

The relationship between subject/knowledge in science education curriculum policies in recent times: post-structural contributions to the debate

Relação sujeito/conhecimento nas políticas de currículo da educação em ciências dos últimos tempos: contribuições pós-estruturais ao debate

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ABSTRACT

From a more significant incorporation of post-structural theories into the curriculum field in recent years, this theoretical essay aims to contribute to the debate around the relationship between subject/scientific knowledge in science-education curriculum policies. It seeks to explore its resonance in the meaning of what came to be considered a “scientifically educated” subject. Which pedagogical and curricular frameworks have been producing the identity of the subject “educated in science” in policies? What can be the contributions of the post-structuralist movement to the debate on the relationship between subject/scientific knowledge when defining what it means to be scientifically educated? To discuss this objective and questions, I decided to go through different curricular records in the Science Education area, without the intention of exhaustion, bringing to this essay some aspects that characterize the scenario of training policies in the field. I mainly focus on those related to scientific knowledge’s role in forming the subject’s identity. Dialoguing with Judith Butler (2015), Gert Biesta (2013), Stuart Hall (2006), Lopes and Macedo (2011), Laclau and Mouffe (2015), among others, the essay is a theoretical defense of narratives open to difference and disagreement on the Science Education curriculum policies.

Keywords: Scientific Knowledge; Science Education; Curriculum Policies; Post-structuralism

RESUMO

A partir da incorporação mais expressiva das teorias pós-estruturais ao campo do currículo nos últimos anos, o objetivo deste ensaio teórico é apresentar contribuições ao debate em torno da relação sujeito/conhecimento científico nas políticas de currículo da Educação em Ciências,

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buscando explorar suas ressonâncias na significação do que venha a ser considerado um sujeito “cientificamente educado”. Por meio de quais enquadramentos pedagógicos e curriculares a identidade do sujeito “educado em ciências” vem sendo produzida nas políticas? Quais podem ser as contribuições do movimento de pensamento pós-estruturalista ao debate em torno da relação sujeito/conhecimento científico na definição do que significa ser educado em ciências? Para discorrer sobre esse objetivo e essas questões, decidi transitar por diferentes registros curriculares da área da Educação em Ciências, sem pretensões de exaustão, trazendo ao ensaio aspectos que caracterizam o cenário das políticas formativas no campo, focalizando especificamente aqueles relativos ao papel do conhecimento científico na formação da identidade do sujeito. Em diálogo com autores como Judith Butler (2015), Gert Biesta (2013), Stuart Hall (2006), Lopes e Macedo (2011), Laclau e Mouffe (2015), entre outros, o ensaio é um investimento teórico implicado na defesa de narrativas abertas à diferença e ao diferir do sujeito nas políticas de currículo da Educação em Ciências.

Palavras-chave: Conhecimento científico; Educação em Ciências; Políticas de Currículo; Pós-estruturalismo

Introduction

The intense penetration of post-structural studies in the field of education and curriculum has led to discussions around the resignification of how we understand the social role of schooling, inviting us to think about less deterministic and essentialist educational processes, training, and curriculum policies (SILVA, 1999; LOPES; MACEDO, 2011; GABRIEL, 2016). Post-structuralist studies have been producing an intense (de)sedimentation of political, cultural, and pedagogical aspects of modern educational theory. This debate questions the idea that education “helps people to develop their rational potential to become more autonomous, individualist, and self-guided people” (BIESTA, 2013, p. 19), leading the educational debate to rethink its terms.

Post-structural ideas create and are created in the spirit of a time that announces radical changes in the perception regarding knowledge, subjects, and the world. A spirit that announces a crisis on modern values, on self-centered identities, on the subject that carries values and competencies considered essential to universal citizenship, a distrust towards utopias of a final social formation reconciled with itself, in which power can be eradicated, among so many others (PETERS, 2000). The theoretical effects of post-structural ideas in the field of the curriculum have been broadly discussed since the late 1990s and early 2000s (SILVA, 1999), guided in the last years towards the discussion on theoretical-methodological discussions of the studies (PARAÍSO, 2004; MEYER; PARAÍSO, 2012), with important epistemological unfoldings, among them: (i) an aversion to teleological and universal explanations, and categories of

“transformation” and “totality”, opening space to the local, the undefined, and the contingent; (ii) the renouncement of modern promises of “discovery”, “revelations”, “apprehension of reality”, among other metaphors of capture and fixation of the reality and the empirical world, highlighting the discursive and inventive production of studies and their analytical devices; finally, (iii) the abandonment of the category ‘subject’ as a self-centered autonomous entity, which is transparent to itself and the other, and the emergence of a more complex, decentered subject, understood as an “effect of language, texts, discourses, history, and subjectivation processes” (PARAÍSO, 2004, p. 286).

While the spread of the theoretical effects of post-structuralism in the curriculum and research in education seems to have deepened recently, we follow Gabriel (2013) when noting that such effects seem to be restricted to the fields of education and curriculum. The author suggests that it might be necessary to articulate them with educational theories of other disciplinary areas, such as the “teaching of” curricula. Gabriel (2013) establishes a dialogue between post-structural discursive mediations and the curricula of specific areas, leading to essential problematizations around the signifiers “science” and “scientific knowledge” circulating in different texts and documents about curriculum policies. The discussions proposed by the author open ways to question the establishment of borders between what “is” and what “is not” scientific knowledge in the curriculum policies of disciplinary areas. This debate paves the way to deconstruct hierarchies among categories such as “scientific knowledge”, “school knowledge”, and “reference knowledge”, among other curriculum categories in these policies, without investing in new essentialist forms of definitions of other border markers. Her findings also allow us to understand the movement of political articulations that operate to hegemonize a biased, dichotomous, and content-oriented perspective of scientific knowledge, “be it as a panacea to overcome the challenges of a quality school, be it as ‘the source of all evil’ that ravage the democratization process of educational institutions” (GABRIEL, 2013, p. 51).

In my recent investigative efforts, I have been articulating post-structuralism discussions in curriculum and curriculum policies.¹ in the subject area of science education, based on a discursive post-foundational focus (LACLAU; MOUFFE, 2015). I have been advocating the idea that it would be fruitful to think about the role of science education in schooling by creating a discussion space between the epistemological and

¹ In my studies, inspired by the discursive record, I have worked with a comprehensive understanding of the conceptual term “curriculum policy”, referring to the articulated and hegemonic discourses around the attempt to define a curriculum order and organization for the educational processes. This way, we open the empirical scope of our investigations on the curriculum texts present in pedagogical projects, periodical publications, and manifests from scientific entities, among others, beyond those considered official, signed by the Ministry of Education.

curriculum modern theories, which normally support the investigation lines of science and education, and the post-structural curriculum theories, mainly those related to indeterminism, anti-essentialism, and the opening to disagreements.

In this path, I have already focused on the signifier “Nature of Science” (NOS)” and its capacity of political articulation around the hegemonization of what is considered relevant and essential to science education in school education (PIMENTEL-JÚNIOR, 2017), channeling explicit guidelines to school pedagogical activities. Thus, it establishes frontiers on what can be considered (or not) a science education practice. More recently, I have been analyzing the pedagogical condition of science education in the *Base Nacional Comum Curricular* (BNCC- National Curriculum Framework), considering the increase of pragmatical language regarding the competencies and the consequent restriction it imposes on the science education policies (PIMENTEL-JÚNIOR, 2021).

Therefore, accepting the dossier invitation, this theoretical essay aims to contribute to the debate around the relation subject/scientific knowledge in the curriculum policies for science education, aiming to explore their resonances in the meanings of a “scientifically educated” subject. This relation is often deterministically understood as possessing scientific knowledge for social action, a knowledge typically “applied”, “universal”, and which leads the subject to make rational decisions in any and every social space (PIMENTEL-JÚNIOR, 2018). Some questions that followed me in this text are: (i) through which pedagogical and curriculum frameworks have been produced the identity of a subject “educated in sciences” in the interface subject/scientific knowledge in the curriculum policies of science education? How can we continue to rely on the sociopolitical role of science education, erasing its rationalist aspirations based on the epistemological universalism of sciences? How can we pedagogically think about the role of scientific knowledge in education without the category of a self-centered subject, the carrier of a scientific knowledge that grounds its awareness and enlightens its social practice? How do we release the relationship between subject/scientific knowledge/sociopolitical action from rationalist and totalizing forms of regulation?

Amidst these questions, this work is a theoretical essay discussing the implications of contemporary movements, mainly those that decentralize the subject in the formative role granted to scientific knowledge in science education represented in the curriculum policies of the area. Therefore, the text focuses on defending curriculum narratives open to differences and disagreements of the subjects in their relation to scientific knowledge in the curriculum policy of science education, continuing to rely on the political and educational potential of science, mainly in contexts of extreme denialism.

To do so, I have moved through different curriculum records in this area, with no intention to exhaust the topic, bringing to this essay some aspects that characterize the scenario of formative policies in the field. When referring to “recent” curriculum policies in the subject area of sciences, I claim the potential of hybridism, an irregular

fluctuation”, contaminated by senses (BHABHA, 2013), and the imprecise circulation of meanings in curriculum policies (DIAS; ABREU; LOPES, 2012), working with vague and imprecise temporal landmarks. Though I understand that landmarks and timeframes in research are important heuristic devices for specific investigations, I see such aspects as decisions, not a defining power nor a solid base to determine what we have called a “temporal delineation” in the studies. I no longer strongly believe in this investigation impulses that, in my opinion, update, in some measure, the wish for purity, a certain metaphysics of the origin of the meaning of time, an artificial time encapsulation over the senses.²Relying on the hybridism of culture and signification and the irregular and incomplete sliding of the meanings in language as powerful reading keys of curriculum policies makes the innocuous the endeavor to identify principles, seek origins, and chase the instant/emergence point of a particular meaning. Thus, I present fragments of several curriculum policies in the field of science education that have permeated my studies³ and other spaces in the later years, focusing specifically on scientific knowledge’s role in forming the subjects’ identities and their capacity for social action. Therefore, I do not seek to explore, in such texts, the specific pedagogical characteristics of the interface subject/scientific knowledge in each policy mobilized, but the relation itself, its discursive configuration, and resonances in science formation.

I organize the text in the following way: I develop some theoretical reflections about the decentralization of the subject and identity in the post-structuralist theory aiming to explore the potential of these readings to think about the relationship between subject/knowledge in the studies in the field of curriculum. After, I present a section in which I establish a dialogue with textual fragments of curriculum policies in science education to discuss the pedagogical and formative characteristics of these texts, focusing and problematizing the relation between subject/scientific knowledge and its implications on the meaning of the identity of a supposedly “scientifically educated” subject. Finally, I conclude my arguments by defending narratives open to differences and disagreements in the curriculum of science education, seeking to open the way to the singular and unpredicted emergence (BIESTA, 2013) of the subject in science education concerning scientific knowledge.

² Despite my criticisms to such methodological research strategies, I believe that the “time frames” continue, in some measure, to be useful and productive to highlight and nuance the reflections in the studies, from the investigation of specific characteristics, prominences, and emergences, articulation and (de)articulation movements in curriculum policies, without, however, granting such moments with a defining power around the interest focus.

³ Among other things, I refer to the research projects (I) Curriculum Policies for Science Education: a discursive approach, and (II) Discursive Interpellations to Methodologies and Science Teaching Approaches, I coordinated in the last years, focusing on texts from the academic area of science education, recognized, referenced, and validated in this teaching area.

The decentralization of the subject: implications to the relationship between subject/knowledge

The post-structuralist production about the subject and identity is extensive and theoretically dense. Some theoreticians even suggest that we should leave behind identity and start thinking about identifications (HALL, 2006), considering the aspects of the ontological relationality that establish us, the fluidity of the relation signifier and signified, and the impossibility of fixating the meanings on language about the experiences that mark our formation processes throughout life (PETERS, 2000; BUTLER, 2015).

However, before entering the theories about the subject and identity, the post-structuralist focus on language allows us to think, from the start, in a relationship between subject/knowledge within a more complex framework, less mechanical and objectivist. Therefore, I defend that the radicalism of the focus on language allows the coextensive criticism to any curriculum rationality grounded in an absolute separation between subject and knowledge, as if these entities were ontologically full and given even before the relationship between them. From the idea that we are language and that our being in the world is mediated in the language (PETERS, 2000; LACLAU; MOUFFE, 2015), that there is no “exterior” to language when it comes to the subject, to knowledge, or to any other entity, it is impossible to talk about the subject, knowledge, and relationship, as if those concepts were given and fixed objects. ‘To be language’ refers to the inseparability of/from the world of signification. So, any attempt to isolate and treat entities as instances that carry a “self” is, in itself, an effect of the power interested in creating essentialist stabilities.

Hall’s (2006) reflections about the subject and identity bring to the post-structural theoretical debate the anti-essentialist ideas of incompleteness, constitutive and unconscious incompleteness, seeking to problematize the subject of modern identity, self-centered, collected. According to Hall (2006), “the identity is something formed, during a time, through unconscious processes, and not something innate, existing in the consciousness during birth. There is also something ‘imaginary’ or disguised under its unity” (HALL, 2006, p. 38). To him, there is no moment of subject fixation, be it through any relation, including the one with the knowledge and the others. Being in the world allows the subject to constantly seek through the unity of identity, unity itself is an illusion. To him, identity is much more grounded in the attempt to fill a *lack* than an innate content of the subject.

In this sense, Hall’s (2006) subject is a lacking one, relational, in the incompleteness of meaning, and every sense of unity refers only to an illusion of stability formed by a lasting and intense identification process with something *exterior*. The Jamaican theoretician defends that the subject and identity always continue the same in a state of openness. They are constantly becoming in the world: “thus, instead of talking

about identity as something finished, we should talk about *identification* and see it as an ongoing process” (HALL, 2006, p. 39). This process has implications for thinking about the relationship between subject/knowledge. I will detail this further on, but they allow some initial reflections: (i) in the relationship subject/knowledge, there is not, nor there will be, a moment of complete identity filled with knowledge, as the *lack* constitutes the subject; (ii) the relationship subject/knowledge is inhabited by an insurmountable lack of guarantee, seeing that the *identification* is always in the order of the contingent, the provisory, the ongoing.

Understanding and relying upon identity as an ongoing process continuously being formed and established in language, with others, each experienced social circumstance makes it innocuous the attempt to talk about the relationship subject/knowledge based on the effort to fixate any social behavior in the subject through knowledge. In the curriculum policies, this implies several aspects in formation, as we no longer rely on a ready and finished subject by the consolidation of learning during formation, able to enact an ability of social action fixated by the curriculum policy at school. That is, there is no consolidated identity, first, by the knowledge so that there will later be the social practice of a stable subject, but a constant action signified in the unpredictable identifications that emerge in/from social practice.

In its turn, Laclau and Mouffe’s (2015) theory on collective identities allows us to see them as the effect of power actions in the political articulations and disarticulation, contingent and precarious, which provisionally form identities. For them, the identifications are always collective. They are discursive formations established by *articulation*, which is a relational and anti-essentialist category in discourse theory. For these theoreticians, the unity established through an identification “is, thus, not the expression of a subjacent common essence but the result of a construction and political fights” (LACLAU; MOUFFE, 2015, p. 129). As it is relational and not determined by any essence, the category of articulation becomes its own level of cohesion determination in the establishment of any identity, i.e., it only emerges, contingently, in the articulatory relation, so that the “non-fixity becomes the condition of all social identity” (LACLAU; MOUFFE, 2015, p. 155). As ongoing identifications establish the identity, “the moment of the final stitch never comes” (LACLAU; MOUFFE, 2015, p.155) because there is no essential ground. This means that the sense of all relational identity is always postponed, never reaching a final point.

Through the discursive approach (LACLAU; MOUFFE, 2015), we can mobilize the relational category *articulation* as a reading key to consider the relationship between subject/knowledge and identity formation. A relation that can only earn this name knowing that it mutually alters both beings involved and emerges from a contingent and provisory articulation, with no essence, never given previously. On the one hand, this idea allows us to question objectivism (GABRIEL, 2016) commonly implied in the relationship between subject/knowledge, so that none of those involved in the relation

are fixed entities and, ontologically, complete before the relation. On the other hand, it allows us to question the subject conditioning in relation with knowledge. The latter is seen as something that alters and changes the first in a given direction.

Besides this, such theorization also allows us to problematize the common artificiality of the relation between subject and knowledge in its being in the world. As it refers to contingent and provisory articulations established in social practice, the use of knowledge and its relation with the subject is unpredictable and uncontrollable in the curriculum. That is, the use of this relationship, if it will (or will not) be useful in the social practice, only emerges in the contingency of the relation of the subject in its being in the world, in the endless and unpredictable identifications it can establish in the social practice. As Biesta (2013) states, this implies that the relation with knowledge can be thought of as something radically open. It is more closely related to “what allows the emergence of unique and singular beings in the world” (BIESTA, 2013, p. 26) than relying on “the production of a particular type of subjectivity, especially the rational subject autonomous from modern education” (BIESTA, 2013, p. 53).

If the relationship subject/knowledge emerges in the articulation, in the contingent and provisory signification, and is not ready and finished before the relation itself, neither the knowledge and the subject are given beforehand in this relation and uses. The discursive approach allows us to think that the relationship between subject/knowledge of educational practices emerges as a contextual *event*⁴ in spaces of social insertion, uncontrollable due to the expectations they create in the curriculum policies.

From Butler (2015), we can add some layers of complexity to the post-structural theorization about the relation subject/knowledge. The feminist theoretician understands the subject as dispossession, exploring the interruptions and inaugural invasions of the subjects even before they come to the world. As I have developed in other works (PIMENTEL-JÚNIOR; CARVALHO; SÁ, 2017; PIMENTEL-JÚNIOR, 2020), Butler’s theorization shows us how the subject is an invaded construction, since the beginning, by *Others*⁵, the other in language, in the everyday relationships that establish us, the interpellation that makes us think who we are, and the testimonies we give to ourselves. In this sense, Butler’s (2015) theory offers us an understanding of the subject as always *dispossessed* of a “self”, an ontological terrain whose property is essential and unquestionable to oneself, disarticulating the principle of identity as “possession”. This makes us think that if ‘we are’, ‘we are’ always in relation with others, because of others, uncontrollably, bring ontological *relationality* as a key to understand and unmake any idea of the purity of a full, self-centered, transparent subject. In this sense,

⁴ I refer here to the notion of ‘event’ in Derrida, from which we understand that the event deserves this name only when involving an “exceptional interruption, absolutely singular, in the regime of possibilities” (DERRIDA, 2004, p. 281), announcing its possibility and constitutive impossibility.

⁵ On this point, I refer to the Other as the space of an endless ethical relationship (BUTLER, 2015).

the subject's constitutive opacity gains a power of expression in its agency in the world.

As Butler (2015), the emerging primary social conditions, which invade and dispossess the subject of any self-property, problematize any curriculum theses related to the social participation of the subject, mediated by knowledge, based on a rational autonomy of the self in relation with the others in the world. That is, it is possible to question the idea that acquiring knowledge within the social process of schooling would guarantee a more participative and enlightened capacity for action.

Besides this aspect, another crucial discussion point emerges from her theories around the subject's dispossession: the criticism towards possessive individualism. From Butler's theorization, the idea that the subject's agency structure itself, individually, from the possession of knowledge, is something highly questionable, because the individual is always with others and the supposed possession of knowledge would not guarantee a capacity of social action for change. Butler (2015) will tackle 'possession', the idea of a subject's property about himself and his capacity to act, keeping in the horizon that the possession is not only an illusion but also does not determine the subject's action.

Relying on and problematizing the role of the relation subject/knowledge through this perspective does not mean ignoring the role of education in schooling and social participation. Contrariwise, it means radically fighting for the social conditions that surpass and precede the subject, invades and dispossesses them, from the beginning, are conditions of less social insecurity and politics, so that any social action can be possible. Therefore, it allows us to claim the social conditions of action capability without atomizing it individually to the subject and knowledge. The lack of social isonomy and social conditions to allow any act of social change to take place, in my opinion, complexifies and makes innocuous the bet on the social transformation of subjects through reason and possession of knowledge.

From different ways and entrances, be they psychoanalytical, cultural, philosophical, political, linguistic, and others, the post-structuralist theses discussed here postulate, as I see, the unfinished characteristic of the subject as a constitutive dimension of identity. As it is constitutive, incompleteness is not something that we can eliminate or surpass from a relation with any type of knowledge, be it epistemological, philosophical, scientific, religious, political, etc. Nor is the knowledge ready, finished, exterior, able to be transmitted. In this direction, trying to radicalize the implications of the approaches debated here, there is no relationship between subject/knowledge based on a gap to be filled by a teaching and learning situation in a schooling space, nor the effect on one over the other is predictable. We no longer bet on this curriculum policy.

Differently, thinking rationally about the relationship subject/knowledge means understanding that there is a mutual implication, instituting change, a productive event, and a differential of senses that form and establish the relation itself. Thus, one can ask how subjects see the world as singular subjects when relating creatively and institutively

with knowledge (BIESTA, 2013). In my understanding, from these references, the focus becomes less on the didactic situations of teaching and learning that can lead to the acquisition of a supposed given knowledge to fill and guide the social conducts of identities and much more on the ways through which the relationship is incessantly signified in social practice.

Formative curriculum practices and the subject in Science Education

How is the subject of science education discursively established concerning the scientific knowledge in the curriculum policies in science education? Broadly, we can say that the tradition of curriculum policies in the subject area of science education has always been grounded in the epistemological assumptions of the “Nature of Science” (NOS) in the configuration of the relation subject/science knowledge and this channeled, with considerable historical variations, the reliance in this area of the idea of identity formation of the rational citizen in modern education (PIMENTEL-JÚNIOR; DIAS; CARVALHO, 2019).

School science should give students an opportunity to experience science and its processes, free from legends, mistakes, and idealizations inherent to myths about the nature of the scientific endeavor. There should be more opportunities for beginner and experienced teachers to learn and apply the real rules of the science game [...]. Only by surpassing the blur of half-truths, revealing science in broad daylight, [...], all students will appreciate the true nature of sciences [...] (McCOMAS, 1998, p. 68).

There is a broad consensus on the need for science literacy that can prepare citizens to make decisions. [...] This “democratic” argument is, maybe, the most widely used by those who claim scientific and technological literacy as a primary component of citizen education. Therefore, scientific literacy [...] imposes itself as a critical dimension of a citizen culture to face the serious problems humanity must face now and in the future (PRAIA; GIL-PÉREZ; VILCHES, 2007, p. 142-145).

With the emergence of the sciences didactic field and the consequent investment in the studies on the area of the methodological diversification of teaching approaches, aspects considered scientific were tinted in the policies, incorporating different theoretical and pedagogical hues to think about science education in school and the relationship of the subjects with the scientific knowledge. Among these approaches to science education, I highlight here some excerpts and aspects of the curriculum policies commonly stressed in the area: (i) science teaching through investigation and Investigative Teaching Sequence (ITS); and (ii) the science-technology-society (STS)

approach⁶ in science education⁷.

Investigative Teaching Sequence is a teaching approach that generally proposes that the classroom work should be provoking and instigating for the students, which can be done when teachers create an investigative environment (CARVALHO, 2011; 2013). With a theoretical base that merges Piagetian and Vygotskian studies, this teaching approach seeks to insert students into the world of science, taking the logic of scientific knowledge building as a reference. In this sense, one should start from the students' reference world, seeking to overthrow the obstacles of everyday culture, aiming to insert them in the processes to build scientific knowledge based on the language of science.

Therefore, teachers' questions should incentivize them to seek evidence in their data, and justifications for their answers, to make them systematize thoughts as "if"/"so"/"then" or the proportional thought. If one of the variables increases, the other also increases or if one increases the other decreases. In these cases, scientific language, i.e., the argumentative language forms itself [...]. Introducing students to different science languages is, in fact, introducing them to scientific culture. [...] This introduction must be done by the teachers, because they are the most experienced adults in the classroom, carefully guiding students from everyday language to scientific language through cooperation and specializations between them (CARVALHO, 2013, p. 7-8).

According to Carvalho (2011; 2013), the Investigative Teaching Sequence (ITS) proposes that the teaching of sciences should didactically work with the characteristics of scientific knowledge and scientific theories, through investigative processes of teaching themes approached in the classroom. That is, there is a guidance for the treatment of science school themes to be redirected towards making the teaching space a place of provocation and stimulation to the investigation, allowing the transition between cultures (every day and scientific).

There is no expectation that students will think or behave as scientists. The proposal is much simpler – we want to create an investigative environment in the Science classroom, to teach (guide/mediate) students in the (simplified) process of scientific work so that they can gradually increase their scientific culture, acquiring, class after class, the scientific language. (CARVALHO, 2013, p. 9).

⁶ Recently, the discussions in science education, the dimensions Science, Technology, and Society were added to the dimension environment, becoming a STSE. About this, see Conrado and Nunes-Neto (2018).

⁷ In these cases, they are curriculum practices that present theoretical, methodological guidelines on pedagogical practices of teachers working in different levels of K-12 Education (Elementary, Middle, and High school) in the area of Natural Sciences.

In this sense of literacy in scientific language, the author will propose ITS and the relationship subject/scientific knowledge. They are sequences of activities that encompass school programs of science education and, at the same time, can provide students with “the conditions to bring their previous knowledge to start something new, to have their own ideas, and to discuss them with their classmates and teacher, going from the spontaneous knowledge to the scientific one and acquiring the conditions to understand knowledge already structured by previous generations” (CARVALHO, 2013, p. 9).

The educator proposes a didactic pathway for the ITS: (i) start with a problem, experimental or theoretical, contextualizing it. It should be able to introduce to students the theme and offer them conditions to work with the relevant variables of the scientific phenomenon investigated; (ii) after the problem resolution, we propose the systematization of knowledge, “preferably practiced through reading a written text that students can discuss, and compare what they did and thought about the problem resolution with the one reported in the text” (CARVALHO, 2013, p. 9). After, we have activities of (iii) contextualization of students’ everyday knowledge “because, at this moment, they can feel the importance of applying the knowledge built from a social point of view” (CARVALHO, 2013, p. 9). She also tells us that “some ITSs, to fulfill more complex curriculum contents, demand many cycles of these three activities or even other types that should be planned” (CARVALHO, 2013, p. 9).

According to Carvalho (2011; 2013), the ITS can foment a relationship between teacher/student and subject/scientific knowledge in which the student protagonism is central in the pedagogical activities, as they actively act in the resolution of problems. The abilities to argue, logical thought, act, question, and the development of critical thinking are some of the potentials to work with investigative teaching sequences

Besides this, the STS approach brings into play the technological, social, and environmental dimensions of science education, previously considered subsumed into teaching approaches that understood science as a neutral rationality. According to Santos and Mortimer (2001), the movement originated in the 1960s and 1970s, mainly concerned with the social and political uses of science products, the aggravation of the environmental crises, and the need for more participative citizenship regarding these processes. That is, faced with a crisis scenario involving diverse social aspects, energy sources, and natural environments, which is and which should be the role of science education? How can science education contribute to overcoming the planetary emergency (CACHAPUZ *et al.*, 2005) we live in? Based on these critical issues, STS has historically claimed a work of scientific knowledge more tuned with the processes’ complexity, approaching different dimensions of production and social and cultural insertion, making knowledge with a more critical and emancipating power in the formation of social subjects, fomenting the participation of subjects in the decisions regarding science, technology, and social development.

In its discursive articulations, the STS approach is fundamentally against the notion of neutrality in science education and teaching, disconnected from ethical, social, cultural, political, and environmental dimensions (SANTOS; MORTIMER, 2001; CACHAPUZ *et al.*, 2005). In this perspective, an education that intends to be neutral becomes impossible, as it is only interested in maintaining social, economic, political, and predatory environmental practices, able to promote the degradation of public social space. This perspective of neutral and traditional science education present in the history of science education, especially between the 1950s-1970s – and, to some, still today –, can be understood, according to Conrado and Nunes-Neto (2018), from some characteristics: (i) emphasis on the transmission of scientific knowledge culturally consolidated; (ii) social and environmental decontextualization; (iii) conceptualism – the predominance of teachers’ explanation and students’ memorization of scientific facts, terms, and definitions; (iv) and instrumentalism, whose emphasis lies on the reproduction of science techniques as a practical illustration of concepts, theories, and terms learned. STS has historically fought against these aspects and demanding a critical position from science education regarding its processes, presenting the scientific endeavor in school space in its internal and external complexity, contextualized in a social space with political, cultural, economical, and environmental questions and problems to be overcome.

The STS movement emerged then contraposed to the scientific assumption that values science on itself, placing blind faith in its positive results. [...]. The criticism of such concepts led to a new philosophy and sociology of science that started to recognize the limitations, responsibilities, and complicity of sciences, evoking science and technology as social processes. Science is not a neutral activity; its development is directly connected with social, political, economic, cultural, and environmental aspects. Therefore, scientific activity is not exclusively up to scientists and has substantial societal implications. Therefore, it needs to have a social control that, from a democratic perspective, implies involving a more significant size of the population in the decision-making about S&T (SANTOS; MORTIMER, 2001, p. 96).

Regarding the curriculum implications, the science-technology-society-environment approach (STSE) focuses on developing subjects’ scientific literacy in educational processes to make them apt to make responsible social decisions and socially participate in the processes involving technology, society, and the environment. Thus, STSE becomes central to forming people for action in the broad exercise of citizenship, the relationship between subject/scientific knowledge, and the action in the democratic decision-making processes. All these involve understanding the impact of science in public life, its social effects, and its political uses for humanity. Therefore, a combination of fundamentals justifies the STS teaching approach. One of a democratic order involving the participation of the subject in social problems and challenges. Moreover, a pragmatic

one concerning the use of scientific knowledge as an aid to ground the processes of participation and social decision-making. These theses bring to the school curriculum and the relationship between subject/scientific knowledge demanded to make decisions, as they claim the formation of the profile of a scientifically educated subject, able to participate in the social processes and, more than that, to demonstrate the involvement and the capacity to use knowledge for social transformation (SANTOS; MORTIMER, 2001; CACHAPUZ *et al.*, 2005; CONRADO; NUNES-NETO, 2018).

Finally, I bring up the debate of the curriculum policy in natural sciences expressed in the *Base Nacional Comum Curricular* (BNCC- Brazilian National Curriculum) for High School.⁸ In this text, I will not deepen into aspects related to curriculum standardization and the supposed consensus around what is expected and essential to all in natural science education, a theme I have discussed elsewhere (PIMENTEL-JÚNIOR, 2021). Here, I approach the relationship subject/scientific knowledge in the policies of the natural science area at BNCC, seeking to explore their characteristics through the general competencies presented in the document.

BNCC presents a formative proposal in the area of natural sciences, which proposes that “the students should build and use specific area knowledge to argue, propose solutions, and face local and/or global challenges related to living conditions and the environment” (BRASIL, 2018, p. 470). The formative policies in the area rely on the idea that, from the relationship subject/scientific knowledge, the students will be able to “make responsible, ethical, and consistent decisions to identify and solve problem situations” (BRASIL, 2018, p. 537). The area is organized didactically into three themes: (i) Matter and Universe, (ii) Life and Evolution, and (iii) Earth and Universe. The general competencies related to the knowledge in natural science, in their turn, are:

- (i) Analyze the natural phenomena and technological processes, based on the relation between matter and energy to propose individual and collective actions that improve productive processes, minimize socio-environmental impacts and to better the life conditions in the local, regional, and/or global contexts;
- (ii) build and use interpretations about the dynamic of Life, of Earth, the Cosmos to elaborate arguments, make predictions about the working and the evolution of human beings and the Universe, and ground ethical and responsible decisions;
- (iii) Analyze problem-situations and evaluate applications of scientific and technological knowledge and its implications in the world, using procedures and languages typical of Natural Sciences, to propose solutions that consider local, regional and/or global demands, and communicate their findings and conclusions to a variety of audiences, in different contexts and through different media and

⁸ Besides being the focus of my studies on science education, I chose the High School BNCC because, usually, in this educational phase, the expectations around the relationship between subject/scientific knowledge in the definition of the subjects' identities seem to gain more evident and normative delineations. This is because it is the last phase of K-12 education.

digital technologies of information and communication (DTIC) (BRASIL, 2018, p. 539).

The BNCC of natural sciences presents a discursive configuration in the relationship subject/scientific knowledge grounded on the everyday usability and applicability of the scientific knowledge in the subjects' social actions, as if knowledge were an object that, after appropriated, can grant a specific capacity of action in a given direction. Regarding the relationship with scientific knowledge, the subject is expected to apply the knowledge learned in real-life situations to develop diverse demands. This way, BNCC relies on the idea that knowledge will emerge as general competencies from a set of abilities in a supposedly calculable and predictable chain in the relationship between subject and scientific knowledge.

In its turn, the concept that the relationship between subject/knowledge will allow solving issues in their everyday lives and jobs refers to the idea that the subjects' abilities for social action are the same. This makes us question if we all have the same social conditions to make decisions for social participation. Thus, the BNCC shows a homogenizing reading about the ability of the subject's social action regarding scientific knowledge, exacerbating the objective and realist aspects of the role given to knowledge in curriculum policies.

In general, be in the policy of NOS, ITS, STS, or the BNCC, the relationship between subject/scientific knowledge in the area of science education emerges to claim the identity of the subjects educated in sciences, which appropriates an apparently objective scientific knowledge, "structured by previous generations", able to be selected from a broader epistemological repertoire of science and directly applicable in everyday situations.

ITS presents to the relationship between subject/scientific knowledge, the demand of a subject that moves from the everyday language to the science language through a cultural transition to science via curriculum. Differently from ITS but also based on some of the assumptions about the educational virtues of scientific knowledge, the STS approach radicalizes the thought about the relationship between subject/scientific knowledge toward the pragmatic and democratic theses of scientific education (CACHAPUZ *et al.*, 2005; PRAIA; GIL-PÉREZ; VILCHES, 2007), demanding from the relation with scientific knowledge the decision-making for change in the concrete social practice of the subject about the problems faced by humanity. In this sense, we add to the relationship between subject/scientific knowledge a moral, deontological dimension related to the *becoming* of the subjects and their being in the world. In its turn, the utilitarian and functional aspects regarding the relationship between subject/scientific knowledge increase and gain homogenizing contours. These delineations are even more realistic in the BNCC of natural sciences, considering a scientifically educated subject through their use of knowledge to solve demands presented by everyday life and the job market.

I defend that the interface subject/scientific knowledge shows itself in the control language in the science education curriculum policies debated here. They establish a highly conditioned relationship with alterity that, inspired by Bhabha (2013), we could call a production relation of *alterity-authorized versions*. An authorization based on neo-enlightened conditioning, erasing its scientific impulse, in which scientific knowledge grants democratic and pragmatic virtues in the pedagogical relationship with the subject. It “consolidates the discourse of modern science, producer of scientific truths as a greater and univocal expression of this freeing and indispensable reason for the formation of subjects” (GABRIEL, 2016, p. 106).

Final remarks: educate in science amidst uncertainties

Faced with all the discussions presented, a question remains: What can be the contributions of post-structuralist ideas to the debate around the relationship between subject/scientific knowledge in the definition of what it means to be ‘educated in sciences’? With no intention to finish the debate, post-structural reflections allow us to think of new relationship forms between subject/knowledge in science education, allowing us to recover seemingly banished meanings in the historical pathway of curriculum policies in this educational area. Meanings concerning the radical indetermination of the curriculum, an indetermination of the formative identity in the relationship between subject/scientific knowledge, and a distant relation from realism and objectivism regarding the subject, the knowledge, and the social practice.

The post-structural reflections debated here give the relationship subject/knowledge a relational character, a mutual implication, and constitutive alternation. Therefore, it would be less productive to talk about the production of a subject or the ability to act from scientific knowledge, updating realism and predictability in the curriculum. Hence, these constructions defy the idea of a universal capacity of action based on the epistemological record of science to be awakened in each subject in their relationship with this knowledge, and that could be mobilized, in every and any context, to enact a social practice. In this sense, post-structural reflections allow us to problematize the curriculum policies in science education, questioning the determinism in the relationship between subject/scientific knowledge, mainly the supposed predictability of the effect of knowledge over the subjects’ behavior.

From the references discussed, I believe it is possible to point out another aspect of the relationship between subject/scientific knowledge in the task to deconstruct forms and connections objectified and deterministic in the curriculum policies in the area of science education: the democratic and pragmatic theses about the importance of scientific knowledge in the policies (CACHAPUZ *et al.*, 2005; PRAIA; GIL-PÉREZ; VILCHES, 2007). From the post-structuralist approach, it is possible to question the idea that the subjects’ social action will be apparent, to them, from the relationship

with scientific knowledge so that the decision-making about science and technology becomes fully viable and automatically predictable in their social conduct. In this sense, the utilitarian aspect of scientific knowledge becomes questionable, and the appeal to the applicability of school subjects' scientific knowledge in everyday life. This language updates an understanding of curriculum policy as if it were a device able to anticipate structural spaces for which the subjects, inexorably, are doomed to occupy and their political agenda. Contrariwise, understanding social practice as a contingent articulation challenge the thought that science education's identity and virtues make certain actions in the subjects' social behaviors perennial. Nor do they determine the social spaces the subjects will occupy in the future.

Finally, I defend that the post-structural contributions to the debate about the relationship between subject/scientific knowledge in the curriculum policies of science education also allow us to question the individualization of social action, mainly in the BNCC policy, the idea of a scientifically-educated subject as a "solver of social demands". The atomization of the subject's social practice to its individuality, grounded on scientific knowledge, updates a wish for curriculum resignification that merges science virtues with a neoliberal scientific-humanist rationality that needs to be confronted. It keeps a humanist-scientific feeling as it continues to imagine the great processes of life centered in the practice of the individual with scientific reasoning. The neoliberal effects are exacerbated through the individual accountability of the subject as they propose the calculation of individual effects of action and social participation in the resolution of complex social life issues, keeping education, in some measure, into a salvationist record (PIMENTEL-JÚNIOR; CARVALHO, 2017). Keeping in the horizon of the curriculum policies of science education the understanding of the relationship subject/scientific knowledge as in the order of the *event*, what cannot be calculated nor predicted because cannot be anticipated (DERRIDA, 2004), means keeping science knowledge in the curriculum endeavor, without ignoring the relationship as educational, though understanding that it is always a bet with no guarantees, a science education amidst uncertainties.

REFERENCES

- BHABHA, Homi. *O local da cultura*. Belo Horizonte: Ed. UFMG, 2013.
- BIESTA, Gert. *Para Além da Aprendizagem: educação democrática para um futuro humano*. Belo Horizonte: Autêntica, 2013.
- BRASIL. Ministério da Educação. *Base Nacional Comum Curricular: educação é a base*. Ensino Médio. Brasília: MEC, 2018.
- BUTLER, Judith. *Relatar a si mesmo: crítica da violência ética*. Belo Horizonte: Autêntica, 2015.
- CACHAPUZ, António; GIL-PÉREZ, Daniel; CARVALHO, Anna Maria Pessoa; PRAIA, João;

- VILCHES, Amparo. *A necessária renovação do ensino das ciências*. São Paulo: Cortez, 2005.
- CARVALHO, Anna Maria Pessoa. Ensino e aprendizagem de ciências: referenciais teóricos e dados empíricos das sequências de ensino investigativo (SEI). In: LONGHINI, Marcos Daniel. (Ed.). *O uno e o diverso na educação*. Uberlândia: EDUFU, 2011. p. 253-266.
- CARVALHO, Anna Maria Pessoa. *Ensino de Ciências por Investigação: condições para implementação em sala de aula*. São Paulo: Cengage Learning, 2013.
- CONRADO, Dália Melissa; NUNES-NETO, Nei Freitas. *Questões sociocientíficas: fundamentos, propostas de ensino e perspectivas para ações sociopolíticas*. Salvador: EDUFBA, 2018. Available at: <https://repositorio.ufba.br/handle/ri/27202>. Accessed on: March 3, 2022.
- DERRIDA, Jacques. *Papel-Máquina*. São Paulo: Estação Liberdade, 2004.
- DIAS, Rosanne Evangelista; ABREU, Rozana Gomes; LOPES, Alice Casimiro. Stephen Ball e Ernesto Laclau na pesquisa em política de currículo. In: FERRAÇO, Carlos Eduardo; GABRIEL, Carmen Teresa; AMORIM, Antônio Carlos. (Eds.). *Teóricos e o campo do currículo*. Campinas: FE/UNICAMP, 2012. p. 200-214.
- GABRIEL, Carmen Teresa. Conhecimento científico e currículo: anotações sobre uma articulação impossível e necessária. *Revista Teias*, Rio de Janeiro, v. 14, n. 33, p. 44-57, 2013. Available at: <https://www.e-publicacoes.uerj.br/index.php/revistateias/article/view/24364/17342>. Accessed on: March 1st, 2022.
- GABRIEL, Carmen Teresa. Conhecimento escolar e emancipação: uma leitura pós-fundacional. *Cadernos de Pesquisa*, São Paulo, v. 46, n. 159, p. 104-130, 2016. Available at: <https://doi.org/10.1590/198053143551>. Accessed on: March 3, 2022.
- HALL, Stuart. *A identidade cultural da pós-modernidade*. Rio de Janeiro: DP&A, 2006.
- LACLAU, Ernesto; MOUFFE, Chantal. *Hegemonia e Estratégia Socialista: por uma política democrática radical*. São Paulo: Intermeios, 2015.
- LOPES, Alice Casimiro; MACEDO, Elizabeth. *Teorias de currículo*. São Paulo: Cortez, 2011.
- McCOMAS, William. The principal elements of the nature of science: dispelling the myths. In: McCOMAS, William. (Ed.). *The Nature of Science in Science Education: Rationales and Strategies*. Dordrecht: Kluwer Academic Publishers, 1998. p. 53-70.
- MEYER, Dagmar; PARAÍSO, Marlucy Alves. *Metodologias de pesquisas pós-críticas em educação*. Belo Horizonte: Mazza Edições, 2012.
- PARAÍSO, Marlucy Alves. Pesquisas pós-críticas em educação no Brasil: esboço de um mapa. *Cadernos de Pesquisa*, São Paulo, v. 34, n. 122, p. 283-303, 2004. Available at: <https://dx.doi.org/10.1590/S0100-15742004000200002>. Accessed on: March 1st, 2022.
- PETERS, Michael. *Pós-estruturalismo e filosofia da diferença*. Belo Horizonte: Autêntica, 2000.
- PIMENTEL-JÚNIOR, Clívio. Articulações Discursivas em torno do Significante Natureza da Ciência: currículo, formação, política. *Revista Teias*, Rio de Janeiro, v. 18, n. 50, p. 88-104, , 2017. Available at: <https://doi.org/10.12957/teias.2017.26713>. Accessed on: Sept 14, 2022.

PIMENTEL-JÚNIOR, Clívio; CARVALHO, Maria Inez Silva de Souza. Profanando o papel da escola? narrativas pós-modernas sobre o processo social de escolarização. *Práxis Educacional*, v. 13, p. 161-183, 2017. Available at: <http://dx.doi.org/10.22481/praxis.v13i24.935>. Accessed on: Sept 14, 2022.

PIMENTEL-JÚNIOR, Clívio; CARVALHO, Maria Inez Silva de Souza; SÁ, Maria Roseli Gomes Brito de. Pesquisa (Auto)Biográfica em Chave Pós-estrutural: conversas com Judith Butler. *Práxis Educativa*, v. 12, n. 1, p. 203-222, 2017. Available at: <http://dx.doi.org/10.5212/PraxEduc.v.12i1.0011>. Accessed on: Sept 14, 2022.

PIMENTEL-JÚNIOR, Clívio; CARVALHO, Maria Inez Silva de Souza; SÁ, Maria Roseli Gomes Brito de. Currículo, (Auto)biografias e Diferença: políticas e poéticas do incontrolável no cotidiano da educação em ciências. *Revista E-Curriculum*, v. 16, n. 1, p. 29-59, 2018. Available at: <http://dx.doi.org/10.23925/1809-3876.2018v16i1p29-59>. Accessed on: Sept 14, 2022.

PIMENTEL-JÚNIOR, Clívio; DIAS, Rosanne Evangelista; CARVALHO, Maria Inez Silva de Souza. Significações de Qualidade e Crise da Educação Científica nas Políticas Curriculares para o Ensino de Ciências. *Investigações em Ensino de Ciências*, v. 24, n. 3, p. 147-168, 2019. Available at: <http://dx.doi.org/10.22600/1518-8795.ienci2019v24n3p147>. Accessed on: Sept 14, 2022.

PIMENTEL-JÚNIOR, Clívio. Demandas Identitárias nas Políticas de Currículo para o Ensino das Ciências. *Revista Atos de Pesquisa em Educação*, v. 15, n. 1, p. 94-119, 2020. Available at: <https://dx.doi.org/10.7867/1809-0354.2020v15n1p94-119>. Accessed on: Sept 14, 2022.

PIMENTEL-JÚNIOR, Clívio. Deslocamentos Discursivos e as Competências das Ciências da Natureza na BNCC: contingência, precariedade e a impossibilidade de um “todos” para o currículo. *Revista Espaço do Currículo*, João Pessoa, v. 14, n. Especial, p. 1-13, 2021. Available at: <https://periodicos.ufpb.br/ojs2/index.php/rec/article/view/60459>. Accessed on: Sept. 14, 2022.

PRAIA, João; GIL-PÉREZ, Daniel; VILCHES, Amparo. O Papel da Natureza da Ciência na Educação para a Cidadania. *Ciência & Educação*, São Paulo, v. 13, n. 2, p. 141-156, 2007. Available at: <https://doi.org/10.1590/S1516-73132007000200001>. Accessed on: March 06, 2022.

SANTOS, Wildson Luiz Pereira; MORTIMER, Eduardo Fleury. Tomada de Decisão para ação social responsável no ensino de ciências. *Ciência & Educação*, Bauru, v.7, n.1, p. 95-111, 2001. Available at: <https://doi.org/10.1590/S1516-73132001000100007>. Accessed on: 21 set. 2022.

SANTOS, Wildson Luiz Pereira; MORTIMER, Eduardo Fleury. Uma análise de pressupostos teóricos da abordagem C-T-S (Ciência - Tecnologia - Sociedade) no contexto da educação brasileira. *Ensaio Pesquisa em Educação em Ciências*, Belo Horizonte, v. 2, n. 2, p. 110-132, 2000. Available at: <https://doi.org/10.1590/1983-21172000020202>. Accessed on: March 06. 2022.

SILVA, Tomaz Tadeu da. *Documentos de Identidade: uma introdução às teorias do currículo*. Belo Horizonte: Autêntica, 1999.

Text received 03/082022

Text approved: 10/11/2022