The Committed Objectivity of Science and the Importance of Scientific Knowledge in Ethical and Political Education

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Abstract

Despite advances in discussions about the nature of science, there is still a paucity of discussion on the ontological dimension of science in science education research that makes it difficult to defend its content and teaching. In this article, the reasons for trusting science and science education are analyzed through three arguments. The first is that both the belligerent obscurantism and fake news of the ultra-right and the postmodern relativism of sections of the leftwing are connected to objective movements from the capitalist socioeconomic reality. The reestablishment of trust in science and its teaching requires an effort to understand the contemporary social contradictions, problems, and challenges. The second argument is that scientific knowledge does not need to abdicate objectivity in order to ground ethical and political positions. The third argument is that the socialization of scientific knowledge through school education is a necessary, albeit insufficient, condition for the ethical–political education of younger generations. The article concludes by stating that it is necessary to overcome the choice between an education that is supposedly neutral in political and ideological terms and an education that rejects the socialization of scientific knowledge in the name of respecting the multiplicity of culturally rooted voices from within the different oppressed groups present in today's society.

Indeed, it is precisely because the findings of science are a constant threat to the spontaneous consciousness of everyday life sanctified by the authority of culture, that doing and teaching science had a subversive quality in my social milieu. It is the contra-conventional character of science that made it an ally of those of us engaged in an internal critique of some of the inegalitarian elements of our culture. The findings of modern "Western" science enabled us to show—with empirical evidence that was publicly testable—that no matter what the consensus of local community is, no matter what the powers that be claim, some social values and some facts of nature

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that these values are informed by, are wrong and must be rejected as false. (Nanda, 1997, p. 307).

1 Introduction

Research in science education has depended directly on advances in the historical, social, and philosophical understanding of science to improve its curricula and methodologies. Villani et al., (2010) trace the historical development of this research area in Brazil, in parallel with movements abroad, explaining this dependence. Historically, different theoretical and practical conceptions of science teaching were accompanied by different conceptions of science.

Initially, traditional teaching models were coupled with static and supposedly neutral views of science. Next, the technicist perspectives and teaching by discovery or rediscovery adopted premises that overvalued experimentation and the scientific method as teaching instruments, transmitting a vision of empirical and positivist science. For many researchers in the field, the constructivist models, as well as those of alternative conceptions and conceptual change, were accompanied by relative advances in discussions on the nature of science. They advocate an investigative approach based on raising hypotheses, sharing ideas among students, developing argumentation, and establishing collective consensus, thereby simulating the activities of the scientific community. This set of guidelines on the nature of science became consolidated, over time, into what is now called the “consensus view” (Lederman, 1992; Lederman et al., 2002; Lederman, 2007). Lederman’s theoretical and investigative perspective on the nature of science identifies characteristics of the production of scientific knowledge in the form of lists, such as the famous Lederman Seven, which highlights its social and historical contextualization, its collective development, its empirical and theoretical character, among others. This view is currently criticized, in the sense of transcending lists, adopting a vision of science that considers, mainly through case studies, the economic, social, and political characteristics within the scientific community that impact its relationship with society and differentiate the specific characteristics of each field of knowledge as opposed to a generic reference to science (Allchin, 2011; Allchin et al. 2014; Clough, 2007; Hodson, 2014; Irzik and Nola 2014; Matthews, 2012; Schizas et al., 2016).

Although the area identifies these advances, there are many problems to be explored, among which we highlight those related to the ontological dimension of science. Consequently, issues such as the relationship between science and religion (Bagdonas & Silva, 2015; Mahner & Bunge, 1996) or even the position of the ethnosciences in science education (Zidny et al., 2020) remain unresolved.

In this context, the open, democratic and mutually critical debate in the articles that compose the special issue of *Science & Education*, organized by Matthews (2009), gains special relevance, in which the relations between science, worldviews, and education are discussed from different perspectives. We agree with Irzik and Nola (2009), when they state that “The current literature tends to characterize worldviews too narrowly. As we will see, worldviews attempt to answer a range of important questions about life and the world, not all of them religious” (p. 730). We also agree that “science has worldview content” and that this fact “has important implications for science education” (p. 730). Matthews (2009) expressed his expectation that this particular issue of *Science and Education* contributes “to a more refined and sophisticated understanding of the interplay between worldviews

and science; and indicates how scientific education can contribute to the formation of more informed, intelligent, and responsible worldviews, and thus to a better and more humane culture” (p. 651). It is this same spirit that motivates us to present our contribution to the search for answers to the central question of this special issue: Why trust in Science and Science Education?

As such, in this article, based on historical-dialectical materialism and the ontological and gnosiological dimensions of science, we use three arguments to propose that analysis of the reasons to trust in science and its teaching should consider the objective movement of capitalist society in recent decades: the dialectical unity, in scientific knowledge, of objectivity and ethical–political positioning, which we call *committed objectivity* and, as a result, the necessary socialization of science through school towards an ethical–political education.

The first argument is that the belligerent obscurantism¹ and fake news of the ultra-right, in addition to postmodern relativism and the denial of scientific knowledge’s objectivity, are expressions, on the level of ideas, of objective movements from the capitalist socioeconomic reality. Thus, the reestablishment of trust in science and science education needs to be seen as part of a larger effort to understand the contradictions, problems, and challenges that capitalist society poses today to humanity as a whole. It is not enough, however, to simply state capitalism’s limitations in overcoming major social problems; as Foster (2019) pointed out, we need to seek answers to the question: what next?

The second argument is that our choice need not be limited to two options: the anti-scientific attitude sustained by certain worldviews or the defense of scientific knowledge’s objectivity as something that implies political and ideological neutrality. Scientific knowledge does not need to abdicate objectivity in order to substantiate ethical and political positions in the face of the problems that afflict humanity today. The fallible and historically situated character of scientific knowledge does not diminish its importance in understanding natural and social reality and in developing plans for transformative action. The limits, gaps, inconsistencies, and contradictions present in scientific knowledge are surmounted in the historical process of production, dissemination, and incorporation of this knowledge into people’s thinking, practice, and life. Believing that it is possible for science to progress in the production of objective knowledge does not in any way imply that science possesses the absolute, definitive, and unquestionable truth. As Sayer (2010, p. viii) explains:

Of course, social science, like natural science, cannot provide ‘a royal road to truth’. No matter how well chosen our methods may be, our ways of thinking may still let us down. Knowledge is fallible, that is, capable of being mistaken about its object. The truth or adequacy of our ideas is a practical matter, and something that we can try to improve. (...) the nature of the world is largely independent of an observer’s ideas about it, and it is this that explains both the adequacy and fallibility of our knowledge, such as it is.

In the same way, the fact that science is embedded in social relations that involve struggles, conflicts, and economic and political power, as well as disputes between conflicting

¹ We define belligerent obscurantism as the individual and collective attitude of permanent struggle against the advance of knowledge and its diffusion. We qualify this obscurantism as belligerent both for its ostensibly aggressive attitude against scientists, teachers, artists and journalists, and also due to its vision of social life as a constant war in which the other is treated as an enemy to be slaughtered and, if possible, eliminated.

worldviews, does not imply the impossibility of knowing what reality is, the internal processes that move it, and the possible directions that these processes may take (Löwy, 1987).

Similarly, our third argument is that the democratization of scientific knowledge's mastery, that is, its socialization through school education, is a necessary albeit insufficient condition for the ethical–political education of younger generations. In this case, it also seems to us to be possible and necessary to go beyond the choice limited to two options: a politically and ideologically neutral education that aims to bring scientific knowledge to all, or an education that rejects the socialization of scientific knowledge in the name of respecting the multiplicity of culturally rooted voices from within the different oppressed groups present in today's society. We believe that the argument proposed by Wheelahan (2010, p. 145) regarding theoretical knowledge in general is valid when applied to the teaching of scientific knowledge in schools:

Access to theoretical knowledge is an issue of distributional justice because society uses it to conduct its conversation about what it would be like. Society uses theoretical knowledge to think the unthinkable and the not-yet-thought, and this makes such knowledge socially powerful and endows it with the capacity to disrupt existing power relations. It plays this role because it is society's collective representations about the social and natural worlds, and we use it to access these worlds to understand how they are constructed, their process of development and how they can be changed.

In the following three sections we develop our argument.

2 Science and Its Teaching as Part of the Objective Movement of Capitalist Society

There is nothing new about the observation that every time the contradictions of capitalism become more acute and more evident, cultural changes occur in the direction of moving away from the search for the production and dissemination of objective knowledge about society. Georg Lukács (1980), in his 1938 essay entitled “Marx and the problem of ideological decline,” argued that from the second half of the nineteenth century onwards, the contradiction between the need for objective knowledge to help solve problems arising from capitalist economic production and the equally necessary diffusion of ideas that prevent people from objectively knowing the society of which they are a part has become increasingly problematic. In the sciences that study society, the ideological struggle against truth shows itself in a more immediately visible way. However, this does not mean that it does not also exist in the natural sciences. This has become particularly evident today through the ideological disputes that have brought to the forefront, in the international media, pseudoscientific explanations that reject and delegitimize scientific evidence that certain productive activities have decisively contributed to global warming and consequent climate change.

Although there is scientific evidence proving the negative impacts on nature generated by the capitalist mode of production and reproduction of social materiality, the legitimacy of this knowledge and its dissemination are hindered by very strong economic and political interests:

Since science provides the basis for the most legitimate discourses in industrial society, those who are questioned by it tend to react by supporting arguments that also

have to be presented as scientific, even if they are not. On almost every occasion in recent decades when powerful economic interests are confronted, this has led to the development of a kind of pseudoscientific controversy, whose purpose is to 'keep the debate alive' in order to 'delay' the approval of that which might hurt those interests. (Leite, 2015, p. 659)

Science, as a result of ideological disputes, needs to be questioned as a type of knowledge that, in order to reveal the truth, must maintain a constant critical position in relation to the economic, political and cultural interests that limit its objectivity. The contradictory movement of society implies considering various pseudoscientific mechanisms sustained by media apparatuses and dictatorial systems, which relativize scientific knowledge by valuing, controlling, and maintaining ideologies that obscure access to the truth. However, contrary to first impressions, this does not mean that science should remain aloof, distant, and omissive in relation to social problems. The freedom to pursue the truth is not increased by embracing an illusory belief in social disengagement of the practice of producing scientific knowledge.

Over the last decade, the worldwide spread of belligerent obscurantism is a phenomenon that has its origins in the crisis of capitalism that, in the 1970s, put an end to the economic cycle of expansionist growth from the post-World War II period. It was not by chance that, in that same decade, the dictatorship implanted in Chile, under the leadership of General Augusto Pinochet, adopted an economic policy directly guided by Milton Friedman and the Chicago Boys. It was also no coincidence that in 1979, Margaret Thatcher was elected as prime minister of England and Ronald Reagan became president of the USA in 1981. In the same period, postmodernism became a major academic and cultural fad, proclaiming the end of modernity, the emergence of a new society, and a new human condition. Smith (1994) questions the premise that undeniable social changes produced a post-capitalist society and a postmodern condition. He argues that "the rise of postmodernist thought coincided with a significant conjunctural transition in the history of twentieth-century capitalism; but the 'restructuring' that we are now witnessing changes nothing essential about the laws of motion of capitalism" (p. 236). The disdain shown by most proponents of postmodernism on the question of relations between society's economic base and the political, ideological, and cultural superstructure can be interpreted as the flipside of the neoliberal thesis on the autonomy of economics from politics. In turn, this separation between, on the one hand, the contradictions that move the economic base and, on the other, the social activities at the superstructural level amounted to a denial of the possibility for objective and rational knowledge regarding the movement of social reality as a whole.

Wainwright (2018) explains that one of the arguments employed in favor of neoliberalism by one of its main theorists, the Austrian Friedrich August von Hayek, is that one should let the market spontaneously determine the directions of society because human beings are unable to know and understand the social totality. As Mackenzie et al. (2014) point out in their critical analysis of postmodern assertions incorporated into the field of Science Education, postmodernism is emphatically opposed to any theory that aims to explain reality as a totality. The localism of the post-modern conception of knowledge and the centrality of tacit knowledge in the neoliberal view of social practice converge to spread an epistemological perspective that denies the possibility for distinguishing between objectivity and subjectivity. Segal (2001), explaining the central ideas of Heinz Von Foerster's constructivism, explains that:

Von Foerster - cybernetician, mathematician, physicist, and philosopher - claims that we CONSTRUCT or INVENT reality rather than discover it. He suggests that we

fool ourselves by first dividing our world into two realities - the subjective world of our experience, and the so-called objective world of Reality - and then predicating our *understanding* on matching our experience with a world we assume exists independently of us. (Segal, 2001, p. 13)

In the educational field, postmodern relativism and anti-realism resulted in a reinvigoration and renewal of progressive pedagogies. This is not a new problem in education: a direct identification between progressive political positions and the so-called progressive pedagogies, on the one hand, and between conservative political positions and so-called traditional education, on the other. Entwistle (1979) showed that Antonio Gramsci (1891–1937) had already criticized this kind of identification: “In the light of Gramsci’s analysis, it is arguable that we need to reconsider the conventional equation of traditional didactic schooling with political authoritarianism, and the progressive education with democracy” (p. 3). In Gramsci’s time, the fascist regime carried out educational reform inspired by progressive pedagogies. At the end of the twentieth century, many neoliberal governments implemented reforms of educational systems and school curricula also inspired by new progressive pedagogies such as constructivism, multiculturalism, problem-based learning, and competence-based pedagogy. In the spirit of postmodernism, the curriculum reforms of the late twentieth and early twenty-first centuries have operated with “a pastiche of theories and approaches that draw from sometimes opposing theoretical premises, which are then blended by processes or recontextualization” (Wheelahan, 2010, p. 134).

The advance of the new ultra-right in many countries, aided by fake news, conspiracy theories, and belligerent obscurantism, has triggered the alarm bell for several social and educational groups that had been identifying epistemological relativism with progressive political positions. For example, faced with the denial of global warming, the holocaust and, in the case of Brazil, the crimes committed by the military dictatorship from 1964 to 1985, a sizeable portion of the left had to review the association between the idea of truth and positivism. In fact, this had been foreseen by Hobsbawm (1997, p. VIII) when he stated that:

relativism will not do in history any more than in law courts. Whether the accused in a murder trial is or is not guilty depends on the assessment of old-fashioned positivist evidence, if such evidence is available. Any innocent readers who find themselves in the dock will do well to appeal to it. It is the lawyers of the guilty ones who fall back on post modern lines of defense.

In this context, science and its teaching, as part of the objective movement of capitalist society, play an important social role in education through the possibility of access to objective knowledge. The non-relativization of this type of knowledge can contribute as an instrument that enables the verification of truth in benefit of a world conception that does not imprison the human being, but promotes freedom in the life of individuals. As such, objectivity and subjectivity are united in the historicity of the social process for achieving freedom, since knowledge of nature in its objective existence facilitates the conscious activity of mastering natural processes.

The realization that epistemological relativism is an expression of the objective movement of capitalist society in recent decades underscores the importance of focusing debate on the need to restore trust in science and science education. To be reliable, science cannot absent itself from the ideological struggle that conceals the economic interests that sustain social inequalities. Its gnosiological dimension, as the material expression of the world’s conception, cannot confuse truth with the political and ethical neutrality of an unquestionable science, but rather consider the ontological dimension involved in the search for

objectivity. This means that science, as a result of antagonistic economic relations, needs to reveal the contradictions through the involvement of science, scientists, teachers, and students with the social problems and conflicts that mark each society and each era of human history.

3 In Defense of the Committed Objectivity of Science

Discussion about the objectivity of scientific knowledge has been marked by two false assertions: (1) the positivist syllogism that if there is no neutrality there can be no objectivity; (2) the multiculturalist premise that the fact that the origin of all knowledge is situated historically, geographically, and culturally, as well as influenced by economic and political interests, makes objectivity impossible and entails, among other things, the denial of all knowledge's universal value. Thus, we realize that objectivity has historically been contested by different hegemonic epistemological perspectives.

The first assertion, namely, that because knowledge is not neutral it cannot be objective either, is a consequence of a positivist syllogism whose major premise is that "there is only objective knowledge where there is neutrality" (Saviani, 2011, p. 49). The Brazilian educator Dermeval Saviani argues that this association confuses ideological elements, neutrality, with gnosiological aspects, objectivity. It is worth historically situating this author's text in the context of the debates that took place in Brazil when it was first published.

In the first half of the 1980s, when democratic forces in Brazil were fighting for the end of the dictatorship that had begun in 1964, there was a perspective in the field of critical Brazilian educational thought that tended to identify the defense of knowledge's objectivity with positivist epistemology and, consequently, with the technicist vision of education adopted by the military dictatorship. Since the technicist conception postulated that education should adopt the assumption that the objectivity of scientific knowledge required its neutrality, many educators who opposed educational technicism believed that it was necessary to oppose the idea that knowledge can be objective. It was in this context that, in 1983, Saviani (2011) published a text that was later transformed into a book chapter in which the author presented what he called: *first approaches to critical historical pedagogy*. In this text, the author called attention to the positivist trap in which critical educators were caught, and that they were throwing the baby out with the bathwater by denying knowledge's objectivity and claiming it was necessary to emphasize non-neutrality. According to Saviani (2011), certain sociopolitical interests oppose objectivity, while others not only do not do so but, on the contrary, demand the objectivity of knowledge. As such, the author argued that schools, from the perspective of their engagement in the pursuit of the democratization of Brazilian society, should strive towards universalizing the mastery of objective knowledge about nature and society.

Returning to the discussion regarding objectivity, Löwy (1987) analyzes the sociology of knowledge by critiquing the various epistemological currents and their relations to the attempts at scientific objectivity that emerged within positivism, historicism, and Marxism. Initially, he highlights the effort to achieve objectivity through the "good will" that was present in the positivist ideology of Comte and Durkheim, for example. Löwy (1987) compares this effort to the children's story of the Baron Munchausen, who manages to escape from a swamp by pulling himself out by his own hair. In these cases, the identification between objectivity and neutrality remains in the ideological realm, since the positivist effort is in the sense of erasing the interested character of knowledge. Löwy (1987) also

analyzes other attempts, such as Karl Popper's, who defends the existence of an institutional objectivity of science. This objectivity would be achieved by aspects of scientific knowledge production, such as freedom of criticism, a common language, the public nature of the method and scientific institutions. Thus, Popper does not resolve the problem, but rather transfers it to a higher level (Löwy, 1987). There is a relative advance, as the discussion becomes gnosiological, supporting objectivity in methods and institutions. Addressing historicism in its conservative/reactionary and relativist facets, Löwy (1987) considers the contributions and limitations of Karl Mannheim's thinking on the need for a critical scientific self-awareness, requiring a new objectivity of scientific knowledge. Although marked by a "sophisticated positivist" relativism, this moment is, according to the author, one of the most fruitful aspects of the historicist tradition for modern sociology, since it problematizes social-scientific objectivity. However, these elements have been constantly manipulated, showing themselves to be fragile in terms of theoretical tools that enable scientific knowledge to be more developed and engaged in its ability to explain reality. Presenting possibilities for advances in a dialectical perspective, Löwy (1987) draws on Lukács and Goldmann to overcome the relativistic impasse of a contemplative science and purely ethical action through the engaged character that indissolubly unites science and class consciousness, knowledge, and praxis. Therefore, it evinces the interested character of all natural and social scientific knowledge, seeing as class consciousness can permit greater or lesser understanding of reality, depending on the progressive or reactionary role a class plays at a given historical moment.

Löwy (1987), Lukács (2012), Saviani (2011), and Wheelahan (2010) argue in different ways that the objectivity of knowledge is not necessarily rendered impossible by the fact that production activities are embedded in power relations.

If the world exists objectively and is not a construct of our minds or discourse, then the purpose of knowledge is to understand that objective reality, even if our knowledge is always partial, socially mediated and marked by the social conditions under which it was produced, and is fallible as a consequence. (Wheelahan, 2010, p. 10)

The fact that scientific knowledge is embedded in the fabric of social power relations is also not an argument for not democratizing access to it. The very decision to democratize scientific education or not is, in itself, an ethical and political position.

Knowledge will inevitably bear the marks of its production because it is socially produced, reworked and modified by communities of knowledge producers, and the state of our knowledge must at any time be regarded as a work-in-progress. However, while knowledge will bear the marks of power and privilege that is not all that it does. Arguments about distributional justice are concerned with ensuring equitable access to knowledge as a work-in-progress so that the less powerful can contribute to the shape and nature of knowledge and this includes participating in defining what is important in knowledge fields. (Wheelahan, 2010, p. 09)

Lukács (2012), in his ontology, states that reality exists and can be known objectively. He argues that the natural sciences perform a process of disanthropomorphism, that is, they remove human aspects from the explanation of natural phenomena. One of the aspects of disanthropomorphization is the elimination, in the explanation of natural phenomena, of any remnant of teleology, that is, purely natural processes are not driven by purposes, but by causalities. In the case of the social being, reality is driven by a dialectical relationship between causality and teleology. However, this does not mean a separation between nature and society, which would be impossible, but only the rejection of the anthropomorphic

universalization of teleology, which is a specific characteristic of human activity that produces the movement of causalities to achieve certain ends. This discussion shows that objectivity cannot be fully reached, in the sciences of nature and society, without understanding reality as a totality. For Lukács (2012), science has two possibilities for development: (1) to substantiate a conception of the world based on a materialist, historical, and dialectical ontology; or (2) to fulfill a merely instrumental and technical role, being more or less conscious of market logic. In this second restrictive and contradictory focus, objectivity is limited to technique and avoids as much as possible making extrapolations in terms of worldview. This second position can be exemplified by a passage from *Life of Galileo* (Brecht, 2015, p. 97) in which Cardinal Bellarmine says: “We must move with the times, Barberini. If new star charts based on a new hypothesis help our mariners to navigate, then they should make use of them. We only disapprove of such doctrines as run counter to the Scriptures.” Lukács (2012, p. 38) cites this passage to illustrate the cynicism of the two-truth theory that admits the advances of science for practical uses that serve the interests of the ruling class while rejecting out of hand any implication of these advances that might clash with the dominant ideology. The development of the productive forces by the bourgeoisie could not be stopped, so science became limited to a technique fragmented from its ontological dimension. Thus, the natural sciences have a core of objectivity that maintains its validity when separated from the logic of capitalist production. Capitalism needs the advance in knowledge of nature, although it has to curtail the diffusion of knowledge, which still needs to be the privilege of specialists.

In France and England the bourgeoisie had conquered political power. From that time on, the class struggle took on more and more explicit and threatening forms, both in practice and in theory. It sounded the knell of scientific bourgeois economics. It was thenceforth no longer a question whether this or that theorem was true, but whether it was useful to capital or harmful, expedient or inexpedient, in accordance with police regulations or contrary to them. In place of disinterested inquirers there stepped hired prize-fighters; in place of genuine scientific research, the bad conscience and evil intent of apologetics. Still, even the importunate pamphlets with which the Anti-Corn Law League, led by the manufacturers Cobden and Bright, deluged the world offer a historical interest, if no scientific one, on account of their polemic against the landed aristocracy. But since then the free-trade legislation inaugurated by Sir Robert Peel has deprived vulgar economics even of this, its last sting. (Marx, 1990, p. 97)

As we have shown, being socially engaged, and therefore not neutral, does not mean that scientific knowledge is not objective. Löwy (1987, p. 104—author’s italics) indicates that “bourgeois ideology does not imply the *negation* of all science, but the existence of barriers that restrict cognitive visibility”. Since knowledge is never on the sidelines of ideological struggle, it has consequences for worldviews and class struggle.

Some postmodern perspectives justify cultural relativism affirming that the available knowledge we have is that which was imposed by the victors. As such, in order to fight for emancipation, they claim that there is no objective knowledge. The reduction of knowledge to a struggle between narratives whose legitimacy is assigned only by power relations had the effect predicted by Hobsbawm (1997), that is, it has served the interests of those who need to conceal the truth. The extreme right has made intense use of this strategy to “rewrite” history, denying the Holocaust, the dictatorship in Brazil, global warming, etc. In opposing postmodern relativism, we affirm that there are political and economic interests that historicize scientific knowledge, but they do not directly imply the non-objectivity of this knowledge. These interests are associated with the objectivity of the material

world and, at the same time that science is influenced by the objective undertakings of the class that holds economic power, generating, among other things, the over-specialization of scientific knowledge with a view to its instrumental economic use, this process does not fail to produce objective advances in the sciences. Dialectics is necessary precisely to understand this historical movement of the sciences in its contradictory character, without falling into Manichaeism. An example in this sense is the scientific research aimed at the production of pharmaceuticals. The powerful economic interests that drive this research are well known. It is also known that these interests can lead to processes of induction of diagnoses and treatments not necessarily beneficial to patients, but that serve the interests of industry investors. This requires a permanent critical vigilance in relation to the knowledge produced in the area, but this can only be done with the resources of science itself and not through campaigns that spread prejudice against science, as is the case of anti-vaccine propaganda.

An example of this complexity can be seen in a recent episode involving the dispute between laboratories over the launch of the Covid-19 vaccine. According to an article by Feuerstein (2020) on the website *STAT News*, “There are currently nine vaccine candidates in Phase 3 trials. AstraZeneca’s is the first Phase 3 Covid-19 vaccine trial known to have been put on hold.” One investor, during a private conference call with investors on Wednesday (September 9, 2020), reported that Pascal Soriot, the CEO of the British-Swedish multinational pharmaceutical and biotechnology company, AstraZeneca, said:

were intended to reassure investors that the company was taking the possible vaccine safety event seriously, and to reverse any damage to the company’s stock price. “A vaccine that nobody wants to take is not very useful,” said Soriot. To date, AstraZeneca’s public statements on the pause have been sparse with details. For instance, the company has not publicly confirmed that this is the second time its trials have been stopped to investigate health events among participants. (Feuerstein, 2020, September 9)

The repercussion of this episode weeks later, on Nov. 27, 2020, when “Astra shares fell 0.8% by 8:57 a.m. in London trading Friday, bringing the decline this week to about 8% amid questions about trial results” (Ring & Paton, 2020, November 26).

The contradictory interests between objective knowledge and economic power relations underscore the trust that can be placed in science in the face of human need. As Löwy (1987) points out, they restrict cognitive visibility. The population, in turn, is left to fend for itself, on a path that increasingly compromises access to the knowledge needed to build an objective view of nature, making room for conceptions that anthropomorphize natural phenomena (Lukács, 2012), as we have seen with creationism, flat-earthers and anti-vaccine movements. The absence of access to scientific knowledge causes fear, rejection, and uneasiness in relation to this prophylactic procedure, as indicated by Succi’s studies (2018). She shared data from a survey carried out in 2016, entitled, *The State of Vaccine Confidence 2016: Global Insights Through a 67-Country Survey* (Larson, et al., 2016), to assess people’s perceptions about the safety, efficacy, and importance of vaccines, as well as compatibility with their religious beliefs, interviewing 65,819 people in 67 countries. The results of the survey point out that:

The determinants of vaccine refusal/hesitancy are complex and can be attributed to the confluence of several sociocultural, political, and personal factors; doubts about the actual need for vaccines, concerns about vaccine safety, fear of possible adverse events, misconceptions about the safety and efficacy of vaccines, concerns over a possible “immune system overexposure,” past negative experiences with vaccines, mistrust

of the seriousness of the vaccine industry and the healthcare system, heuristic thinking, and philosophical and religious issues may be involved. (Succi, 2018, p. 576)

The determining factor that appears as the main cause of this context is “The access to information (and misinformation) on vaccines released by the media influences decision-making on whether or not to vaccinate” (Succi, 2018, p. 576).

Both the hesitations over vaccines and the economic disputes over laboratories also highlight the trust one can have in science education. The scientific knowledge accumulated by biology since the mid-nineteenth century through Darwinian theory seems to have no space as knowledge that enables a disanthropomorphized reflection of reality. We still experience debates about the space for creationism or evolutionism in schools, and there are authors who defend the coexistence of both views in science classes (Sepulveda and El-Hani, 2004). Science education, understood as the space for pedagogical work with fundamental concepts of the theory of evolution, seems not to affect the class interest of working populations, as the promotion of a materialist, historical, and dialectical conception of the world in the relationship between nature and society. Basic principles of the evolutionist theory, such as variability, genetic background, and selection, still remain as a valid core to explain sanitary, infectious, and prophylactic principles, and could reveal the truth through a scientific knowledge committed to the exploited classes, especially because they are the most affected and exterminated by epidemics resulting from the way of producing life in capitalism.

Still on Darwinism, considered one of the most important revolutions in science, it is possible to identify several disengaging distortions that, as indicated above, do not invalidate its valid core. Jair Bolsonaro’s Brazil has turned us into a factory of coronavirus variants, proving the authenticity of the theory of evolution on a daily basis. In a human cell, over a 24-h period, coronavirus can produce up to 100,000 copies of itself (Ansele, 2020, April 03). Each replication of the virus can create several variants, among which some are better adapted to our organism and to the virus’ survival. Despite copious evidence to prove this theory, it is not safe from various pseudoscientific distortions. One of the best known cases is Social Darwinism, which has been constantly revived in history to justify social inequalities as if they were natural. Lukács (1981) analyzes race theory, from its beginnings in the eighteenth century in Gobineau’s Racial Theory Argument, through Social Darwinism and up to the ideas of Chamberlain as the Founder of Modern Racism. The author points out that biologism, employing disfigured and deformed biological concepts, has always been the basis of reactionary ideological trends.

Like Lukács (1981), Saviani (2011) shows how the bourgeoisie sometimes denies, other times claims—depending on the role it assumes in history—an ideological defense of privileges based on equality/inequality among men and women. Hence, albeit without scientific substantiation, the race theory resurfaces historically, seeking arguments in the scientific theories in force and counting on the backing of scientists. The concept of race has existed since the eighteenth century, but it was in the nineteenth century that it gained more strength as a category used to differentiate human beings and hierarchize their physical, emotional, and cognitive qualities, justifying various forms of exploitation. Gobineau, according to Lukács (1981), produced the first work that reconstructed the entire universal history based on race theory, reducing all crises, conflicts, and historical and social differences to races. But only with Social Darwinism did this theory manage to assume a modern character of scientificity (Lukács, 1981). As such, the theory of evolution, which represented a true revolution in the conception of the world, “became the cliché” capable of unifying the sciences of nature and society (Lukács,

1981, p. 683). The strength of this ideology refers to its ability to no longer deny the perverse aspects of capitalism, but to affirm and justify them as immutable, natural, and eternal (Lukács, 1981). Finally, Chamberlain develops race theory by arguing that the value of science lies in its methodological applicability rather than its truth content (Lukács, 1981). Thus, as we observe in the context of maritime expansion, the theory of evolution becomes a technique stripped of its ontological character and its ability to explain the world (Lukács, 1981, 2012).

If science is reduced to an instrumental function, scientific knowledge will be considered important or not for school curricula depending on the assessment of its usefulness in adapting individuals to the status quo of the market society. In circumstances where scientific knowledge can go beyond this adaptive function and produce questioning in relation to dominant worldviews rooted in common sense, all kinds of supposedly epistemological, pedagogical, ethical, and cultural arguments are raised so that this knowledge is not inserted in school curricula, or is removed from them. Feeling helpless, the population resorts to tradition, family life history, friends' opinions, and pseudoscientific information to the detriment of historical and systematized knowledge. Discussions about the relevance of science in school curricula cannot, therefore, separate epistemological and pedagogical issues from the historical analysis of science as a permanent and dialectical process of approaching the truth. As Saviani (2011, p. 51) states: "Historicization, then, instead of denying the objectivity and universality of knowledge, is the way to rescue them."

The historicity of knowledge does not only mean that it is transformed throughout history and that knowledge taken as true in a given social and historical context may later be considered partially true or even as entirely false. Likewise, to assume that the process of pursuing the truth is historical does not imply an attitude of total relativization of said truth. It is a process that makes advances, marked by contradictions, struggles, gains, and setbacks, which allow us to affirm that certain knowledge is closer to the truth than others.

Marx's second thesis on Feuerbach, regarding the relationship between the objective truth of thought and practice, is well known:

The question whether objective truth can be attributed to human thinking is not a question of theory but it is a practical question. Man must prove the truth, i.e., the reality and power, the this-worldliness of his thinking in practice. The dispute over the reality or non reality of thinking which isolates itself from practice is a purely scholastic question. (Marx, 1998, p. 572)

It turns out that this thesis can be misunderstood if one does not distinguish between the everyday practice of individuals and social practice throughout history. In other words, one must distinguish the relationship between thought and action in the everyday life of individuals from the relationship between theory and practice in the social evolution of science and philosophy. Heller (1984, p. 203) states that everyday knowledge is always opinion, *doxa*, that is, it is never *episteme* (science or philosophy) and argues that *doxa* is verified in practice, but it is not about social practice as a whole but rather the immediate utilitarian practice of everyday life:

As we know, *doxa* is inseparable from practical activity: it is in practical activity and nowhere else that *doxa* is verified. But this does not refer to *praxis* as a whole or even to a major segment of it; it is always in certain types of particular concrete and successful action that *doxa* is verified. (Heller, 1984, p. 203)

The relative or absolute, particular or universal character of scientific truths is demonstrated by *praxis* throughout human history. *Praxis*, in this sense, is not synonymous with

practical activity as distinct from theoretical activity, but is the historical human activity of transforming the world and creating the human world:

In its essence and generality, praxis is the exposure of the mystery of man as an onto-formative being, as a being that forms the (socio-human) reality and therefore grasps and interprets it (i.e. reality both human and extra-human, reality in its totality). Man's praxis is not practical activity as opposed to theorizing; it is the determination of human being as the process of forming reality. (Kosik, 1976, p. 137)

But this historical understanding of the advancement of scientific knowledge requires a vision that recognizes the existence of development in history, but driven dialectically by contradictions and struggles that can often produce setbacks, stagnation, and even irrecoverable losses. Sayers (1985) discusses the relations between the progress of knowledge and the nature of truth based on the philosophical reference of Hegelian-Marxist dialectics. In this context, he argues that observation of the existence of historical progress in knowledge does not imply a teleological view of history:

I should make it clear, however, that when I say that the development of knowledge involves progress, I do not mean an inevitable or necessary progress towards a predetermined end. Indeed, I would specifically deny this. For it seems all too possible that humanity will destroy itself, or come so near to doing so as to set the course of history back catastrophically. Unlike the nineteenth century idealists, I am not suggesting that there is a teleology, immanent either in ideas or things, driving them towards a predestined goal. Nevertheless, the development of knowledge, as a matter of fact, has a progressive form. If one looks at the course of history, a pattern of progress is apparent. Or, to put it in a less empiricist manner: the development of knowledge can be adequately and coherently comprehended only in terms of the view that it has involved progress. (Sayers, 1985, p. 164)

This endless historical approach to truth is analyzed by Lukács (1978) by reference to two decisive issues for the dialectical method in Marx. One is the dialectic between concrete and abstract in the process by which thought seeks to explain the complexity of concrete reality by taking two paths:

from the concrete reality of singular phenomena to the highest abstractions, and from these again to concrete reality, which - with the help of the abstractions - can now be understood in an ever more approximately exact manner. Here it must be stressed, especially for our considerations, precisely the approximative character of science. (Lukács, 1978, p. 103)

The other question refers to the dialectic between singularity, particularity, and universality. For Lukács (1978), science is always in search of universal laws, but with the advance of knowledge that which at one time was interpreted as a universal law is subsequently embedded in broader theories, thus becoming a particular manifestation of laws provisionally deemed universal. Furthermore, according to Lukács (1978), the scientific theoretical elaboration of new universalities reveals new previously unknown particularities whose study will produce increasingly enriched comprehension of universalities.

But neither the relations between the concrete and the abstract nor the relations between singular, particular, and universal exist only as movements of thought. They exist first and foremost in objective reality itself, and understanding the historical relations between theories and reality requires that we do not lose sight of the question involving the relations between theory and practice, provided that practice is not confused with everyday utilitarianism and theory with pragmatic thinking. Sayers (1985, p. 179) quotes Hegel who stated

that “the truth is whole,” but Sayers adds that “the whole involved in knowledge is first of all primarily real and practical in character.” The universality of knowledge advances historically with the widening and deepening of social practice as a whole:

The increasing system and order of our ideas is based upon and reflects an extension and intensification of our practical activity in the world. In the course of historical development, we have extended not only our theoretical understanding of the world; for along with this widening and deepening of scientific understanding, has gone the development of new techniques and practical abilities, in relation to an increasing range of natural forces and phenomena. A deeper and more extensive vision and understanding of the world goes hand in hand with a wider and more intensive practical relationship to reality. Theory and practice form a necessary unity. (Sayers, 1985, p.179)

Therein lies the necessarily engaged character of scientific objectivity. The production and also the diffusion of scientific knowledge is part of human practice in its totality, that is, the historical effort of humanity to bring about transformations of the natural and social world towards the construction of conditions increasingly favorable to the dignity of life. Often-times, science has been and continues to be used to the contrary, that is, in the destruction of nature and human life itself, the exploitation and domination of human beings, generating alienating social processes that subjugate and alienate humanity itself. However, this does not invalidate the thesis defended here that the objectivity of scientific knowledge is necessary in facing the great challenges posed to humanity. The fact that science is, in certain social circumstances, directed to destructive and dehumanizing ends does not prove the human incapacity to master science. It merely shows that we can make ill-judged decisions about the destination we assign to the objective processes we set in motion. To conclude from these poor decisions that science contains an intrinsically dehumanizing rationality is to adopt a fetishistic view of science, attributing to it powers that it does not have.

For those who are used to considering scientific objectivity as synonymous with axiological and political neutrality, the term committed objectivity will sound like a paradox, as with Kelly’s (1986) use of the term committed impartiality. The difference, however, is that Kelly argues that the paradoxical character of the term committed impartiality in the positioning of teachers regarding controversial issues in school does not imply incoherence, whereas by employing the term committed objectivity, we do not intend to indicate a paradox because we believe that, in this case, it does not exist. As we have tried to show, the historical quest of science for objectivity is an ethical and political engagement with the social horizon of humanity’s emancipation as a whole.

Guiding science to the humanization of life and making scientific objectivity an engagement for the formation of a worldview geared towards the emancipation of all human beings from the many forms of exploitation and domination that currently prevail in social relations entails science no longer serving the restricted interests of political and economic elites, instead becoming the heritage of all humanity. A part of this process in democratizing science must be accomplished through education.

4 The Socialization of Science as Part of the Ethical–Political Education of Younger Generations

According to Moore and Muller (1999), conceptions about school knowledge and curriculum have been influenced since the 1970s by the English current of the New Sociology of Education, which questioned the objectivity of knowledge. In the 1980s and 1990s, that

questioning intensified through the influence of post-modern and post-structural relativism. This broad and heterogeneous current of thought, besides spreading a fundamentally negative view of scientific knowledge, decisively contributed to the incorporation, through common consensus among educators, of the idea that school should focus on everyday and practical knowledge, sidelining or even abandoning the effort to master scientific and theoretical knowledge. This kind of pedagogical orientation is linked to two conceptions of the world. One of them is neoliberalism, which imprisons the horizons of society and people's lives to an eternal adaptation to market logic. In this worldview, the knowledge worked on in school should always be aimed at the practical resolution of daily capitalist problems, and any kind of intellectual production that does not serve this purpose should be excluded from school curricula. The other worldview is of the increasing fragmentation of society and culture into identity groups that consider themselves owners of an experience that cannot be accessed or understood by any person from another group, as Gandesha (2018, November 19) explained:

I would suggest (though I can't show this here) that rather than an individualistic, rights-based model, identity politics is based on a particular, in my view reified, account of experience as expressed in the statement 'You wouldn't understand because it's a Black, Asian or queer, thing.' It is a staking out of a proprietary relation to an experience understood not as a process and a social relation but as a thing.

Obviously, this worldview excludes the possibility for a historical construction of a universally valid knowledge, since all knowledge will be connected to some identity. And any attempt to argue for the validity of scientific knowledge beyond a specific cultural context will be seen as a reproduction of colonizing attitudes. The scientist and historian of science, Meera Nanda (1997) advocates a quite different position from this one:

The sociological theories of science which see natural science as purely local and context-specific practice contradict the very rationale that made it possible for me to learn modern science while growing up in a small and rather provincial city in Punjab. The entire idea of adopting modern scientific education in non-Western countries is premised on a belief in the universality or trans-contextuality of scientific knowledge. (Nanda, 1997, p. 306)

Our argument is that science education is necessary for the ethical and political education of younger generations because the problems humanity is facing today require structural social changes that will hardly occur without popular mobilization accompanied by an adequate understanding of the fundamental processes that produce the movement of nature and society. In order for people to be able to adopt ethical and political positions on contemporary reality and future possibilities, they need to know reality not as something static, but as movements that have generating dynamics that can be studied, understood, and within certain limits, modified or redirected. But to achieve this, it is necessary to go beyond daily appearances. Participation in discussions about the processes that drive natural and social reality requires the mastery of theories and abstract conceptual systems. The president of Brazil, Jair Bolsonaro, in trying to justify the use of chloroquine as a preventive treatment for Covid-19, claimed in January 2021 that 200 people living in the same building as him had been contaminated with the virus and none of them had been hospitalized because they had undergone "early treatment" with chloroquine and ivermectin (Andrade, 2021, January 15). This is the type of reasoning easily assimilated by people who analyze reality from immediate daily experiences. The president clearly employed this rhetorical artifice because he was convinced that a large number of people would not only

accept this type of argument, but would also identify with a president who “thinks like us.” This line of thinking is limited to *doxa* and has difficulty dealing with abstractions. Ganesha (2018, November 19), commenting on the problematic nature of false concreteness, quotes Moishe Postone when he analyzes the relationships between the feeling of insecurity in contemporary capitalism, the difficulty in understanding the abstract structures of capital, and conspiracy theories: “That is, the sense of the loss of control that people have over their lives (which is real), becomes attributed, not to the abstract structures of capital, which are very difficult to apprehend, but to a Jewish conspiracy.” This example clearly shows the links between the neo-fascist views that have gained significant political and sociocultural space in various countries and the limitations of the ways in which one thinks about the world.

Saviani (2011, p. 14) stated in the early 1980s that the school’s task is to socialize the mastery of systematized knowledge or *episteme*, differentiating this type of knowledge from *doxa*, or “spontaneous knowledge based on everyday experience.” New Zealand researcher Elizabeth Rata (2012a, p. 1) makes a similar distinction, employing the terms “disciplinary knowledge and social knowledge.” She argues that:

There is a type of knowledge that should be created in universities and taught in schools and to all students regardless of race, religion, and culture. That knowledge—variously known as academic, disciplinary, epistemic, erudite, scientific, esoteric, rational, abstract, and objective—is the disciplinary knowledge of the sciences, arts, humanities, and social sciences. (Rata, 2012a, p. 1)

However, according to the author, in recent decades, school curricula have undergone successive reformulations that have moved this type of knowledge to the background, being replaced by a social knowledge which she says is also known as “doxa, culture, beliefs, everyday knowledge, common sense, tacit knowledge, and folk knowledge” (Rata, 2012a, p. 1). Like Saviani (2011), who states that access, through school education, to systematized knowledge, namely, to the *episteme*, does not detract from the importance that popular knowledge, or *doxa*, has in people’s lives, Rata (2012a, p. 1) claims that “disciplinary knowledge and social knowledge are both important—each for its own purpose”. These purposes, however, are quite distinct:

Social knowledge comes from an individual’s experience within a socio-cultural group. It is the beliefs, values, and practices that reinforce an individual’s identification with the group and ensure the group’s cohesion. Disciplinary knowledge, on the other hand, disturbs that common sense understanding of the world. It provides the means for doubt, criticism, and judgement—intellectual tools that change individuals and change the world. (Rata, 2012a, p.1)

Rata (2012b, pp. 104–105) opposes the loss of distinction between these two types of knowledge resulting from postmodern relativist and socio-constructivist positions that consider all knowledge to be ideological and justified purely in terms of power relations. The author argues that such a view fails to consider the fundamental differences between scientific knowledge and the beliefs present in worldviews belonging to specific cultures: “However, the status of scientific knowledge is seriously eroded when the same status is awarded to social knowledge. This equalising of status has occurred in the case of indigenous knowledge in universities in New Zealand, for example” (Rata, 2012b, p. 105).

At the same time, the importance of scientific knowledge for the curriculum is also eroded by visions that seek to attune school education to the demands of the contemporary capitalist economy. As Wheelahan (2010) shows, curriculum reforms undertaken

since the 1990s in several countries around the world have moved theoretical knowledge away from school education, instead focusing on an instrumental view of learning that would supposedly prepare students for an imagined world of work that “consisted of the ‘natural’ free market populated by entrepreneurial, flexible workers who took responsibility for their firms’ outcomes, but without the hierarchical (and expensive) management structures characteristic of Fordism” (Wheelahan, 2010, p. 129).

If, however, we agree with Rata (2012a, 2012b), Saviani (2011), and Wheelahan (2010) that school education should constitute a socially organized effort for the democratization of access to epistemic knowledge, it becomes necessary to inquire whether the democratic perspective itself would not require teaching to focus only on the specific knowledge of the natural sciences while avoiding political positions. Our argument is that this is neither possible nor desirable.

Let’s start with the argument about the impossibility of teaching the natural sciences in a neutral manner. If we seek neutrality in this teaching, a first concern would be to avoid controversial issues. It is not the purpose of this article to analyze the existing literature on controversial issues in school and the different criteria proposed by authors to define what a controversial issue is. But we would point out that the decision regarding which issues are controversial involves political and ethical positions. There is, for example, an insurmountable inconsistency in the approach of trying to eliminate controversial issues from curricula and school debate in the name of educational neutrality given that the elimination of these issues is, in itself, the result of ethical and political judgments, which negates the premise of neutrality. This becomes even more evident when we see that, depending on the type of common sense in a given sociocultural context, some topics are considered absolutely normal and uncontroversial because they do not contradict the prevailing worldview, while other topics may be considered controversial and even offensive for the opposite reason.

Would it not be possible, however, to address controversial issues in a neutral way at school? The literature is also extensive in this regard, and it won’t be possible here to analyze the various lines of analysis. Teachers can indeed adopt strategies to conduct classroom activities in such a way as to avoid having to state their personal positions on controversial topics. Nonetheless, these strategies very often have negative consequences for a proper conceptual understanding of the knowledge being studied. Let us leave this discussion for another time, however, and focus our attention on something that seems decisive to us: the search for truth. We have already cited authors who claim that the school curriculum should be a constant search for an approximation to the truth. Paula McAvoy makes a distinction between the explicitness of teachers’ political positions and the commitment to truth.

Political views reflect beliefs and choices that individuals in a democratic society are allowed to make for themselves. In contrast, if a student in a history class wanted to argue that the Holocaust did not happen and a teacher uses evidence and argumentation to try to convince the student that it did happen, the teacher is not sharing a political view. Instead, the teacher is trying to correct the student’s factual misconception. (McAvoy, 2017, p. 375)

We agree that the teacher should present facts and arguments that demonstrate that the Holocaust existed, just as, in the context of Brazilian reality, the teacher should present facts and arguments that demonstrate that a dictatorship existed from 1964 to 1985. However, just as some students and parents of students will consider that the teacher is taking a political position by teaching about the Holocaust, so too in Brazil will students and parents of students who

are followers of Jair Bolsonaro consider that the Brazilian political regime from 1964 to 1985 was not a dictatorship but a necessary effort to rid the country of the danger of communism.

Commitment to truth becomes a political position when there are economic, political, and ideological interests that move in the opposite direction. This is not a historically recent phenomenon, but it has been accentuated in recent years as a result of the worldwide advance of belligerent obscurantism.

Although the examples of the Holocaust and the Brazilian dictatorship are from the area of social history, the argument is also valid for the natural sciences, not only because of the existing relationships between the various areas of knowledge, but also because of the fact that a significant part of the objects of study in the natural sciences is directly or indirectly connected to the study of the relationships between society and nature. Thus, it may be possible to keep the study of certain specific topics away from directly ethical and political positions, but the attitude of permanent search for scientific approximation to the truth tends to produce, in the study of natural sciences as a whole, the need for positions on the consequences of the choices that contemporary society makes regarding its relations with nature. In the examples cited throughout this text, an ethical and political position of defending scientific truth implies not accepting alternative explanations to the theory of evolution, such as creationism. It also implies not accepting that the ideas of common sense or the ethnosciences have the same ontological and epistemological status as scientific ones.

In addition to asserting the impossibility of ethical and political neutrality being adopted as a guiding principle for the teaching of natural sciences in schools, we also argue that it is undesirable. Firstly, because that would convey to students a mistaken image of both scientific endeavor and the significance of the natural sciences for society and people's lives. The teaching of natural sciences should not aim at purely instrumental purposes, but rather to educate in ways of knowing and analyzing the world that allow human beings to make ethical and political decisions based on assessments of objective possibilities. Secondly, because the first two decades of this century have shown forcefully that environmental destruction and the accelerating advance of a culture of fear and hatred need to be confronted in a broad, deep, and urgent way if we want to build a solid foundation for the dignity of life to benefit present and future human generations. The opposite to the cultivation of hatred and disrespect for democratic debate is not omission or neutrality, but a position that has the courage to make itself explicit, being permanently open to a revision of positions when objective evidence and rational arguments demand it.

5 Conclusion

Why trust in science and science education? In relation to science, the arguments we present in this article seek to base trust in scientific knowledge on historical, dialectical, and materialist analyses. Historically, scientific activities have achieved a relative autonomy in relation to the production and reproduction of the materiality necessary for human life, but this does not mean that scientific activities may have a self-justifying existence detached from social practice in its totality. Scientific knowledge is one of the expressions of consciousness, which does not exist except in the form of a being that develops consciousness of itself and the world. As argued by Marx and Engels (1998) in *The German Ideology*, in order for human beings to develop consciousness, they need to produce

and reproduce their objective existence as living beings and, in this process, also produce and reproduce social relations and ideas about nature and society. Science, as the most developed form of objective knowledge of the world, dialectically expresses the contradictions of human history and allows human beings to make choices regarding the possibilities of intervening in objectively existing processes to direct them in accordance with the ethical and political value of respecting the dignity of life. Put this way, the question of trust in science shows that it is not a naïve and unconditional trust, that is, it is not a relationship of faith. Heller (1984, pp. 209–210) makes a distinction between “blind faith” and “trust,” clarifying that they are not epistemological categories, or rather, they are not types of knowledge, but two different types of sentiment in the relations between people and knowledge or between people and other people, institutions, etc. It is our understanding that the relationship between people and scientific knowledge should be accompanied by the feeling of trust, but not of faith, since faith is a feeling that stands above the objective confirmation or refutation of an idea. Although faith is a feeling more clearly identifiable in the field of religions, it also shows itself in other phenomena, such as the fanatical faith of people in certain leaders. The followers of Trump in the USA and of Bolsonaro in Brazil blindly believe whatever their leader claims, even if the claims are in absolute and proven disagreement with the objective evidence and, not infrequently, with their leaders’ own previous claims. It is also the faith in fake news and conspiracy theories that causes these fanatical followers to reject *a priori* scientific knowledge no matter how well-grounded it is in objective evidence and consistent rational argumentation. One does not combat the faith of the denialists by cultivating faith in what scientists say. Trusting science does not mean blindly following scientists; to the extent of each person’s capacity for comprehension, it entails trying to evaluate the debates among scientists, their arguments, their evidence, and the rigor with which they carry out their investigations.

This goes back to the issue of trust in science education. No science education curriculum will ever be perfect, just as no science teaching strategy will ever be infallible. But it is necessary that we move toward agreement on certain principles that seem self-evident, but that have been rejected for a variety of reasons. One such principle is that there is scientific knowledge that explains objective reality more truthfully than other knowledge. This scientific knowledge should be taught to all children, adolescents, and young people, without any distinction. Another principle is that this kind of knowledge cannot be learned spontaneously, because its learning requires the systematic acquisition of ways of acting, thinking, and feeling, which does not occur without a deliberate and institutionally organized teaching activity. A third principle is that without the social valorization of teachers, ranging from their teacher education courses to their working and living conditions (including their retirement), there is no possibility of achieving this kind of education. Finally, the fourth principle is that the goal in terms of educational policy should be the universalization of free, secular, and high-quality education, without which the principle of democracy in education cannot be realized. Just as we argue that trust in science is not diminished but strengthened by the recognition of its links to the materiality and dialecticity of the historical process in the praxis of humanity as a whole, so too trust in science education is strengthened by the recognition that there is still much for us to grapple with in order to achieve the ideal of democratic education.

Declarations

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

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