Brazilian Nacional Curriculum and Socioscientific Issues: openings and (im)possibilities for Science Education in the Elementary School

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Abstract: This paper discusses the possibilities of adequacy or the obstacles presented in the Brazilian National Curriculum (Base Nacional Comum Curricular - BNCC, in Portuguese) for the development of Socioscientific Issues (SSI) in science education for Elementary School. Therefore, our main objective is to understand the elements, perspectives, and formative aspects present in the document that indicate possibilities or obstacles for the development of practices aligned with the perspectives of Socioscientific Issues. To this end, we focus our discussion on three broad axes: General formation conceptions and (mis) alignment with the SSI perspective; Formative itineraries for science education centered on SSI; Relevant contents and topics in SSI treatment. Based on the analysis, we understand that, at a discursive level, there are openings from which it is possible to undertake practices based on the perspectives of SSI, although not without an explicit investment in the production of appropriate conditions for such.

Keywords: Socioscientific Issues. BNCC. Curriculum. Critical Formation.

Curriculum Nacional Brasileño y Questiones Socio-Científicas: aperturas e (im)posibilidades para la Educación en Ciencias en la Escuela Primaria

Resumen: Este artículo discute las posibilidades de adecuación o los obstáculos presentados en el Currículo Nacional Brasileño (Base Nacional Comum Curricular - BNCC, en portugués) para el desarrollo de Cuestiones Sociocientíficas (CSC) en la enseñanza de las ciencias para la Enseñanza Fundamental. Así que nuestro principal objetivo es comprender cuáles son los elementos, perspectivas y aspectos formativos presentes en el texto del documento que indican posibilidades u obstáculos para el desarrollo de prácticas alineadas con las perspectivas de las Cuestiones Sociocientíficas. Con este fin, enfocamos nuestra discusión en tres grandes ejes: Concepciones generales de formación y (des) alineación con la perspectiva CSC; Itinerarios formativos para la enseñanza de las ciencias centrados en CSC; Contenidos y temas relevantes en el tratamiento de CSC. Con base en el análisis, entendemos que, a nivel discursivo, existen aperturas desde las cuales es posible emprender prácticas a partir de las perspectivas de CSC, aunque no sin una inversión explícita en la producción de condiciones adecuadas para ello.

Palabras clave: Cuestiones Sociocientíficas. BNCC. Currículo. Formación Crítica.

BNCC e Questões Sociocientíficas: aberturas e (im)possibilidades

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Resumo: Este trabalho busca discutir as possibilidades de adequação ou os entraves apresentados na Base Nacional Comum Curricular (BNCC) para o desenvolvimento de Questões Sociocientíficas (QSC) no Ensino de Ciências para os Anos Iniciais do Ensino Fundamental. Para tanto, o nosso objetivo central é compreender quais são os elementos, as perspectivas e os aspectos formativos presentes no texto do documento e que indicam possibilidades ou obstáculos para o desenvolvimento de práticas alinhadas às perspectivas das Questões Sociocientíficas. Centramos nossa discussão em três grandes eixos: Concepções gerais de formação e o (des) alinhamento com a perspectiva das QSC; Itinerários formativos para o Ensino de Ciências centrados nas QSC; Conteúdos e temáticas relevantes no tratamento de QSC. A partir da análise, entendemos que, em nível discursivo, há aberturas a partir das quais é possível empreender práticas fundamentadas nas perspectivas das QSC, embora seja preciso um investimento explícito na produção de condições apropriadas para tal.


1 Introduction

The Base Nacional Comum Curricular (BNCC) is a normative document that defines the expected learning from all Basic Education students in the country. Its formative, ethical and aesthetic principles are based on the Lei de Diretrizes e Bases da Educação Nacional (LDB) and in the Diretrizes Curriculares da Educação Básica (DCN) (BRASIL, 2019). The BNCC states to be anchored in the pillars of formation for the construction of a society founded on principles of justice, democracy, and inclusion, through a human formation centered on the development of competencies and from the perspective of integral education, seeking to align with the which guidelines of the Plano Nacional de Educação (PNE) (BRASIL, 2014).

In this sense, we understand the BNCC as a national curriculum that, according to Apple (2002), concerns both a system of national objectives and nationally standardized assessment instruments — usually guided by performance — and a slightly more veiled modality, related to trends in textbook choices (including editorial issues and underlying policy) and their distribution and use in the education system. According to the author, some key points must be considered when dealing with a national curriculum in the sense of adopting official knowledge:

[...] even though proponents of a national curriculum may see it as a means of creating social cohesion and enabling us to improve our schools by assessing them against “objective” criteria, its effects will be just the opposite. The criteria may seem objective, but the results will not be, given the differences in resources, social class, and racial segregation. Instead of
cultural and social cohesion, what will emerge are even more pronounced differences, socially produced, between “us” and “the others”, aggravating social antagonisms and the resulting cultural and economic breakdown. (APPLE, 2002, p. 75-76).

Although it is not the focus of this article to discuss the contradictions or conditions of the production of a national curriculum, we understand that some issues must be on the horizon of the debate in the areas of Education and Science Education, especially considering the historicity and accumulations that these fields of knowledge produce. It is true that in the debates of the last decades, interculturalism and multiculturalism have been highlighted, as well as the position of issues of gender, race, culture, sexuality, behavior, identity issues, differences, and human rights (CANDAU, 2008; SILVA, 2000) in curricula and school practices, besides the resistances, obstacles, and diverse narratives inherent to such markers.

The need to highlight issues of subjectivity, identity, cultures, and differences in the educational field emerges from the diverse voices of organized society, of engaged subjects, of social movements, especially those who are not in a position of power and privilege and/or do not benefit from them. And it is precisely because of the risk of making them invisible and silencing them that authors such as Michael Apple bring light and elaborate critical categories that allow the analysis of the curriculum issue focusing on: standardization movements; power distribution; policy of official knowledge, and articulation of education with the logic of the productive system.

From the perspective of Science Teaching, we also recognize movements in discursive and practical terms, of contestation of hegemonic norms and discourses, of the standards that value the issue of human rights, diversity, and ethnic-racial issues in this area of teaching and research (OLIVEIRA and QUEIROZ, 2016; VERRANGIA and SILVA, 2010). It is an influx in the opposite direction, of resistance, that seeks to rescue particularities of cultures and subjects in the context of Science Teaching, against trends of massification, standardization, and generalizing assumptions that silence diversity and life itself.

Productions in education for the relationship between Science, Technology, and Society (STS Education) and Socioscientific Issues (SSI) for Science Teaching have also moved in a similar direction. Both question the naturalized relationship with the scientific and technological enterprise, beliefs and elaborations strongly rooted in positivism and in the principles of technical rationality about what science is, which
feeds ideas such as scientific neutrality, absolute and incontestable truths, science as the savior and redeemer of humanity. Added to this, it provides for the development of argumentation, the ability to evaluate controversies from scientific, ethical, moral, and value contexts (SADLER, 2004; ZEIDLER et al., 2005), aesthetic, political, legal and, finally, well-founded public participation (ERDURAN and JIMÉNEZ-ALEIXANDRE, 2008; KOLSTØ, 2006; RATCLIFFE and GRACE, 2003).

Therefore, our proposal is presented based on the problem: What are the elements, perspectives, and formative aspects present in the BNCC, especially concerning Science Teaching in Elementary School, that indicate possibilities or obstacles for the development of practices aligned with the perspectives of Socioscientific Issues?

2 The Socioscientific Issues, curriculum and official documents

Since the 1980s, the international community of studies and research in science education has recognized and discussed the fact that there is a great diversity of perspectives on Science Teaching. In his work entitled “STS Education: A Rose by Any Other Name”, Canadian professor and researcher Glen Aikenhead (2003) builds this panorama in which he highlights the potential of holistic worldviews to always bring new ways of thinking — which happened with the STS perspective in Science Teaching.

Benzze et al. (2020) also gather under the term Science-in-context the approaches of Socioscientific Issues, the interrelationships between Science, Technology, Society and Environment (STSE) and Socially Alive Issues (or socially acute, depending on the translation). According to the authors, both perspectives envisage scientific training in favor of a broader and contextualized understanding of science, seeking to overcome a Science Teaching reduced to the decontextualized appropriation of products and practices of scientists and engineers.

In Brazil, Santos and Souza (2019) also agree with the interactions between the SSI and STSE, and propose, based on the broad concept of Ecology, to identify elements of Scientific Literacy anchored to this assumption.

Quoting Fensham (1988 apud AIKENHEAD, 2003, p. 2), we recognize that “curricula are thought not only within the social reality but also respond to changes in society” (our translation). In this context, the STS perspective emerges to question the...
status quo in Science Teaching, humanizing the school curriculum and envisioning new formative horizons that can be reached by science, with science, and through reflections on science.

Despite recognizing the lack of consensus, or rather, a univocal interpretation of the relations between science, technology, and society, some historical analyses of the different appropriations of the STS perspective in teaching have been carried out in the literature, making it possible to understand the many formats, proposals, resources, and goals of a scientific education based on such assumptions.

From a broad curriculum perspective, especially centered on Science Teaching, Aikenhead (2003) foresees an articulating structure between traditional Science contents and STS contents, which can be implemented from eight points of view, systematized from the different possible relationships within a curricular structure:

1. Motivation from STS contents;
2. Casual insertion of STS contents;
3. Purposeful insertion of STS content;
4. Specific subject through STS content;
5. Science through STS content;
6. Science with STS content;
7. Inclusion of science in the STS content;
8. STS Content (our translation)\(^4\).

This scenario reveals different possibilities for implementing STS Education within the Science curriculum. According to Santos and Mortimer (2002), the STS content as motivation concerns the traditional teaching that seeks to “gild the pill” of purely conceptual courses. The casual insertion would be the incorporation of STS studies as curricular appendices, but without unifying or integrating them with the schedule, as opposed to purposeful insertion that discusses the STS contents integrated with regular Science topics.

In planning a specific discipline through STS content, the scientific subjects would be the same as in the list of traditional curricula but now organized around themes that problematize the relationship between science, technology, and society. When the subject starts to be organized from the STS, multidisciplinary themes, and no longer by a list of fragmented disciplinary contents, we say it is about science through the STS content. When the teaching focus is on STS topics and Science

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content only serves to complement and/or enrich the discussions, we say it is Science Teaching with STS content. In the inclusion of Science into the STS content, it is about focusing on the STS content, complemented by a Science content in a non-systematic way. Finally, there is the possibility of carrying out studies on STS issues, in which “Science content is mentioned only to indicate a link with science” (SANTOS and MORTIMER, 2002, p. 124-125).

Aikenhead (2003) affirms that the scope of the social context of science in STS materials was sometimes limited to the observation of science and technology in the curricula, regardless of the positivist nature of those traditionally considered contents or the utilitarian perspective of technology that prevailed in the proposals. Adding to this, and quoting Ziman (1984), the author found that “a more comprehensive treatment of the STS [perspective] includes the internal social context (epistemology, sociology, and history of science itself) and the external social context of science” (AIKENHEAD, 2003, p. 7, our translation).

In this sense, between a teaching organization according to the traditional science program or the sequence suggested by the STS contents themselves, Aikenhead (2003) proposes a curriculum planning that tensions and mobilizes the field of traditional science and its contents with the approach of the actual social issues, related to the technological mastery of students’ daily lives, in a construction of more elaborate formative meanings related to the relations between science, technology, society and environment.

The biggest obstacle to changing the curriculum is the change itself. The shift is well known to the scientific community because scientists change paradigms from time to time, but not without difficulty. I predict that now is the time for science educators to shift from a traditional paradigm to an STS paradigm for school science in order to ensure educational excellence and relevance for all students. (AIKENHEAD, 2003, np).

The findings of Aikenhead (2003) on curricular change seem to converge with the diagnosis of Ivor Goodson (1997), a curriculum designer who argues that there are a series of social mechanisms that act together and simultaneously and that result in patterns of stability and change, especially if we consider school subjects. Such mechanisms would be related to the internal aspects of the constitution and the external aspects of these subjects, generally associated with organizational issues of education.
For Aikenhead (2003), the reason why specific contents or teaching perspectives have been historically hegemonized in school curricula - despite attempts at change - can be explained by the lack of harmony between the decisions planned at a given level (such as in the scope of the formulation of policy texts) and the ideas and interests produced and experienced at other levels (such as in school institutions and disciplinary communities). This implies conceiving the curriculum as a production resulting from a series of disputes and agreements.

From a perspective similar to Goodson's (1997) but that reconfigures the way we conceive the relationship between stability and change, Ferreira (2007a; 2007b) proposes that we think of these phenomena not as antagonistic or excluding but as complementary. This means thinking of disciplinary traditions as devices that, simultaneously, stabilize specific aspects related to a given discipline, but that can, depending on the case, allow the irruption of curricular innovations.

Considering the recent curricular transformations that permeate the Brazilian educational scenario, the interest and need to look at documents based on the contributions and ruptures that work with the SSI offers to the field of scientific education is salutary. On the one hand, working with Socioscientific Issues has great potential for students’ critical scientific education: it enables the problematization and contextualization of Science contents; the approximation of knowledge with the concrete reality of social life; reflections on the nature of science and its implications for society; mobilization of scientific knowledge and other dimensions of knowledge (ethical, moral, political, economic, cultural, social, environmental, and religious, among others); and encouragement to argumentation raised from controversial issues (RATCLIFFE and GRACE, 2003; SADLER, 2004; ZEIDLER et al., 2005; REIS, 2014). On the other hand, its effectiveness is interdependent on multiple factors related to the teachers’ performance and education, including:

- A lack of confidence or ability on the part of teachers to deal with problems without “correct” answers;
- A lack of knowledge/proficiency in teaching strategies to deal with controversial issues;
- Dealing with bunches of inevitably incomplete information;
- Perceived mastery in the curriculum for acquiring knowledge and understanding concepts — therefore, there is no link with the consideration of social and ethical issues;
- Teachers’ perception that social issues should not be part of the Science curriculum;
- Logistical (and philosophical?) barriers in cross-curricular collaboration
Despite the importance attributed to the work with Socioscientific Issues in scientific education, the concrete reality of the curricular organization added to the new demands that this perspective brings to the pedagogical practice are obstacles to be overcome for its realization. Reis and Galvão (2005) attribute to this the great extension of the disciplinary programs, which stiffen the discussions and limit the time available for the treatment of the contents, the absence of topics that suit or allow the performance of discussion activities and “the type of national exam proposed that induces teachers to prepare their students for a type of assessment centered almost completely on memorization and practically not at all on critical analysis” (REIS and GALVÃO, 2005, 155-156).

Thus, it is possible to understand that the glimpse of a Science curriculum that dialogues with the formative assumptions of Socioscientific Questions must be thought of in an immanent way to the concrete conditions for the realization of this praxis by the subjects, understanding the intrinsic and extrinsic contradictions of the process. In the meantime, one can reflect on to which extent the lack of citizenship in the procedure of doing science impacts restrictions on citizen formation in the pedagogical processes of teaching science and teaching about science. Starting from this diagnosis is fundamental to put into perspective which horizons one has to plan the organization of Science Teaching for today’s students.

When reflecting on the relationship between science education and citizenship, Pinhão and Martins (2016) say that discourses that relate scientific education and citizenship are hybrids and can carry ambiguities of meaning. Thus, “it is therefore necessary to pay attention to the different meanings of the term that these expressions assume, for example, in official documents for science education” (PINHÃO and MARTINS, 2016, p. 11). The polysemy of concepts could thus give way to their emptying and meaningless use. Quoting Levinson (2010, p. 72), the authors continue: “the danger of such omnipresent rhetoric is that it can come to disguise problems and contradictions that, if ignored, can lead to the persistence of undemocratic practices” (apud PINHÃO and MARTINS, 2016, p. 12).

Thus, because historically, it has been constituted as a broad and diverse slogan, characterized by the plurality of meaning, it is necessary to propose and defend formative elements that place the STS perspective at the forefront of criticality in the
formation of subjects for the 21st century. Therefore, there is the defence of the Socioscientific Issues as a teaching perspective that makes it possible to think and organize curricular elements in order to envision the realization of a critical education for our students.

3 Criteria for the analysis of curricular alignment from the perspective of Socioscientific Issues

To define the criteria adopted for the proposed analysis, we list categories based on the literature on Socioscientific Issues, highlighting aspects that are valued in the field of research and that characterize Science Teaching from the SSI perspective. Thus, the axes and subaxes are:

a) General conceptions of education and the (mis)alignment from the SSI perspective (FORM);

b) Educational itineraries for Science Teaching focused on the SSI (ITF):
   i. Citizenship and citizen education within the scope of the SSI (ITF1);
   ii. Assessment of articulated scientific, technological, social, and environmental risks/problems/controversies (ITF2);
   iii. Values, moral and ethical reasoning in the context of scientific and technological problems and controversies (ITF3);
   iv. Relationship between Science and popular/traditional, cultural and/or everyday practices (ITF4);
   v. Argumentation, decision-making and public participation as lessons relevant to the SSI (ITF5);

c) Relevant contents and themes in the treatment of the SSI (CONT).

We present below our understanding of each of those categories, indicating how they are powerful for thinking about Science Education from the perspective of the SSI.

4 General conceptions of education and the (mis)alignment from the SSI perspective (FORM);

This category includes the fundamental concepts that concern the general conception of education. Although those concepts are an abstract elaboration of the intentions and the understanding of the educational phenomenon and its
consequences in society and culture, they shed light on concreteness insofar as they are projects, propositions for actions and their pertinent methods.

Thus, as fundamental concepts to support the conceptions of formation, we recognize that the idea of critical formation, transformation, public participation, decision-making, and understanding are prerogatives for a school formation that favors dialogue, argumentation, analysis, and well-founded criticism.

5 Educational itineraries for Science Teaching focused on the SSI

a) Citizenship and citizen education within the scope of the SSI

The education for citizenship, a fundamental formative element provided for in the Constitution by the Lei de Diretrizes e Bases da Educação Nacional, is one of the pillars that support the processes developed in the educational scope. Located in a polysemic conceptual field, the idea of citizenship can take on different contours according to ideological alignment, interests and hegemonic trends. The literature on SSI also disputes narratives about citizen formation, providing principles that guide its definition, profiles and knowledge of the citizen, and unfoldings and implications of education for citizenship.

Citizen education from the perspective of the SSI concerns cultural education, providing conditions for the development of values, principles, cosmovision, critical, conceptual and methodological categories for the definition, analysis and evaluation of scientific and technological problems/themes. Besides training for purposeful action and social performance based on summaries and the definition of problems in the sense of individual and collective organization for transformation.

b) Assessment of articulated scientific, technological, social, and environmental risks/problems/controversies

The modernization process that constituted the industrial society also established the risk society, as already denounced Beck (2011). According to the author, the production of wealth is also the production of risks, which have changed their configurations throughout history, following changes in the economic system, science and technology. Thus, we currently face invisible risks, related to radiation, polluting and toxic substances, which, due to their scope, relativize ideas of borders, even though margins continue to be the primary target of the consequences of the
production processes.

In this way, we find ourselves in a contradictory scenario of wealth and risk distribution, of qualitative and quantitative leaps by scientific and technological production, while witnessing environmental impacts, health consequences, and questionable changes in behavior and pace of life that resemble an essentially controversial cultural and concrete context.

Assessing themes of a controversial nature (or that are problematized by the teaching process) in order to highlight the nuances, the contradictions, understand themselves as part and potential solution to problems seem to be essential knowledge for the formation of citizens in the current times. Considering the implication of Science Teaching in this agenda, the thematic approaches based on the assumptions of STS Education and SSI offer a powerful opening for the assessment of themes, problems or controversies articulated in the fields of science, technology, society and environment.

Among the topics, we can list issues in food production, energy, communication, health, sexuality, medication and drug addiction, interfaces between science and gender and race issues, scientific and technological productions in general, understanding them from their bases in science and technology and exploring their relationships with society and the environment, therefore, also mobilizing concepts, laws and theories, and discursive, aesthetic aspects about behavior, risks, laws, and regulations.

c) Values, moral, and ethical reasoning in the context of scientific and technological problems and controversies

Within the scope of the problems highlighted in item b, Zeidler et al. (2005) highlight the need to develop moral and ethical reasoning to deal with Socioscientific Issues, which, despite having a scientific and technological basis, demand knowledge, look, and analytical-conceptual perspectives from other areas of knowledge because of the borderline nature of those themes. When dealing with real, concrete and controversial problems, strictly scientific and technical knowledge proves insufficient to broadly and critically reach the dimensions of the problems, influencing the quality of decisions and the basis for citizen participation.

Thus, some attitudes come into play as attitudes of participation, regulation, and
monitoring, such as pondering, judging, considering the limits of scientific and technological knowledge, apprehending discourses and explanatory structures from different fields (beyond the specialist and technical fields), such as the religious, the activist and the popular discourses to elaborate arguments, take a stand, and participate with criticism, establishing the frameworks that delimit the extension of action, the guidelines, and the nature of the production of science and technology,

d) Relationship between Science and popular/traditional, cultural and/or everyday practices

One of the aspects highlighted by Ratcliffe and Grace (2003) about the nature of SSI is the fact that it has local, regional or global relevance, i.e., the issue gains potential insofar as it is part of everyday life, which is present in the media, in everyday conversations, stands out in the list of topics addressed on a daily basis. Without a consistent project of Scientific Literacy, serious education in Science and committed to the concrete and cultural reality and its transformations, the themes are submitted to the sieve of common sense and incorporated from the traditional and popular categories, which can result in the maintenance of situations in the hands of those who hold the power of knowledge and decisions.

Robottom (2011) suggests the identification of the SSI within the community itself. The organizing principle of the curriculum, the source of knowledge from which the definition of formal teaching guidelines would be developed, would reside in the community, which would recognize in this movement a high connection with people’s lives, an alignment with the community of interest, and the valorization of idiosyncrasies that concern, by nature, different sectors and fields of knowledge and practice.

Thus, we recognize a strong appeal of the treatment of the SSI linked to the culture and popular/traditional knowledge of the students as a way of accessing their own culture, with an evaluative, analytical and questioning look from the body of scientific and technological knowledge, resignifying understanding and appropriation of reality itself.

e) Argumentation, decision-making, and public participation as lessons relevant to the SSI

The notion of argumentation, strongly mobilized in the SSI context, concerns its
very nature. Because they are controversial, of an interdisciplinary nature, and deal with uncertainties and open questions, the treatment of the SSI requires students to engage in argumentative processes to deal with the profusion of information and diversity of discourses and develop an autonomous and well-founded position (SIMONNEAUX, 2007).

According to Acar et al. (2010), the exercise of argumentation is favored within the scope of the SSI to the extent that controversy and the diversity of discourses confront students with a framework of evaluative issues, explanatory structures and options, requiring the evaluation of alternatives and, mainly, decision making. In this sense, we emphasize decision-making as a discourse and a formative horizon that is highly valued and debated in Science Teaching (BELL and LEDERMAN, 2003; KHISHFE, 2012; KORTLAND, 2001; 1996). In fact, decision making provides for deliberations, judgments, choices, and definitions of the best explanatory or evaluative structure, guided by assumptions that are also evaluative, besides conceptual, before different points of view and different explanatory bases.

The decision-making perspective can also be read from an individualistic and uncritical point of view, of conformation with the model of society, since it would be up to citizen education to prepare for a careful and well-elaborated choice before already defined and ready situations, to the taste of neoliberal agendas. Depending on the care taken and the tone of the speech, this perspective triggers citizenship for conformity and adaptation, which is insufficient for an unequal and contradictory society that requires transformations. Moreover, the issue of activism (BENCZE; SPERLING and CARTER, 2011; HODSON, 2003; HODSON, 2011; REIS, 2014) and public and democratic participation also take part in the discussions in SCI, which recover the issue of being positioned through investigations, simulations, but it foresees learning about participation, involvement, elaboration of strategies, analysis of the conjuncture for the viability of an active, contextual, ethical, and transforming participation.

6 Relevant contents and themes in the treatment of the SSI

Essentially, the contents and themes related to the SSI are controversial and open, transiting the border of scientific knowledge, providing opportunities for students to problematize reality, exercising interdisciplinarity and, especially, inviting students to argue, develop judgment and ethical reasoning, and mobilize values and scientific knowledge, take a stand, and elaborate alternatives, in short, participate. In this sense,
it is important that, in the education process, contemporary, real, concrete and, above all, controversial topics are included in science and technology associated with social and environmental issues, such as food (production system, food distribution, exploitation, food habits, food shortages), energy (production structure and demands for fossil fuels, contradictions in sustainability discourse and practices, energy matrices, and risks) and health (vaccines, their risks and anti-vaccine discourses, sexuality and self-care, self-medication, drugs, and culture), among many others.

7 Openings and (im)possibilities in the BNCC: analyses and reflections

For the analysis and pertinent reflections, we retrieved the texts in the BNCC: item 4.3, “The area of Natural Sciences”, the “Specific Competencies of Natural Sciences for Elementary School”, item 4.3.1., “Science”, and item 4.3.1.1., “Science in Elementary School — Initial Years: thematic units, objects of knowledge and skills”. Item 4.3.1.2., “Science in Elementary School — Final Years: thematic units, objects of knowledge and skills”, was left out of our analysis due to the limitation of this article, but it remains in our horizon of interest so we can have better conditions to reflect on Socioscientific Issues in Elementary School.

We used the criteria for the analysis of the curricular alignment with the perspective of Socioscientific Issues to read the elements of the BNCC. We present our analysis perspective, supported by the theoretical framework, highlighting the back-and-forth of approximations and estrangements and other relevant aspects.

Item 4.3 of the BNCC is concerned with covering education concepts for the area of Natural Sciences, presenting an overview of the expected education for the Initial and Final Years of Elementary School, and education assumptions aligned with general competencies and competencies for the area and school level.

The second paragraph of this item presents a perception we align with and which fosters enthusiasm for those who are seeking adjustments with what has been discussed in the scope of the STS Education, Scientific Literacy and Literacy or SSI, which is the element of contradiction and openness to problematization: “the same scientific and technological development that results in new or better products and services can also promote imbalances in nature and society” (BRASIL, 2019, p. 321).

Still following the exercise of looking at the elements present in the text of the item above, we recognize some General Formation Conceptions (FORM) involved in
the formative perspectives or in the learning expected for the students and that dialogue with the assumptions of the SSI. Namely, the debate and stand-taking (ITF5) and the elaboration of the understanding to deal with issues that transit the border of scientific knowledge, requiring other knowledge, as exemplified by the excerpt: “To debate and take a stand on food, medicines, fuel, transportation, communications, contraception, sanitation, and maintenance of life on Earth, among many other topics, are essential for the ethical, political, cultural and scientific knowledge” (BRASIL, 2019, p. 321).

There is a recovery of the theoretical perspective of Scientific Literacy (FORM) that concerns an education that observes, interprets, but also transforms, indicating an active and transforming model of citizenship (ITF1), as in the excerpt: “a commitment to the development of scientific literacy that involves the ability to understand and interpret the natural, social, and technological world, but also to transform it based on the theoretical and procedural contributions of the sciences” (BRASIL, 2019, p. 321, text underline). Another passage that concerns an active citizenship (ITF1) speaks of the “capacity to act in and on the world, important for the full exercise of citizenship” (BRASIL, 2019, p. 321).

Another understanding that addresses the concept of formation (FORM) highlights “that those students are expected to have a new look at the world around them, and make conscious choices and interventions based on the principles of sustainability and the common good” (BRASIL, 2019, p. 321, our emphasis), which also concerns the exercise of decision-making and participation (ITF5), under the expression “intervention”, besides “revisiting their knowledge and understanding of the world in which they live” (BRASIL, 2019, p. 322), which is related to a conception of education based on reflection and access to knowledge and self-understanding, which indicates relationships with the ITF4.

The perspective of teaching using the investigation is strongly present as a formative concept (FORM), which is indicated in the following excerpt and structures the formative assumptions of general competencies:

[...] the area of Natural Sciences, through a synthetic view of different fields of knowledge, needs to ensure that elementary school students have access to the diversity of scientific knowledge produced throughout history, as well as a gradual approach to the main processes, practices, and procedures of scientific investigation. (BRASIL, 2019, p. 321).
General competencies, in turn, present a gradually increasing framework similar to the investigative perspective, whose axes that concentrate the intended learning are: problem definition; survey, analysis and representation; communication; intervention. Which indicates, from verbs like to plan, develop, organize, participate, introduce, and implement, among others, a claim to an active, analytical, purposeful, and participatory education (FORM), which would certainly establish a fertile environment for the development of the SSI, with the addition of encouraging argumentation, analysis, evaluation, participation, and intervention.

Specific competencies are also presented from the logic of the modification of an action, starting from the perspective of understanding and ending in action (ITF5), including debates on technological, scientific, socio-environmental and world of work issues; analyses and relationships between the natural, social, and technological world; assessment of political, socio-environmental, and cultural implications of science and technology (ITF2); construction of arguments, communication, and proposition of alternatives (ITF5). Some values (ITF3) are clearly evidenced in the specific competencies, such as: respect; autonomy; responsibility; flexibility; resilience; determination; ethical, democratic and sustainable principles; solidarity; although not all of them align with the SSI perspectives from a critical point of view, beyond the issue of decision-making (ITF5).

Item 4.3.1 — “Science” — presents the learning expected for this curricular component and its structure in the BNCC. The Science curricular component is divided into three thematic units: Matter and Energy; Life and Evolution; Earth and Universe.

In the introductory paragraph, the concept of formation (FORM) aligned with a citizenship perspective (ITF1) for action in the world is reinforced: “Those learnings, among others, enable students to understand, explain and intervene in the world they live” (BRAsIL, 2019, p. 325).

Regarding the thematic unit “Matter and Energy”, for the Early Years, the text indicates important aspects that may indicate possibilities for treating the SDIs at this stage, even though research on this topic is still incipient. Regarding this finding, when performing a State-of-the-Art analysis, Ferst (2013) recognizes the incipient number of research on SCI in the Initial Years, most of which were focused on conceptions and representations.

In the same sense, Silva and Strieder (2020) emphasize that, keeping the
cognitive conditions and the particularities of age-related development, Scientific Literacy should be developed at any school age, inviting children to think about the world and question reality. Genovese, Genovese, and Carvalho (2019), when rehearsing on Socioscientific Issues and their implications for the Early Years, also highlight:

Knowing how to take a stand and being able to see scientific advances as coming from a historical, social, political, and economic process is to have a critical view of scientific and technological development. This critical view of the techno-scientific enterprise can be stimulated and experienced since the early years of Elementary School, by exercising argumentation, provided by teaching methodologies that value the students’ opinions, based on the knowledge studied in the classroom and on the human being that is in the formation process. (GENOVESE; GENOVESE and CARVALHO, 2019, p. 14).

Thus, we have a formative conception that understands experiences as a starting point (FTI4) without necessarily predicting contrasts and differentiations, defining that:

In the Early Years, children are involved with a series of objects, materials, and phenomena in their daily lives and in their relationship with their surroundings. Such experiences are the starting point for the construction of the first notions about materials, their uses and properties, and their interactions with light, sound, heat, electricity, and humidity, among other elements. (BRASIL, 2019, p. 325).

From the same perspective, “the most concrete elements and the environments that surround them (home, school, and neighborhood), offering students the opportunity for interaction, understanding and action in their surroundings” (BRASIL, 2019, p. 326) are valued at this stage, indicating the context also as a place of action.

Actions related to the development of values and moral reasoning (ITF3) and reflections on risks (approximation with ITF2) are also considered for the Initial Years, when the text says that they foresee “the collective construction of proposals of recycling and reuse of materials, [and that] the construction of healthy and sustainable habits is also encouraged through discussion about the risks associated with physical integrity and auditory and visual quality” (BRASIL, 2019, p. 325).

That document also states that students are expected to recognize the importance, for example, of water, in its different states, for agriculture, climate, soil conservation, electricity generation, atmospheric air quality, and ecosystem balance (ITF3 and ITF2).
In the initial grades, the possibilities and openings for contradiction focus mainly on the 5th grade. We venture to say that this is because, historically, there is a change in the formative culture from the Early Years to the Final Years: the “aunt” becomes “the teacher”, the number of teachers increases and the specific subjects also diversify. The arrival of contents related to Chemistry and Physics, which traditionally occurred from the 8th grade onwards and especially in the 9th grade, are now presented since the beginning of the final grades of Elementary School, with particular emphasis from the 6th grade onwards. In this movement, the curriculum of the Science school subject seems to inflect the curricular traditions, in which the marks of reference knowledge emerge as devices that contribute to regulating the form that the curriculum takes, which can have the effect of gradually interdicting this approach over the series.

Throughout the reading of the skills evidenced for the 5th grade, some formative itineraries, especially the ITF5, suggest the possibility of dealing with themes with openness to the conformation of argumentative contexts, calling for decision-making and more active participation. It is true that, given the formative traditions of our Science Teaching, there is no guarantee that the problem or thematic will be approached in those terms, i.e., that the teaching practice of what is set out in the BNCC deals with contradictions and open questions, evidences risks, exercises problematizations, mobilizes values and moral and ethical reasoning, relates science to popular/traditional knowledge, culture, behaviors and everyday practices, nor that argumentative practices will be developed or decision-making stimulated or students prepared for the public participation in society.

Following the reflection, throughout the curriculum conformation for the Initial Years, we noticed the absence of controversies as a formative principle, even though we see the presence of problematizations of science faced with aspects of reality. For example, in the introductory text of the general conceptions, the students are assigned important functions such as comprehension, understanding, evaluation, and proposition. Silva and Strieder (2020) also recognize that there are curricular spaces in the BNCC for the development of proposals based on the STS perspective; however, they are associated with less critical perspectives, especially focused on perceptions and conscious uses of natural resources.

Thus, without the controversial aspect tensioning the concepts with reality, the only type of contradiction appears with the presence of a few binaries of the benefit-
harm, and advantage-disadvantage type. As Santos, Costa, and Brito (2020) show, controversy is central to dealing with the SSI. The authors even propose delimiting the controversy as one of the moments of a teaching focused on SSI. Furthermore, it is essential to highlight that there is no explanation of moral or ethical issues involving science and technology as an approach provided for in the curriculum text, although we can infer that there are openings in some skills.

8 Discussions and conclusions

Our reflections revealed that in a language of possibility and in an exercise of recognizing possible openings, the provisions of the BNCC neither prohibit practices aligned with the SSI nor boost them. It is vital to highlight that, in addition to what is exposed in the document, to talk about the feasibility of teaching practices we must recognize other crucial elements, such as state, district, and municipal curricula; guidelines for teacher education and various formative practices; the actual conditions and school culture to embrace the foundations of the SSI.

In this sense, at a time when the BNCC is in force, both by the movement of translating its assumptions into the curricula of subnational spheres and by the actual occurrence of those curricula in the contexts of practice, making visible possibilities for the teaching work aligned to the SSI seems powerful to us. This means betting on the teaching action that contributes to signify the curriculum in text production and educational institutions, perceiving it as a producer of meanings that can incorporate the SSI.

In fact, the BNCC does not herald a totally eclipsed path to the development of the SSIs. Nor does it take them for granted. Even if there is a mismatch between what is presented in the general and specific competencies of Natural Sciences for Elementary School and some utilitarian and individualist perspectives of science expressed in important topics about the expected education, there seems to be, at discursive levels, indications of other concepts of science and technology, as well as their relationship with society, culture, and the environment. In the same way that the education for dealing with scientific and technological controversies and moral and ethical issues involving these fields of knowledge, central to Socioscientific Issues, they also do not occupy places of evidence.

Considering the reality of Science Teaching in Brazil, changes in the conception
of the teaching function would certainly be very welcome in the understanding of what science, technology, and its combination with other fields of knowledge and concrete reality are, and an invitation to reassess the formative profile of the student in Elementary School Sciences.

However, we also recognize that the discourses of the Parâmetros Curriculares Nacionais (PCNs) in the late 1990s contained elements that would indicate another Science Teaching, given the past 20 years. Therefore, it does not seem prudent to occupy ourselves with thinking about possible alignments and entries without thinking about the formation of those who will carry them out in practice: the teachers (MACIEL, 2012).

Without ignoring the changes in the guidelines for teacher education implemented by Resolution CNE/CP No. 02/2019 (and this is certainly a matter for future studies and critical analysis), we must highlight demands from the cultural, epistemological, social, political, and material field to be able to aspire to and vigorously demand deep transformations in Science Teaching. As long as science is understood as neutral and an accumulation of extraordinary facts under the sign of ingenuity, an exotic and esoteric entity, the debate, the oral and written synthesis, the linguistic development, and the development of moral and values will be seriously compromised, given that these elements still do not participate in what is understood culturally as part of doing, learning, and teaching Sciences.

As Lopes (2018) criticizes, it is necessary to pay attention to the excessive attribution of the function of salvation to education. Inequalities are not effectively remedied from a common teaching, a general curriculum, or a homogeneous conceptual-methodological structuring since the structural problems of society, the contradictions of education, are constituted from and rooted in diverse processes.

Thinking about implementing the SSI in the educational field also means requiring that, at school, there rests in gentle meadows a culture of investigative practices and argumentative approaches dealing with contradictions and controversies, the exercise of problematization, and spatial and temporal location of what is taught, and that science relates to economic, social, cultural structure, aesthetics, ethics, and morals. Otherwise, we will still have an arduous exercise of looking for needles in haystacks, lights in small cracks, of starting from the little.

If inserting the SSI into the curriculum would not necessarily demand significant
changes, without them, those will not become everyday practices either. Besides counting on the sensitivity and attention of managers, principals, and public policy makers engaged on the topic (which does not give us guarantees, given the priority of the political and economic demands, such as ranking and large-scale assessments), it is also important that we consider the location of those foundations in the education of teachers and, mainly, the cultural formation of our society. Otherwise, curriculum changes will be of little value since the reading, interpretation, and practice of the curriculum are contextual and respond to factors that, in the order of priorities or magnitude, are prior to public policy, as they refer to epistemological, evaluative, and aesthetic foundations about what, how, and for what to teach Science. And this is a theme that is worth developing at another time.

References

ACAR, Omer; TURKMEN, Lutfullah; ROYCHOUDHURY, Anita. Student difficulties in socio-scientific argumentation and decision-making research findings: Crossing the borders of two research lines. *International Journal of Science Education*, v. 32, n. 9, p. 1191-1206, 2010.


GENOVESE, Cinthia Letícia de Carvalho Roversi; GENOVESE, Luiz Gonzaga Roversi; CARVALHO, Washington Luiz Pacheco de. Questões Sociocientíficas: origens, características, perspectivas e possibilidades de implementação no ensino de ciências a partir dos anos iniciais do Ensino Fundamental. **Amazônia: Revista de Educação em Ciências e Matemáticas**, Belém, v. 15, n. 34, p. 5-17, jul./dez. 2019.


HODSON, Derek. **Looking to the Future:** building a curriculum for social activism. Rotterdam: Sense Publishers, 2011.


LOPES, Alice Casimiro. Apostando na produção contextual do currículo. In: AGUIAR,


