutrons directly impacts his ability to sensitize the minister. Latour discusses such symmetries and interdependencies in terms of the translation process. That is, an epistemic practice can be translated into political influence and vice versa. Such a process, however, cannot be thought of as linear and determined; on the contrary, it always involves uncertainty and indetermination. Bruno Latour has performed different studies in which he stresses the interdependence between natural and social aspects of scientific practice, such as his analysis of Pasteur's articulation of microbes (Latour, 1988b). The study of these translations, therefore, is the subject of a specific field, called political epistemology (Latour, 2016).

Advancing in a critical field, studies on political and epistemic relations have long pointed to a commitment of science to colonialism and capitalism (Santos & Meneses, 2009)[4]. In particular, Foucault (2018) proposes a very clear relationship between power and truth when stating that the truth would be the result of the clash of forces not only between the state and society, but of the power relations that are capillarized throughout society. In making such notes, the authors point to the need for democratization of scientific institutions and for a greater commitment on the part of these institutions to face the existing inequalities in their most different manifestations.

The first decade of the twenty-first century, however, marks a new period for the field of political epistemology. With growth of studies on global warming and indication of scientists about the need to curb some economic activities, science has become the target no longer of the colonized, but of the colonizers themselves. More than that, the arguments developed by critical thinkers and science studies, in general, came to be used to discredit science in relation to conclusions that would harm big capital—a problem that was discussed by Latour (2004). Although many factors to this new anti-science (and not only science) movement could be pointed out, we may stress that it has been deeply motivated by economic interests, and it has been committed to the accumulation of wealth in spite of environmental destruction, as discussed elsewhere (Latour, 2004; Vrieze, 2017).

Beyond this scenario, in the words of Latour himself, it is necessary to rescue the authority of science (Vrieze, 2017). Nonetheless, this should not be achieved naively, as it would pave the way back to a positivist notion of neutral and depoliticized science. Indeed, it is necessary to recognize the social, cultural, and political dimensions of science. However, it is also necessary to emphasize that scientific practice cannot be reduced to its political and social dimensions, but, yes, there are times when science offers answers that must be heard and considered by society. For this, science needs to be portrayed more closely to its official practice. It is necessary to present, as suggested by Latour, science in action (Latour, 1988a), and this can only be done when we analyze controversies before they are solved. Only then, we may acknowledge all the different dimensions (political, epistemic, cultural, etc.) that are entangled in scientific practice. In *Science in Action, Latour* suggests to choose open controversies as a first methodological rule for a sociological study of science:

> Rule 1 We study science in action and not ready made science or technology; to do so, we either arrive before the facts and machines are blackboxed or we follow the controversies that reopen them. (Latour, 1988a, p. 258)

[4] According to Santos (2016), capitalism, patriarchy, and racism should be considered as different manifestations of the same deep extractivist worldview.

Furthermore, Venturini (2010) exposes some methodological orientations related to the adoption of actor-network theory in science studies. Again, he stresses the importance of choosing open controversies:

> Although every collective phenomenon can be observed as a controversy, not every controversy makes a good object of study. Unfortunately, there are no exact instructions on how to choose a good controversy—all that we can provide are some recommendations to avoid bad ones: 1) Avoid cold controversies. As we said, we may want to call controversy anything between reciprocal indifference and full harmony. Still controversies are best observed when they reach the peak of their overheating. If there is no debate or the debate is lethargic, if all actors agree on the main questions and are willing to negotiate on the minor, then there is no authentic controversy and the resulting cartography will be either boring or partial. Good controversies are always "hot": they may involve a limited number of actors, but there must be some action going on. 2) Avoid past controversies. Issues should be studied when they are both salient and unresolved. Once an agreement has been reached, a solution has been imposed or the discussion has been closed in some other way, controversies lose rapidly all their interest. Past issues can be investigated only if observation can be moved back to the moment when the controversy was being played out. (Venturini, 2010, p. 264)

Advocating this, we sustain that despite the impression that it would be hasty to mobilize a controversy that is still unfolding and about which we do not have all (or at least many) the elements to analyze, it seems to be a timely and significative occasion to build a study which seeks to explore co-production of science and politics aiming Science Education research field. Undoubtedly, the lessons we can draw from this vivid controversy can provide us with ideas to sharpen our lenses to better perceive sciences in a society aiming for more politicized Science Education.

At this point, it should be noted that several approaches to socio-scientific issues (Bencze, 2017; Marques & Reis, 2017) and to the nature of science (Dagher & Erduran, 2016; Allchin, 2011) are continuously approaching a more complex representation of the scientific enterprise, namely, perception of this enterprise as "science in action". About this, Erduran & Dagher (2014), by stating that science studies have been pointing out how science is done and that they address aspects of scientific work as "influenced by societal and cultural forces" add three specific categories in its nature of science model that seeks to emphasize these aspects, which are "social organizations and interactions," "political power structures," and "financial systems". However, as we explore, from Shapin and Schaffer (1985) and Latour (2016), it is possible to notice that science and society are continuously co-produced. According to Jasanoff (2004), "co-production is shorthand for the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it" (p. 2). In this sense, scientific knowledge exists only embedded in social practices, identities, norms, conventions, discourses, institutions, and instruments, as well as a society cannot function without this very knowledge. Considering that, we may be facing a complex problem that urges us to take steps towards seeing this co-production of sciences and societies in a more organic way, namely, to take steps towards the understanding of "science in action". In these new steps, as we will explore later, it may be necessary to have a disciplinary reorganization that calls into question the boundaries of Science Education as we know it today, which requires us precisely to discuss the limits of this field.

The use of case studies related to complex problems, such as the case of the COVID-19 pandemic, helps us to understand why and how the outlines of such problems go beyond the boundaries of the scientific field and can only be understood from their interconnection with politics and society. With this, we seek to defend a position that departs from logicist or dogmatic epistemology and from the totally relativistic description of scientific reality.

In order to support our arguments, in the next sections we present, using the case of COVID-19, a description of relationship between scientific productions and political decisions, as well as the influence of political interests in the legitimation of scientific discourses by society.

3 Scientific Studies and Political Decision

On December 31, 2019, the WHO office in China reported cases of etiologically unknown pneumonia, detected in the city of Wuhan, in the Chinese province of Hubei. Only on January 7 were Chinese scientists able to genetically isolate and identify a new form of coronavirus, Sars-Covid-2 (WHO, 2020c). Twenty days after the first notification in Wuhan, the presence of the virus had already been recorded in Japan, Thailand, and South Korea. This motivated WHO to launch the first Novel Coronavirus (2019-nCoV) Situation Report (WHO, 2020c). In this document, the World Health Organization presented the first actions to prepare for the control of the spread of the disease and assumed its relationship with researchers and specialists.

> to coordinate global work on surveillance, epidemiology, modelling, diagnostics, clinical care and treatment, and other ways to identify, manage the disease and limit onward transmission. WHO has issued interim guidance for countries, updated to take into account the current situation. (WHO, 2020c)

Although the WHO does not recommend any action on the closure of businesses or isolation of the population in this report, the central government of China decreed a lockdown for the more than 11 million residents of the city of Wuham, showing the state's commitment and concern with the containment of the virus (Crossley, 2020). This attitude by the Chinese government suggests that very special attention was paid to the work of researchers who already indicated, at that time, the potential for transmission of the virus from the free circulation of people (Bogoch et al., 2020) and recommended greater restrictions on the part of health system authorities (Hui et al., 2020). This fact shows how research in the medical field may have directly influenced political decisions. Nevertheless, political decision-making based on scientific studies was not the norm in fighting coronavirus, as we will see in the next example.

Just under a month later, on February 12, the WHO launched the first global action plan, the COVID-19 Strategic Preparedness and Response Plan, recommending eight pillars to be followed by countries around the world for disease control. As of that date, COVID-19 was already spreading in 24 countries worldwide and with the first death recorded outside of China (WHO, 2020a). In this sense, the WHO warned countries about the need for special preparation for what was to come, from care with prevention and control at airports to the preparation of the health system to increase the demand for hospital beds. The pillars of action identified by the WHO at that time were as follows: Country-level coordination, planning, and monitoring; risk communication and community engagement; surveillance, rapid-response teams, and case investigation; points of entry, international travel and transport; national laboratories; infection prevention and control; case management; operational support and logistics; and maintaining essential health services and systems. Unlike the first Situation Report, in this document, we can identify clearer guidelines for countries to fight the virus; however, there is no mention in the text of the social isolation of the population (WHO, 2020b), even with research at the time reinforcing this need (Sanche et al., 2020). However, this second document stands out from the

WHO's second pillar of action, which deals exactly with the risks associated with failures in communication with society. This item points out that it is a public health issue to establish a clear and efficient dialogue between science and society; after all, fake news tends to spread faster and can reach a larger number of people than real news (Vosoughi et al., 2018).

> It is critical to communicate to the public what is known about COVID-19, what is unknown, what is being done, and actions to be taken on a regular basis. Preparedness and response activities should be conducted in a participatory, community-based way that are informed and continually optimized according to community feedback to detect and respond to concerns, rumours and misinformation. Changes in preparedness and response interventions should be announced and explained ahead of time, and be developed based on community perspectives. Responsive, empathic, transparent and consistent messaging in local languages through trusted channels of communication, using community-based networks and key influencers and building capacity of local entities, is essential to establish authority and trust. (WHO, 2020b)

In other words, the WHO shows, in this document, concerns with the possibility of the existence of cross-information about COVID-19, which could significantly affect actions to control the spread of the disease.

At the same time that health researchers increasingly demonstrated the importance of social distancing and different countries in the world decreed the lockdown, economists published papers revealing impacts of COVID-19 on the global economy (Ahmed et al., 2020; Khalidi, 2020). The closures of business activities, restrictions on movement of people and the requirement to stay home would bring serious economic losses to different countries. The impacts would be most strongly felt by people belonging to the popular classes. It was estimated that for each 1% drop in the global economy, more than ten million people could be pushed into a situation of poverty around the world (Vos et al., 2020). That is, from the perspective of economists, the spread of COVID-19 and the consequent slowdown in the economy would cause serious losses for the poorest, including in relation to food security (Vos et al., 2020).

This other dimension of scientific production and its uses further complicates the analysis of political actions carried out based on the studies of scientists. However, by tracking the scientific production and political decisions of this initial period of the pandemic, the overlap between the epistemic and political fields is evident. That is, epidemiology studies showing the spreading power of the virus impacted the Chinese government's decision to close its borders; at the same time, social isolation in China and other countries have mobilized economists to publish studies revealing the impacts of isolation on the world economy. The influence of social distance in the fall of the world economy may even have caused WHO to take a long time to declare the spread of the coronavirus as a pandemic. Of course, the political implications can have different directions, depending on the lenses used to look at the COVID-19 problem.

In the Milan case, that we mentioned before, a few days after the publication of the WHO Response Plan, for example, the mayor of Milan posted a video on Twitter of a campaign totally averse to WHO recommendations. In this promotional video for the *Unione dei Brand della Ristorazione Italiana* shared by the mayor, the Italian population was asked not to stop their activities based on the hashtags #wewontstop and #milanononsiferma. As expected, the mayor's attitude brought disinformation to the population and reduced the effectiveness of actions to combat the disease, leading to an increase in the number of people infected in the city. Less than a month later, the mayor went public and apologized for his attitude (Piano, 2020). This episode in Milan seems to be another link in the co-production chain between science and politics, since the mayor's decision was based on estimates of the fall in the Italian economy.

The position of the mayor of Milan of discrediting the size of the health crisis was not restricted to Italy. The US, UK, Brazil, and Belarus are some of the countries that initially minimized—and still minimize in the case of the last two countries mentioned—the pandemic. Nonetheless, an academic study had a strong influence on the change of direction in the fight against coronavirus in some countries. Researchers at Imperial College of London showed that, based on data from the USA and the UK, "suppression will minimally require a combination of social distancing of the entire population, home isolation of cases and household quarantine of their family members" (Ferguson et al., 2020, p. 1). If these measures were not adopted, more than 2 million US citizens could die (Ferguson et al., 2020). Donald Trump[5] cited this study to reinforce isolation measures in the USA.

It is worth saying that pandemics raise several complex issues linked to the environmental crisis, the huge social and racial inequality that is growing in the world, and many others as Alsop and Bencze (2020) have pointed out elsewhere. Nonetheless, our approach leaves out several of these aspects, favoring some others that help to sustain our point in this article. In this section, in particular, stressing some of these aspects, we showed how politicians appropriated the discourses produced by science and how political decisions mobilized scientific production. In the next section, we look at situations where the WHO recommendations and results of research are distorted to meet the interests of specific political actors.

4 Political Interests and the Role of Science: Some Aspects of the Brazilian Case and Beyond

The first COVID-19 case reported in Brazilian territory was on February 26, 2020. Since then, more than 800 thousand cases have been confirmed, and almost 42 thousand people lost their lives (on June 12, 2020). Possibly until the publication of this work, these numbers will be three to four times higher. Initially, every day around 5 pm, representatives of the Brazilian Ministry of Health gave a press conference in which they updated the numbers of infected and recent victims in each state of the country. The then Minister Luiz Henrique Mandetta was fired from his post on April 16, and his assistants worked to combat the spread of the virus and expand the capacity of the public health system. Mandetta defended the social distancing of the population with important restrictions on productive activities and did not approve, for now, the use of the substance hydroxychloroquine in the treatment of the new coronavirus. In the eyes of the country's health experts, the work of the Ministry's team was irreparable. In this sense, it can be said that Mandetta's guidelines were in line with scientific recommendations and, to some extent, ignored possible economic consequences.

The opinion of the president of the republic, in the same direction as the studies on the economic consequences of horizontal isolation (Ferrante and Fearnside 2020), was contrary to that of the Minister of Health. In this section, we analyze some aspects of the fight against pandemic, focusing on Brazilian case, but briefly relating to other realities, such as the US case. We use official and informal statements, interviews, and social networks as data sources.

Bolsonaro[6]'s first mentions of the new coronavirus came through his personal Twitter account, starting on February 26. They were tiny assertions, just mentioning COVID-19 among other publications. It was on March 6, however, that the president made his first

[5] Donald John Trump was the president of USA from 2017 until 2021.
[6] Jair Messias Bolsonaro is the president of Brazil from 2019 until 2022.

official statement, broadcast on an open TV and radio network throughout the national territory. In this speech, the president briefly announced that the virus was already present in Brazil and stated that: "Strictly following the experts' recommendations is the best protective measure" (Bolsonaro, 2020a, 1:45). A few days later, in a new official statement, noting the progress of dissemination throughout the country, Bolsonaro pointed out that the classification of the disease by the WHO as a pandemic was "responsible" (Bolsonaro, 2020b). Furthermore, in the same space, the president supported the recommendations of the health authorities to avoid large popular concentrations (Bolsonaro, 2020b). We can observe, therefore, that during the first 15 days of the disease in Brazil, the president's speech was cautionary and well-aligned with that of scientists and specialists, suggesting that the recommendations of health authorities should be followed and that agglomerations should be avoided.

Despite affirming in the official pronouncements that the social distance indicated by the experts was important to fight the pandemic, on March 15, Bolsonaro participated in demonstrations of support for his government in front of the Alvorada Palace. He met people who were waiting for him; he took photos, shook hands, and hugged more than 250 supporters (Nomura, 2020), disregarding the recommendations of health experts and his own indication, made a few days earlier. This happened without Bolsonaro knowing if he himself had not contracted the new coronavirus while travelling to the USA the previous week (Fabrini & Uribe, 2020). In addition, he shared videos of other events that took place in Brazilian cities on social media. It was clear at that time that the president was not acting in accordance with WHO guidelines. On the same day, the Minister of Health spoke out against Bolsonaro's stance, stating that the guidelines to avoid agglomerations should be respected by everyone, including the president (Cancian, 2020).

Most of Bolsonaro's supporters who took to the streets in protest on March 15 directed their criticisms of the Brazilian legislative and judicial systems, for issues prior to the pandemic itself. However, in some cities, criticism was made of the governors who were decreeing quarantine in their states, indicating an acceptance of the president's behavior in minimizing the health crisis and defending the sustainability of economic activity. The governors decided to act autonomously, since they realized that the president was not taking the necessary control and prevention measures, and decreed the closure of schools, universities, and, in some cases, airports.

The prominence that some governors ended up acquiring from the anticipation of the recommendation of social isolation made Bolsonaro start a campaign of criticism to these governors defending free movement of young people and adults, isolating only the elderly and people with serious illnesses, which he called vertical isolation. This measure is not recommended by WHO or by epidemiologists (Wang et al., 2020), as it would quickly lead to the collapse of the country's health system, as observed in Italy, which decided to adopt the same strategy at the beginning of the pandemic. Even in Brazil, as well as in Milan, there was a campaign by the government called "Brazil cannot stop" (Bertoni, 2020), in which people were asked to return to work and continue their activities normally. In practically all the speeches and posts of the president, he minimized the action of the new coronavirus and presented that the main problem in the country would be the unemployment of the population. The increase in the number of studies on the economic impacts of the new coronavirus on the economy (Fernandes, 2020) and the opinion of economists criticizing the restrictions imposed on the circulation of people in the Brazilian press (Oliveira, 2020), to some extent, may have fostered a more emphatic position from Bolsonaro.

In Brazilian case, an aspect that connects both Brazilian and US realities is the recommendations about the use of chloroquine (CQ) and hydroxychloroquine (HCQ). Both Jair Bolsonaro and Donald Trump supported, publicly, the use of CQ and HCQ to treat COVID-19. On March 21, Trump posted on Twitter:

> HYDROXYCHLOROQUINE & AZITHROMYCIN, taken together, have a real chance to be one of the biggest game changers in the history of medicine. The FDA has moved mountains - Thank You! Hopefully they will BOTH (H works better with A, International Journal of Antimicrobial Agents)..... ....be put in use IMMEDIATELY. PEOPLE ARE DYING, MOVE FAST, and GOD BLESS EVERYONE! @US_FDA @SteveFDA @CDCgov @DHSgov. (Trump, 2020)

Seven days after that, on March 28, the Food and Drug Administration (FDA), US agency responsible, among other things, for "protecting the public health by ensuring the safety, efficacy, and security of human and veterinary drugs, biological products, and medical devices" (FDA, 2020a), issued an emergency use authorization (EUA) that allowed the distribution and use of CQ/CHQ for treatment of COVID-19 in adolescents and adults (FDA, 2020b). Letting alone possible financial interests that were thought to be behind Trump's interest of CQ/HCQ use, after that, an intense debate took over the public arena. More than 2 months after, FDA revoked EUA for CQ and HCQ on June 15 (FDA, 2020c). The same day, it was announced that the USA would send to Brazil millions of pills of HCQ (Chade, 2020).

Back to Brazil, on March 28, Bolsonaro followed Trump and mentioned that CQ/HCQ was "succeeding everywhere" (Sanches, 2020), which was, according to him, a positive evidence in favor of its use. Bolsonaro insisted since the first cases in Brazil that HCQ/CQ was a good treatment for patients with COVID-19. He was so convinced of that he ordered the army to produce CQ pills. By the mid-April, Brazilian army had already produced 2.2 mi CQ pills following the president' orders (Carneiro & Seto, 2020). It is also important to mention that from March until May 15, two Brazilian health ministers (Luiz Mandetta and Nelson Teich) were fired (or quitted the job, in the second case), after being involved, besides other issues, in public controversies about CQ/HCQ use by COVID-19 patients. After that, the new Ministry—the military Eduardo Pazuello—issued authorization for the use of HCQ/CQ to treat COVID-19 patients.

Regardless of details on this CQ/HCQ case, which seems to corroborate our main point in this article is that when Trump first mention CQ/HCQ benefits and push FDA to authorize its use for COVID-19 treatment, he refers to a study that actually exists. The paper was published in a reputed journal with a high impact factor and that has as conclusion: "hydroxychloroquine treatment is significantly associated with viral load reduction/disappearance in COVID-19 patients and its effect is reinforced by azithromycin" (Gautret et al., 2020). Hence, this is not the case of anti-science discourse but the use of selective information in a situation of ongoing controversy in science. This study was confronted by other subsequent papers (e.g., Machiels et al., 2020) that questioned methods and conclusions announced by Gautret et al. (2020), and there was announced other studies with many problems associated with CQ/HCQ administration for patients with COVID-19 disease (Sanches, 2020).

Also noteworthy is the FDA position, which authorized the administration of HCQ/CQ even without robust evidence of its effectiveness, what makes one think about the political contours of this decision, especially after the president's continuous and public insistence on this treatment. The same goes for the Brazilian case, in which 2 ministries were out after disagreements with the president around this question. Another aspect that Vazire (2020)—ex-editor of an important journal on psychology—raises in public debate is the new ways of producing and communicating science that became popular in the midst of a pandemic. As she notes, the rush

(whether being justified or not) of scientific community to discover cures and treatments for COVID-19 created a direct channel between these scientists and the community. This can sow doubts in the greater public that is not accustomed to a high degree of uncertainty typical of "science-in-the-making" processes. This is also because, as largely documented by Science Education and public understanding of science research fields, the public generally has an idealized image of science which prevents best understandings of science processes of inquiry.

Still, Vazire (2020) points out that many scientists have been communicating their results direct to the public even without having their papers published and, so, validated by peer-review processes. One can say this is reckless and that only peer-reviewed scientific results published in good journals should be disseminated to the public. But what to say about those papers published in well-reputed journals that were retracted because of serious flaws even after the peer-review? Science can fail and we know that, but we are not accustomed to catching these errors "in the making". This can be dangerous, especially in times of growing skepticism and distrust towards sciences.

How could we, science educators, cope with that? As we are going to defend, assuming the co-production between science and society and between science and politics can be an antidote both to combat an idealized image of science and the rampant distrust in the institutions in the current state of affairs.

5 What Can We Learn From This Episode?

As we discussed in Section 2, when we adopted the concept of political epistemology, we understand that scientific practices are not only influenced by a socio-political context but are completely hybridized with it, being affected by and also affecting it. Boyle's empirical method was, to a certain degree, a political action, and Hobbes's political conception required a certain criterion for validating the truth. Joliot was only successful in his political advances when he was able to work with neutrons to the same extent that he was only successful in his research with neutrons when he was able to work with the Minister of Defense. In this sense, it is observed that the positioning of actors in this complex political-scientific network includes human and non-human actors (Callon, 1984). It should be noted, however, that the role or the power of such actors are not necessarily the same. We recognize that the different actors associate, compete with each other, and affect each other, bringing consequences for the formation and stabilization of nature and society.

Clear examples of this mutual influence between different actors appear explicitly in Sections 3 and 4. We note that scientific discourses are co-produced by political discussions, just as political decisions are guided by convenient scientific work. A first example of this is that the WHO, publicly identified during the pandemic as "the voice of science", produced, as data points out in the previous sections, guidelines that also related to political decisions that should be taken by governments. In its "what we do" page (WHO, 2020d), the WHO points out that one of its objectives is, in fact, to produce guidelines and parameters to support public policies related to health; however, its identification with the "voice of science" is undeniable in the episode analyzed. If at first sight, this perspective seems to point to a scientific body acting politically, that is, taking the conclusions of science to the political sphere, this perspective falls apart when analyzing evidence that the WHO could have taken into account, for example, the economic impact of social isolation in producing its

guidelines to combat COVID-19. In this way, it would no longer be a question of science reaching the public through WHO, but orientations vocalized by the "scientific voice" that are co-produced by the political scenario.

The example in the opposite direction can also be highlighted: the Chinese government isolated the residents of Wuhan at a time when the first studies indicated the contamination power of the new coronavirus, even without clear guidance from WHO regarding the indication of lockdown as a combat measure against the dissemination of COVID-19. It is then possible to perceive a political action that anticipates what is determined by the "scientific voice" in the present case, which again points to a non-univocal relationship between politics and science. We also noticed that the isolation measures enacted by politicians mobilized scientific claims in the economic field, which ended up conveniently supporting political actions in the opposite direction, to make activities more flexible. It is clear that the actions of politicians who sought to minimize the effects of the disease on public health, as was the case in Italy and the UK, ended up worsening the situation in their countries.

The Brazilian case seems to be very emblematic in the discussion we propose for Scientific Education in this work. Bolsonaro uses inaccurate and even false data and information as if they were scientific to defend his point of view, a common practice among right-wing leaders (Mouffe, 2018). That is, when the population comes into contact with Bolsonaro's speech, they are exposed to political arguments that are disguised as scientific. It takes a certain political-scientific literacy to understand the intentions and misrepresentations carried out by Bolsonaro. We defend in this work that it is precisely at this point that Science Education must act.

The controversies observed around COVID-19 point to a messy and uneasy relationship between politics and science, which is precisely the point highlighted by studies that defend political epistemology, as we discussed earlier. In this case, it would be inappropriate to point out the political, economic, and social aspects as external to scientific production on COVID-19. Similarly, analyzing this episode only in terms of financing mechanisms for proposals to combat coronavirus and its consequences in scientific production on the subject would not allow us to see the intertwining between politics and science that were the subject of our narrative in the two previous sections. In other words, the proposals for scientific analysis through input-output recipes[7] between sciences, politics, and society (or that separate these dimensions) are insufficient to deal with the complexities of the subject.

When affirming the insufficiency of "input-output" models to deal with this episode—and not just this one, because, it is worth remembering, case studies serve to raise aspects that may be overlooked in other cases—a question that arises, in a reading attentive, it would be: insufficient for what? When our students do not do well in an evaluation, many of us evaluate it as "insufficient", which means that he did not reach the expected goals for that activity. What does it mean, then, to say that a particular approach is insufficient for Science Education? This issue calls for a debate proposed by Biesta (2007) about the ends and means of education. According to Biesta (2007), educational policies have been increasingly focused on the so-called evidence-based research proposals, although the results are not always positive. When analyzing this paradox, Biesta proposes that this occurs due to the distance between the ends and means of education. As part of education, the criticisms also apply to Science Education: by focusing on the "optimized" means of teaching science, we lose sight of the ends for which we teach science. In appropriating this debate,

[7] We use this expression to summarize the normative views of this kind of controversies in which social, political, and economic factors (or, conversely, scientific factors) are interpreted as having precedence in relation to the other factors playing a role in the controversy.

we understand that affirming the insufficiency of any proposal is linked to the supposed objectives for such action. In this case, we point out that it is insufficient to address "science in context" in input-output models if the objective of addressing these issues in Science Education goes beyond a contemplative dimension, but is intended to equip students to deal with these controversies in their day-to-day life. It would not be insufficient if the objective were just to have a less naive view of the scientific enterprise, for example.

In this sense, approaches to nature of science that were hegemonic in the past (e.g., Lederman et al., 2002; McComas et al., 1998) have proven effective in several empirical studies with respect to a more refined epistemological understanding on natural sciences. On the other hand, recent calls for a political and social understanding (dos Santos, 2009; Rudolph & Horibe, 2016) of sciences and their context have changed the needs of contemporary Science Education, which has reassessed such epistemological approaches to science in terms of effectiveness. We are facing a paradigmatic question, a strong question, in the sense of Santos (2016), which makes us reflect on which science and which science teaching we need now. For which society? What knowledge do we need to build now and, together with them (since knowledge is always accompanied by ignorance), what ignorance (Santos, 2009) can we admit at this moment?

This makes us carry on our objective as a position paper, to reevaluate what can be understood as Science Education in the current context (of a global pandemic) that will certainly leave its imprints in the coming years or even decades—which increases the importance of this analysis. In addition, we will seek to analyze the role of HPSS in this alleged reformulation of what is meant by Science Education. We take the COVID-19 crisis as a starting point to discuss some aspects of Science Education boundaries, its possibilities and challenges, that is, what we count as Science Education now and how we could think of it differently. With that, we hope to sow reflections not only related to the current crisis but also more broadly to this research field/school discipline. In the next section, we will move forward with these objectives, seeking to point out how the COVID-19 crisis exposed tensions in our area that had already been brought about by other studies, suggesting that it is necessary to move forward with certain guidelines if we want Science Education to participate in the construction of a world where tragic moments like the one we live in now can be minimized.

6 For a Socio-Political turn in Science Education

Despite the fact that we have referenced the need to think about the objectives of Science Education in contemporary times from the discussion of Biesta (2007), we understand that this task is not at all simple in the current setting. Few of us, researchers in Science Education, would disagree until recently that a good objective to be aimed for in this disciplinary field would be "to evaluate the reliability of scientific information" (Allchin, 2011), for example. However, what about when reliable scientific information is used for obtuse political purposes? And when we do realize that, in "real time", scientific institutions also have political interests[8] and dialogue with those interests when they are publicly made? Our times of hyperhistory (Floridi, 2015) mean that these facts are experienced very closely and in real time, with all the contradictions of "Science in-the-making"

[8] With this, we do not intend to say that the intertwining between science and politics is surprising. There are several historical studies that point this out reasonably clearly. Our point is that this can be a shock for the general public, which often has an idealized image of science.

being exposed to the general public. Therefore, we are facing a situation in which there is plenty of availability of reliable scientific information, but which is not capable of handling decision-making on its own. The question "what or whom to trust" (Allchin, 2011) remains important, but identifying whom or what to trust does not, in itself, define the best actions to take. In this case, something beyond science is needed to help us decide on one direction or another. For that, it is important a political literacy (dos Santos, 2014) that perhaps allows us to perceive not only the entanglements between science and politics but also that highlights the consequences in the reality according to each choice (Santos, 2002), considering that this reality is affected by inequalities at a global and often local level. Yet, this political perception of reality needs to include the perspective that not every type of decision is possible for every type of person, as an ordinary citizen. In this sense, Science Education for decision-making would be of no use if it is not observed that certain decisions are far beyond a personal choice (Pinhão & Martins, 2016). In the case of Brazil, for example, many of the actions taken by the president that ended up causing an aggravation of the pandemic in the national territory are not liable to be countered by exclusively individual attitudes of citizens. Therefore, a population well-informed about all aspects of the virus and the disease would be useless if certain actions (such as lockdown, financial aid measures for the poorest) depend on political decisions by the central government.

As pressure from social forces has increasingly pushed the field of Science Education and Teaching to a moment when we can realize the importance of directing efforts in our research to the construction of a less unequal and more sustainable world (Tolbert & Bazzul, 2017), we think that the important issue here is to try to see/propose what this socio-political turn should look like, if we want to achieve this goal, and, in our case, how HPSS could contribute to this perspective.

It should be noted that advocating for socio-political perspectives for education is not new. As dos Santos (2009) observes, Freire (1987) already defended some decades ago that there is no education in a political vacuum. Even in Science Education, Hodson (1994) already advocated a political perspective, deepening in subsequent works (Hodson, 2003, 2010) and which even generated new perspectives for activist socio-political action for educating in sciences (Alsop & Bencze, 2014). In particular, Tolbert and Bazzul (2017) point out that a socio-political turn in Science Education is imminent and necessary. It is almost a consequence of the exploration of cultural perspectives in science teaching in the past decades, when issues related to identities, gender, culture, politics, and economics became more strongly on the agenda of this disciplinary field (Lemke, 2001), making us reassess what it means to learn and teach (Gutiérrez, 2013).

Gutiérrez (2013) defends a similar shift in mathematics education. For the author, the field previously dominated by cognitive perspectives and by a perception of mathematics itself as something strictly logical, rational, and universal, started to value research where meaning, thinking, and reasoning are products of social activity, as socio-cultural perspectives became more popular. In addition, Gutiérrez (2013) analyzes that there is an increasing amount of work that seeks to investigate issues related to identities and power in mathematics education. For her,

> [...] many researchers who have dedicated their work to understanding and advocating for anti-racism, social justice, and transformation have moved beyond using the kinds of sociocultural tools that draw primarily from cultural psychology to highlighting identity in social interactions; they privilege the voices of subordinated groups and forefront the politics and power dynamics that arise from sites of interaction. In this work, a shift has occurred from examining structures and institutions to examining discourses and social interactions. This is not just about understanding students' identities in some kind of developmental, linear trajectory, or deterministic manner. It is about how identities are (re) constructed in spaces and moments. In this work, questions shift from what do American Indian students know/learn in mathematics to what forms of power and authority are enacted in determining what American Indian students learn and from whose perspective do American Indian students learn. (p. 2-3)

Still defending the socio-political turn in mathematics education, the author focuses fundamentally on two points that should be at the center of research that seeks to align with this shift: power and identity. This means scrutinizing how knowledge production is imbued with power relationships—"what counts as knowledge, how we come to 'know' things, and who is privileged in the process"—and mobilizing/producing identities that incorporate these views and are capable of reducing inequalities related to the asymmetry of powers in society (Gutiérrez, 2013). Without a doubt, these are two fundamental questions that can also be explored in Science Education, in addition to mathematics teaching. This is important to say that the presence of the epistemic domain in the socio-political turn is fundamental. As we tried to demonstrate above, politics and epistemology are linked together. Especially with regard to power—in the binomial power-identity—, research in HPSS for Science Education is a privileged space for carrying out this discussion, particularly the Cultural History of Science (Moura & Guerra, 2016; Nyhart, 2016), and other emerging perspectives both in the history of science and in science teaching, such as Global History (Gandolfi, 2019; Roberts, 2009), and inherits precisely this politically committed way of looking at history. As has long been defended in the literature, the study of the history of science in education can be a great ally in the critical understanding of contemporary science. In this political perspective, the history of sciences can also help to equip students to understand the asymmetries of power in the production of knowledge, besides becoming more aware of the issues related to politics of knowledge, so widely discussed in the field of science studies. We chose in this article to scrutinize an open and contemporary controversy to see the unravelling of politics of knowledge, but the general idea applies to other types of controversies, even historical ones.

Before considering this, the first hindrance that we understand that needs to be overcome is that, as a community, we create hurdles to say what it means to do Science Education. Moura (2021), drawing from the lessons of the practice turn of science studies, shows that, as in the case of the disciplinary fields of science that are the object of study in Science Education, scientific education itself is constituted by, many times tacit, historical agreements. The limits of what we mean as science education, therefore, are products of the collective practices of its practitioners (Moura, 2021); in this sense, these boundaries can be redrawn to include perspectives that are not so researched in our field today and sciences that are marginalized (perspectives of ethnomathematics, ethnobotany, ancestral knowledge, among others), but which can be potent in pursuing the goals of social justice that we think are fundamental in these times of increasing inequality. Today, when we refer to Science Education, there is a certain imaginary of what this would mean: atoms, complex theories, and (perhaps) The Scientific Method (with capital letters), among other concepts and contents that are at the heart of what we think education in science is. With that, what we created for the field of Science Education is in dialogue with this imaginary, either to build from it or to deny it (in the case of the Scientific Method, for example). What we need is an exercise of imagination: how could science education be without those elements (but others) at its core? What elements would these be and how would they dialogue with our current contexts?

Certainly, questions may arise regarding this argument. One is that we would lose the scientific component within Science Education and that it would therefore be a general education. About this, it is worth remembering that the "scientific component" we are talking about is precisely linked to this imaginary of what the sciences are, which, in turn, is linked to common sense. Today the sciences are so diverse that we can ask, in the case of chemistry, for example, why we continue to teach organic chemistry nomenclature instead of green chemistry principles. Or why don't we teach molecular modelling in basic education, which would make

excellent connections with programming and mathematics, for example? New kind of scientific enterprises or disciplines such as biomathematics, biometrics, nanotechnology, and data science, among others, are very recent sciences and of great importance in today's society; however, they still do not appear formally in most curricula around the world. Another point is that what we know as science has changed a lot and will continue to change. The continental drift theory, for example, was only recognized as something scientific a few decades ago (see Oreskes, 1999), and today no one passes through school without learning about this theory. Therefore, as strange as it sounds to think of new central axes for school science, this is not an implausible proposal. In fact, if we consider the current global danger of mass extinction that we face, wouldn't it make sense to think about Science Education that was first and foremost aimed at creating a political-environmental awareness to prevent this from happening? Some researchers (see Gray, 2018; Lima & Moura, 2019) have argued that the environmental catastrophes we live in today and will still live in invite us to think about new foundations for Science Education that considers a more holistic view of science and that aims for a more sustainable future. Also in line with this, Sjöström and Eilks (2018) have been advocating an emerging vision of scientific literacy, called Vision III, which should imply a politicized Science Education aiming at emancipation and socio-ecojustice[9].

To summarize the ideas discussed so far and with no intention to exhaust the debate, we argue that a socio-political turn in Science Education should include:

1. Recognition that any form of education in science encompasses a political position (dos Santos, 2009; Freire, 1987). Therefore, it is up to us, who advocate the socio-political turn, to adjust our ways of doing Science Education to a position that meets a less unequal and more environmentally sustainable society.
2. Recognition that affirming a scientific education practice as optimized is linked to an objective, whether explicit or not (Biesta, 2007). Therefore, evidence-based practices may not work—or, more carefully, they may work to achieve other goals—in teaching contexts different from those for which they were proposed, since the contexts around the world are very diverse. If we are going to embrace the socio-political turn, it is necessary to realize that ready-made recipes are unlikely to be valid without major changes in multiple contexts. This is because the political contexts to which they report are very different from each other and the very story that is intended to be told about scientific knowledge was experienced by different perspectives in different locations around the world. For instance, in the region now known as Latin America, many peoples have had advanced knowledge about astronomy, and with the colonization process—and the decrease of at least 48 million people in the local population (Lewis & Maslin, 2015)—much of that knowledge was erased or expropriated. So, the story about who was privileged in the process (Nyhart, 2016) will likely vary according to who tells the story.
3. Recognition that knowledge and politics are intertwined all the time (Latour, 2016)—and that this is neither bad nor good, but it is an important characteristic for decision-making that may have been under-emphasized in previous proposals. In recognizing this, what comes together is the perspective that science does not have the power to solve all problems and that even "established scientific facts" need to undergo external scrutiny

[9] This call on politicized science education generated some interesting projects as STEPWISE Project by L. Bencze (www.stepwiser.ca) and "Climate Change before the court", by T. Feierabend and I. Eilks (Feierabend & Eilks, 2011).

> capable of evaluating, for example, its relationship with the sustainability of the planet and with the reduction of inequality. In addition, the availability of access to scientific facts that are still under dispute makes it even more important the need to have criteria that are not only the reliability of scientific information, but its usability and the consequences in the real that may arise from the use of that information—Santos (2009) names this precautionary principle procedure.

What could these three proposals mean for classroom activities and the design of curriculum proposals? In the case of proposal 1, this means that any proposal for classroom or curricular policy must take into account the political aspect of education and thus must reflect on the aims of the proposed actions and perspectives. In the case of curricular policy, it is important that such purposes dialogue with the different realities to which such policy is applied. This discussion relates to proposal 2, in the sense that, with local variation, the stories we intend to tell about the sciences can vary considerably according to the context. In this manner, questions such as "how does this discussion that I am proposing dialogues with my students' life contexts?"; "How does this proposal align with the urgent issues of the contemporary world, such as climate and social issues, even if indirectly?"; "Am I critically considering this idea based on research evidence in my implementation context?"; and "Do the stories about the sciences that I am proposing to work with relate to the life stories of this particular group of students?", among others, are possible guides for curriculum design and proposals for the classroom. Regarding the third idea, it is important that classroom practices are aligned with the perception of science as a robust but fallible human construction, that is, that it needs to continue to be considered as a producer of fundamental answers for our time, but that, for being limited and fallible, is not able to give all the answers. This idea, which could give rise to the risk of harmful relativism, in reality has its risk minimized as larger issues related to social justice and environmental issues (and the need to think about practices for a more sustainable world) are put in first place in proposal 2. Therefore, it is possible to critically evaluate (Yacoubian, 2020) the proposals that are most likely to approach, in practical terms, this more sustainable and socially just world that we intend to build.

There are different approaches that could lead to the acknowledgment of the political aspects of science in Science Education. In any case, we believe that the starting point, for an effective large range impact in contemporary education, should be a structural modification of the teacher training. We believe that the formation of pre-service teachers should encompass a political dimension as well as the technical and epistemic dimensions in such a way that it allows them to regard science as a complex practice. This formation implies, necessarily, to conceive the science teacher as a critical scholar and not a rationalist technician (Contreras, 1997).

7 Final Remarks

Our purpose in this article was, in response to the editorial call of Erduran (2020a), to discuss the role of HPSS in Science Education considering the crisis of COVID-19, as well as to think how Science Education could look like beyond the pandemic. That is, considering that this exceptional situation confronts us with certain aspects that can be considered more generally for Science Education. Considering these editorial provocations as a starting point, we indicate that the thesis to be defended in this article is that the contours of the public controversy involving COVID-19 bring elements that allow us to defend that Science Education needs to

embrace perspectives that highlight the role of politics as a co-constitutive of science, and not in a subsidiary role to it. To defend this thesis, we proposed an analysis of the public controversies surrounding COVID-19, in its most central aspects, trying to observe how the intertwining between science and politics took place.

With these objectives in mind, we produced a theoretical framework which stressed, from science studies and history of science, the thesis of co-production between science, society, and politics. We presented historical examples to illustrate this point, and, then, we used the arguments produced within this framework to analyze public controversies around COVID-19.

From the analysis of events related to COVID-19 around the world, we showed how politicians appropriated the discourses produced by science and how political decisions mobilized scientific production. In the first case, we noticed that the Chinese government decreed a lockdown in Wuhan when the first epidemiologists showed the danger of the virus (Bogoch et al., 2020; Hui et al., 2020). In the second case, when different countries in the world began to impose social distance and the closure of the productive sector, economists published papers revealing the impacts of COVID-19 on the global economy (Ahmed et al., 2020; Khalidi 2020). This result highlights the co-production between science/society and science/politics (Harding, 2015; Jasanoff, 2004, 2015; Latour, 2016).

Still using the theoretical frameworks mobilized and the case study on screen, we synthesize the main lessons of such an episode, explicitly highlighting the evidence of the intertwining between epistemology and politics, confirming the thesis of co-construction between science and society and therefore emphasizing the need to approach this perspective in Science Education. We point out that there are already initiatives in the literature that, in our interpretation, move towards showing this co-construction in more depth[10] (Bencze, 2017; Marques & Reis, 2017; Alsop & Bencze, 2014; Erduran & Dagher, 2014; Dagher & Erduran, 2016, among others), which need to be emphasized or more confronted with empirical data so that we can understand in what ways advances in this research program are possible.

In defending a socio-political turn in Science Education (Tolbert & Bazzul, 2017) like Gutiérrez (2013) in mathematics education, we point to two paths: the first is to rethink how we stabilize the meanings of what Science Education is and how we can (Moura, 2021) and should move in this field. The second path concerns how we can move forward with a research program at HPSS that embraces this proposal. We present conceptual reasons that reinforce certain emerging views such as the Cultural History of Science (Moura & Guerra, 2016) and the Global History of Sciences (Gandolfi, 2019) as possible paths in Science Education to achieve the socio-political turn. Analyzing the limits of our proposal, we stress out the need for empirical studies that confront the conceptual reasons presented in this study so that this path can be trodden more robustly. Finally, we summarize some general proposals for questions and reflections that could be included both in the planning of actions in the classroom that consider the socio-political turn as well as in the design of curricular policies that embrace the discussions proposed in this article.

With all this, we also seek to show the value of case studies (although this case study is very unique in our history) as a generator of reflections for Science Education in general. We hope that the Science Education community (and other academic communities) will not wait for new serious moments like this to think and implement changes in our ways of life on Earth that will lead to a more socially just, equal, and environmentally sustainable world in the future.

[10] In recent article, Bencze et al. (2020) analyze some of the premises of "Science in Context" lines of research, in particular Socio-scientific issues (SSI), Socially Acute Questions (SAQ) and Science, Technology, Society and Environment (STSE) movement. It seems to us that especially SAQ are closer to the decentering from science that we are proposing in this paper, although all of them generally goes in line with main political premises we depart from.

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Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

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