



# Using productive disciplinary engagement and epistemic practices to evaluate a traditional Brazilian high school chemistry classroom



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## ABSTRACT

In this article we explore a dilemma a Brazilian teacher faces: on the one hand, she tries to implement inquiry-based teaching in her high school chemistry classroom. On the other hand, she faces the pressure of her private school, which expects that their students pass the tests needed to attend college. In studying this dilemma, we shall explore the epistemic practices students engage during a lab work as possible indicators of the occurrence of productive disciplinary engagement (PDE). The empirical data was obtained from the video of 6 students working as a group during lab work on thermochemistry and kinetics. The results show that PDE may not be sufficient to analyze the construction of knowledge in more traditional classrooms.

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## 1. Introduction

Nowadays, in most countries teachers and science education researchers face a challenge when trying to balance a commitment to authentic inquiry-based science in classrooms (for example, [NRC, 1996, 2000](#)) and the pressure to increase students' scores on standardized tests that are used to assess teacher or school effectiveness or to gain access to colleges.

Inquiry science requires that students learn not only the content of science, but also the practices that characterize the construction of scientific knowledge. According to [NRC \(1996\)](#), inquiry is described as “activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world” ([NRC 1996, p. 23](#)). This requires time to engage students in “doing science” rather than “doing the lesson” ([Jiménez-Aleixandre, Rodríguez, & Duschl, 2000](#)). This involves a series of activities in which teachers should engage their students: asking scientific questions, considering evidence in responding to questions, explaining scientific ideas from evidence, connecting explanations to scientific knowledge, and communicating and justifying findings ([Meyer & Crawford, 2011](#)). Students may not necessarily generate these questions, but they are responsible for figuring out how to answer them, to collect or use data during their investigation, and to interpret these data to construct some kind of answer to these questions ([Sandoval, 2005](#)).

On the other hand, there is the pressure from standardized tests, which influence the curriculum followed by schools. These tests cover a great number of scientific topics and act in opposition to inquiry, because they focus on just the content of science that should be learned at schools and not the practices that scientists do in studying the natural world. In addition, engaging in inquiry is likely to affect students' understanding of the nature of science.

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In this article we explore an example of one Brazilian teacher's dilemma when she tries to implement inquiry-based teaching at least for introducing the phenomenological bases of two topics of the traditional curriculum in high school chemistry: kinetics and thermochemistry. Unfortunately, she also faces the pressure of her private school, which expects their students to pass the tests required for access college. In studying this teacher's dilemma, we shall explore the epistemic practices that are described in the Science Education literature (e.g., Jiménez-Aleixandre & Reigosa, 2006; Kelly & Duschl, 2002; Sandoval & Morrison, 2003; Sandoval & Reiser, 2004,) as possible indicators of the occurrence of productive disciplinary engagement (PDE, Engle & Conant, 2002). To do so we examine the behavior of six students working as a group in a high school chemistry classroom, during lab work on thermochemistry and kinetics. We videotaped six lessons in the first and three lessons in the second subject.

In this article we analyze epistemic practices that predominate in the lessons in order to qualify the engagement of students. We also analyze the teacher's practice, which allows us to show that what seems to be a lack of time for the students to do the activities reflects more general constraints linked to the organization of a school, which does not support her attempts to use inquiry in her classroom. We also discuss possible links between the four principles that foster PDE and more traditional ways of teaching. In this sense we try to answer the following research question: Is there a relationship between the diversity of epistemic practices and the disciplinary engagement of the students? We also explore implications of trying to apply PDE to more traditional classrooms.

## 2. Theoretical framework

According to Engle and Conant (2002), there is a need to consider each part of the phrase "productive disciplinary engagement" in order to evaluate if students are engaged and if this engagement is disciplinary and productive. Thus, they offer for each part of the phrase a subset of behaviors that assure that students are engaged, that the engagement is disciplinary and that it is productive. For the engagement Engle and Conant (2002) advanced a series of characteristics that students do when they are engaged: (a) More students in the group make substantive contributions to the topic under discussion; (b) students' contributions were more often made in coordination with, rather than independently of, each other; (c) few students were involved in "off-task" activities; (d) students were attending to each other as assessed by alignment of eye gaze and body positioning; (e) students often expressed passionate involvement by making emotional displays; and (f) students spontaneously got reengaged in the topic and continued being engaged in it over a long period of time.

Of course a student can be engaged in a lesson but this engagement would not be necessarily disciplinary. To be disciplinary, Engle and Conant (2002, p. 404) argue that "there is some contact between what students are doing and the issues and practices of a discipline's discourse." Finally, students' engagement is productive to the extent that they make intellectual progress.

We should consider also the four principles for evaluating the learning environment that potentially fosters it, as defined in Engle and Conant (2002), as we are making reference to them throughout the paper:

- (1) problematizing subject matter;
- (2) giving students authority to address such problems;
- (3) holding students accountable to others and to the discipline; and
- (4) providing students with relevant resources.

In this paper we relate these characteristics of productive disciplinary engagement to a set of epistemic practices we define in what follows. We investigate the degree to which students were engaged and if this engagement was disciplinary, as the epistemic practices are a consequence of a disciplinary way of working.

### 2.1. Epistemic practices and the analysis of PDE

Kelly (2005) and Sandoval, Bell, Enyedy, and Suthers (2000, see also Sandoval, 2005) have studied the production of school science, building on the principles of anthropology and sociology of science. They emphasize the importance of understanding science as an intersubjective process, as scientific knowledge is constructed and justified within a community. They argue that studies on epistemic learning should recover the concept of epistemology, as a field of study on the development of knowledge, the nature of evidence, the criteria for the theoretical and methodological choices and other aspects of the structure of disciplinary knowledge. The studies by these authors are dedicated to in situ analysis of the processes of school knowledge construction. They are marked by the choice of educational contexts in which students are involved in inquiry-based activities.

The studies that align with this analytical perspective have used analytical tools linked to discourse analysis to investigate the processes of appropriation of concepts and discursive practices of the scientific community by the students. In this sense, the view of disciplinary knowledge is highly compatible with the PDE view, as Engle and Conant (2002, p. 404) advance that "by using the term disciplinary engagement in a school context, we mean that there is some contact between what students are doing and the issues and practices of a discipline's discourse."

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