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Latour goes to kindergarten: Children marshaling allies in a spontaneous argument about what counts as science

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ABSTRACT

Increasingly, researchers interested in science education have come to recognize the value of promoting scientific practices—ways of talking, acting, and engaging with ideas such as conducting inquiry—instead of simply helping students to memorize facts or complete experiments whose purpose they cannot yet discern. By focusing on activities that are typically viewed as core to science, this research may inadvertently overlook those ancillary activities where students demonstrate and refine their own understanding of what constitutes science in non-normative ways, particularly in early elementary classrooms. We propose the use of the Actor–Network Theory as a way of framing and examining students' scientific discourse and offering a fruitful approach to recognizing the strengths that young children bring to science education. From this perspective, students' ability to engage in arguments where they enlist allies—including their peers, the teacher, and scientific norms—are an important and understudied resource. We present a case-study analysis of six kindergarten and first-grade students engaging in an impromptu debate as an illustration of the proposed analytic frame, organized around the three questions: 1) what is being negotiated, 2) who and what are the actors being leveraged in the negotiation, and 3) how are the actors constructed into networks?

1. Introduction

Increasingly, researchers interested in science education have come to recognize the value of promoting scientific practices—ways of talking, acting, and engaging with ideas such as conducting inquiry—instead of simply helping students to memorize facts or complete experiments whose purpose they cannot yet discern (Lemke, 1990; NRC, 2007, 2013; Roth & McGinn, 1997; Roth et al., 2009). Practitioners who are aligned with this approach aim to create classroom spaces that resemble key aspects of the contexts in which professional science takes place and to have students engage in work that looks similar to that of professional scientists. Unfortunately, this is more challenging than it might at first appear as ethnographic studies indicate that the work of professional scientists is actually quite diverse, messy, and inconsistent (Hall et al., 2007; Hall et al., 2010; Kuhn, 1970; Latour, 1999; Latour & Woolgar, 1986; Wong & Hodson, 2009).

Attempts to encourage students to participate in normative scientific practices are further complicated by increasing recognition of the fact that scientific engagement is rarely constrained to set and clearly delineated class times. Rather, students engage in non-scientific activity during science class, and also engage in scientific practices while at home, at the museum, online, and in other contexts (Bell et al., 2009). Furthermore, studies which explore the nature of science as practiced by youth have also noted that the lines

Abbreviations: ANT, Actor–Network Theory; NOS, nature of science.

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between what is and is not science are rather blurry (Macbeth, 2000). This would appear to create a real dilemma for those interested in students' conceptions of scientific practices—how do we know when students are engaging in activity that *they* believe is science, and when that definition of science doesn't mirror our view of professional practice how might we begin to help students to transition towards a more normative set of practices? In order to understand how students' practices relate to science, it is particularly important to understand local ideas for what constitutes science, and for what aspects of science are valued (Barton, 1998; Barton et al., 2008; Roth & Lee, 2004).

Our goal in this paper is to propose a framework intended to help simultaneously make visible what students view as relevant and/or scientific in their local context, and how this might map onto normative conceptions of scientific practices. By exploring both of these issues in one analytic framework we believe that it will be possible to simultaneously honor the students' perspectives regarding the kinds of practical work they are attempting to accomplish while also suggesting opportunities for designing or adapting instruction to help students to transition into more normative scientific practices when it will benefit them. To accomplish this, we propose that it is valuable to begin with an analytic framework that is grounded in examinations of the day-to-day work of scientists in action (c.f., Latour, 1987), and yet recognizes the myriad practices and motivations that such scientists hold. Specifically, we suggest that it is beneficial to analyze students' interactions in terms of Actor–Network Theory (Callon, 1986; Latour, 1987, 2005). While ANT has been taken up in a number of ways, leading to disagreements about what it specifically includes (Fenwick & Edwards, 2010) we propose to build upon ANT by focusing our analysis upon three key elements. Specifically, we aim to analyze the *negotiations* that take place during students' scientific activities, *the actors* present in the situation (e.g., the people, objects, and institution as reified in norms and rules), and the way that the students position the actors into *networks* of allies, which students then leverage in negotiating what it means to do science in their classroom.

To illustrate the promise of this framework—a focus on negotiations, actors, and network construction for interpreting students' interactions—we will employ it in analyzing a case-study of six kindergarten and first grade students interacting during science time. In particular, we focus on one exchange in which an extended debate occurred amongst the students despite the fact that the teacher was largely absent. However, this debate initially seems problematic as it is neither explicitly about the science content (leaves), nor is it resolved in a particularly sophisticated way, at least from a scientific-argumentation perspective. Furthermore, this episode takes place in the area right outside of the classroom, and the students are working with wooden blocks rather than more traditional school materials such as pencils and paper. For these reasons, many science educators are quick to dismiss this episode as a free play activity and not at all related to learning science.

Nonetheless, as we will indicate below, the students themselves view this as a science activity, and thus indicate through their participation what they view as the bounds of science. That is, we can begin to reconstruct the students' notion of what science is by observing their interactions during this extended debate. Our goal is not, however, a thorough exploration of young students' conceptions of science (For such a review, see Deng et al., 2011). Rather, we wish to demonstrate that ANT can be a useful analytic tool for exploring those boundaries in a manner that simultaneously holds true to the students' conceptions and provides insights into how an instructor or designer might support a transition into more normative scientific practices. Thus we will also indicate how ANT helps to make these opportunities or teachable moments visible to the analyst, and suggests some possible transition points where an educator might help bridge between students' existing networks and those that scientists promote. Given such a framing, we believe that students are more likely to come to see such activities as scientific, and will in fact develop a notion of what science is from these discussions (Lemke, 1990) regardless of their non-normative nature. Thus, we endeavor through our ANT analysis to identify and support opportunities within these other science activities to help students develop an accurate view of science as a process of negotiation and not simply memorization.

2. Theoretical framework

As noted above, our examination of students' scientific activities is grounded in Actor–Network Theory (ANT). ANT was proposed by Latour (1987) and other sociologists of science (e.g., Callon, 1986) as a way of explaining how scientists actually interact to accomplish the work of defining and extending scientific disciplines rather than focusing on idealized descriptions of the nature of science. From an ANT perspective, science is a complicated web of people, places, theories, inscriptions[1] and practices. For scientific ideas to be accepted by the community at a particular point in time, they need to be supported by the elements of this web; the more support for an idea, the more influence it will have on the field and the harder it will be to change or contradict. Thus science is viewed as a process of building, supporting and sometimes deconstructing these webs. While we don't often view it as such, students do the same kinds of things in classrooms, integrating their own ideas and observations with a large network of ideas and approaches that are considered "scientific" by their peers, teachers, and curriculum designers. By examining students' activity with this lens, we can therefore understand how their work parallels and diverges from that of the professional scientific community. That is, we can begin to understand the necessity of giving students the agency to assemble and negotiate networks. Further, to the degree that we conceive of science education as enculturation into the historical practices and values of professional scientists, we can begin to articulate when and where student's agency needs to be balanced by accountability to the types of actors that practicing scientists include in their networks.

To examine classroom practices within the ANT framework, we have identified 3 core foci of the framework, which we describe in greater detail below. First, science is a process of negotiation. Second, this negotiation involves multiple human and non-human

[1] Latour uses the term inscription to help clarify that he is referring to physical material representations, not mental or conceptual ones. The kinds of inscriptions that Latour describes, such as drawings, graphs, and data displays are often referred to as simply representations or even models in the science education literature, however.