

## Considerations about the Presence of Nature of Science in Official Educational Documents: A Very Brief Comparison between DCN (Brazil) and NGSS (USA)

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### Abstract

Nowadays the importance of History, Philosophy and Sociology of Science (HPSS) for science education is a consensus in the research area. After several years, it was built what is called today Consensus Vision of Nature of Science (CVNOS), based mostly in the works of Lederman and collaborators (2007) and also McComas (1998), among others. The CVNOS, or the "Lederman's seven" as it is known (Matthews, 2012), was an important achievement in the area, however, only after some few years its contributions came up explicitly or effectively inside official educational documents worldwide. Nevertheless, when it became a new fashion, heated debates arose about the philosophical foundations of the CVNOS. And it paved the way for several critics (not only philosophical) over the so-called "Lederman's Seven." In this work we examined some of CVNOS impacts in the discourse of two official educational documents: the *Diretrizes Curriculares Nacionais* (DCN, or National Curriculum Guidelines) in Brazil (Brasil, 2013) and the Next Generation Science Education Standards in the United States (NGSS, 2013). We point out to the similarities and differences on the NOS approach in both documents, discussing its failures and achievements.

### Keywords

Nature of science, Science Education Standards, NGSS, DCN

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### Introduction

Nowadays there is a consensus among researchers about the importance of History, Philosophy and Sociology of Science (HPSS) for science education. One can find several proposals in the specific literature about HPSS, mainly regarding applications in classrooms from elementary school to colleges. After generating such academic impact, HPSS and also what it is known as Nature of Science (NOS) slowly started to take place in the official educational documents, school curricula and syllabus, as teaching sequences proposals, and so on. At the same time, long discussions took place in the academic sphere on how to conceptualize the NOS in a way

didactically applicable and pedagogically interesting. After several years, it was built what is called today Consensus Vision of Nature of Science (CVNOS), based mostly in the works of Lederman and collaborators (2007) and also McComas (1998), among others. Below is the most known list of tenets of NOS elaborated by Lederman group (2007)

- Science is empirically based;
- Theories and laws are different kinds of knowledge;
- Scientists are creative and imaginative;
- Scientific knowledge is theory-laden;
- Science is culturally and socially embedded;
- There is no the scientific method;
- Science is tentative.

One could add to the Lederman's list the McComas and Nouri's list (2016):

- important role in science.

The CVNOS, or the 'Lederman's seven' as it is known (Matthews 2012), was an important achievement in the area, however, only after some years these contributions came up explicitly or effectively inside official educational documents worldwide. Nevertheless, when it became a new fashion, heated debates arose about the philosophical foundations of the CVNOS. And it paved the way for several critics (not only philosophical ones) on the so-called Lederman's Seven. In the following sections we briefly compare the CVNOS presence in two official educational documents: the *Diretrizes Curriculares Nacionais* (DCN, or National Curriculum Guidelines) in Brazil (Brazil, 2013) and the Next Generation Science Education Standards in the United States (NGSS 2013a; 2013b). For the later we consider the analysis by McComas (2015) and McComas and Nouri (2016). Although DCN and NGSS have not necessarily similar structures and political intentions, the NOS subject transpires in both of some peculiar ways. In the NGSS (2013b) the NOS tenets appear in a similar form as the Lederman's seven, but even in a simpler and uncontextualized way, as we will show. On the other side, in the DCN (2013) the subject is not mentioned explicitly - it is possible, however, to grasp its discourse using basic features of polyphonic analysis and find some implicit NOS elements guiding the construct of the science syllabus. Finally, we comment some critical concerns about the NOS tenet approach in official education documents.

### Brazil's National Curriculum Guidelines and the Nature of Science

The chapter 'National Curriculum Guidelines for Secondary School' in Brazil's DCN (2012) is basically composed of a report that aims to justify (in many dimensions, especially politically and socially) and clarify the curriculum guidelines. In general, the report does not present any explicit criteria for the selection of the scientific knowledge content to be introduced in the last stage of basic education. However, one can grasp some elements that could be understood as metacriteria for that selection, by using Ducrot's polyphonic analysis (1990). Elsewhere (Noronha 2018), we explicitly show that there are at least three implicit NOS elements inside DCN:

- Science is an endeavor that unveils reality through a method that starts from empirical concrete;
- Scientific knowledge is cumulative, socially accepted, and its apprehension of reality is of a progressive kind;
- Scientific knowledge is both a historical and cultural construction, made by humanity through social interrelations.

Naturally, these are debatable elements. On the other hand, they partially reflect consensus topics on NOS, although its controversial points ('science indeed 'unveils' reality?', 'there is only one scientific method?', 'science is indeed cumulative and progressive?', to quote just a few) and deserve a more serious and careful discussion.

### USA's Next Generation Science Education Standards and the Nature of Science

Although the construction of the CVNOS was seen as a major achievement in the area of science education research, it took a long time for political incentives to be effectively included in the curricula of basic education. McComas (2015) emphasizes that a more substantial inclusion of (consensus) elements of NOS occurred in the USA only in a revised version of the NGSS (2013a). Until then, all major US national educational documents did not take into account the contributions of Lederman, McComas and others. In the revised version of NGSS (2013b) one can find eight assertions about the NOS, which is called 'matrix of NOS basic understandings':

- Scientific investigations use a variety of methods;
- Scientific knowledge is based on empirical evidence;
- Scientific knowledge is open to revision in light of new evidence;
- Science models, laws, mechanisms, and theories explain the natural phenomena;
- Science is a way of knowing;
- Science knowledge assumes an order and consistency in natural systems;
- Science is a human endeavor;
- Science addresses questions about the natural and material world. (NGSS 2013b, p.8)

One can realize that the matrix above is indeed very similar to Lederman's seven or 'McComas' twelve' NOS tenets. Nevertheless, according to McComas and Nouri (2016) this matrix has no prominence in NGSS, mainly because it takes place in an appendix. This was shocking to some USA science education researchers. In Lederman words, "NGSS have chosen to bury NOS" (apud McComas & Nouri 2016, p.565). Despite this, the next step according to McComas and Nouri is to take advantage of that NOS presence in NGSS and hoping it takes place too in national assessments and end-of-course tests.

### A Very Brief Comparison and Conclusion

A brief comparison highlights some visceral features of both documents. NGSS is more 'representative' of current research topics on NOS in science education, due to its 'tenets' presentation – DCN avoids itself (inadvertently) some of the criticism over the CVNOS. The main problem with tenet approach, as pointed by some authors (Martins 2015; Allchin 2013), is that they usually take the form of simple, uncontextualized and presumably universal assertions

about science. Furthermore, they tend to avoid controversial topics about the NOS, which are a central feature of science endeavor and its historical development (Noronha, Bagdonas & Gurgel 2018).

Apart of this brief comparison, McComas and Nouri's appeal about CVNOS tenets presence in national tests is critical – mainly because in the case this appeal is addressed, we shall see CVNOS tenets questions in high-stakes assessments in USA (and elsewhere) in the following years. The problem is that McComas and Nouri seem not to be aware of the alerts on high-stakes assessments policies by several critical curriculum theorists. On the other hand, they argue that this would "encourage teachers to include NOS more extensively in science teaching" (ibid., p.568), without pointing that 'encouraging policies' may be very stressful to teachers and students (Au 2009). Also, this kind of policies is at the heart of well-known phenomenon called by Au (2011) as 'teaching to test', which consist of teachers mechanically teaching test contents, disregarding other relevant educational subjects. This '-mechanical-neotaylorist' assembly line in classrooms (ibid) is a symptom of the commodification of education process (Leher & Accioly 2016), as alerted by several authors in the last years. This process is closely related to the neoliberal wave in the 1990s, that still rages on (Apple 2006). The so-called neoliberal ideology reflects in educational policies and curriculum discourses by what Apple (1979) calls an 'anticonflict ideology'. In turn, this reflects in science education as a scientificist-anticonflict view of NOS (Noronha & Gurgel 2016), which denies the conflicts within science and undermines a the HPSS rapprochement. As we argue elsewhere (Noronha 2018, to be published), critical curriculum theory shows us that time has come for an epistemological-political NOS approach, in order to oppose ideology and at the same inside engage students to a more critical-conflictive conception about science.

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