

What Does “Doing” Science Mean in the Elementary School Classroom? Bruno Latour, Inscriptional Transformations, and a New Look at Children’s Interactions with Phenomena

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Abstract: Redesigning the way children interact with phenomena is critical to supporting learning science’s core ideas through authentic scientific practices. Examining one design experiment through the lens of Latour, we analyze how 2nd and 3rd grade students interact with phenomena at a botanical garden and how their inscriptional transformations parallel Latour’s observations of scientists’ field research and laboratory interpretation. Our analysis suggests these practices support children understanding science’s “big ideas” as they learn in multiple contexts.

The NRC’s *Framework for K-12 Science Education* (2012) calls for integrating crosscutting concepts, core ideas and scientific practices. This conceptualization of science teaching represents a fundamentally different relationship between phenomena and science learning, engaging children in “doing” authentic science instead of enacting “hands-on” activities that lack deeper conceptual understanding. Given the central role that model building plays in scientists’ interaction with real world phenomena (Mayr, 1997; Giere, 1997), we focused our analysis on this interaction in the context of an elementary school design-based research project.

Latour’s (1990, 1999) “cascade of representation” framework is particularly fruitful for conceptualizing of the bidirectional connections between phenomena and model building. His research describes scientists’ interaction with phenomena, detailing: (a) how scientists use tools, inscriptions, and the transformation of inscriptions to make sense of complex phenomena; and (b) how this “cascade of representations” enables core aspects of phenomena to travel between disparate physical contexts. In our case study analysis of three lessons, we used Latour’s framework as an analytical tool for understanding a more synergistic relationship between elementary school science classrooms and phenomena. We examined how children’s interactions with phenomena at a botanical garden and their ensuing inscriptional transformations parallel Latour’s observations of scientists conducting field research and laboratory analysis. In detailing this parallel, we also explored how these practices simultaneously support children’s understanding of science’s core concepts and synergistically connect children’s science learning in varied contexts.

Method

The case study analysis drew from a larger research project that studied 2nd and 3rd graders’ developing understanding of the conceptual underpinnings of evolution, in the context of their study of plants or animals (Metz, 2013; Metz et al., 2010). The project took place at a public school classroom and a summer school in an urban metropolitan area serving mostly low SES, ethnically diverse students. This case study was based on a sequence of three lessons, drawn from the 30-hour curriculum module. Data for this study includes: (1) students’ written and illustrated work, (2) teacher-generated visual artifacts of instruction, and (3) video recordings of the classroom and field-based instruction. Video recordings of children’s work in the three lessons were coded for the scientists’ inscriptional phases articulated by Latour. Then teacher actions were coded for support of students’ inscriptional transformations and interpretations. Students’ written and illustrated work and teacher-generated artifacts were examined for evidence of inscriptional transformations and abstraction of patterns.

Results

Latour (1999) noted that scientists’ field research in the Amazon rainforest was motivated by a distinct question: Is the savannah advancing or retreating on the rainforest? To motivate the children’s field research at a botanical garden, the instructional module posed a “big” question - “How do differences in plants’ structures help them get what they need in different environments?” - and fostered initial puzzlement about plants’ form, function, and fit through class discussions and a variety of media. Building from these questions, students were introduced to tools that allowed them to query the botanical garden’s phenomena. The tools included a “sky cover instrument” to measure canopy coverage, a “green strip instrument” to measure plant chlorophyll concentration, and thermometers.

Latour observed scientists in the field using tools to generate initial inscriptions. Working in pairs at the botanical garden using selected tools, children transformed biological phenomena into words, tally marks, numbers, shaded squares, sketches, and photographs. In the rainforest and desert greenhouses, children recorded

environmental data (skycover, humidity, and temperature) and plant data (green scale measurements, sketches and photographs of plants) using observation sheets and digital cameras.

Upon returning to the laboratory, Latour noted how scientists repeatedly transformed their field inscriptions to explore patterns in the data. Back in the classroom, children continued transforming their inscriptions through a “cascade of representations”, ultimately generating two aggregated data charts. In the photographs below (see Figure 1) showing part of one cascade, children used a green strip instrument to transform desert plants’ chlorophyll data into tally marks and later, each pairs’ chlorophyll data mode was used to construct a histogram. These charts, coupled with teacher support, were used to engage children in making inferences about the complex patterns among plants’ form, function, and the environment in which they live.



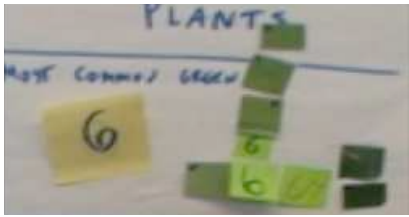
		
<p>Child using green strip instrument to quantify the amount of chlorophyll in desert plants at botanical garden</p>	<p>Children's initial chlorophyll inscriptions</p>	<p>Chlorophyll data assembled into a histogram (part of larger aggregated data classroom chart with environmental and plant data)</p>

Figure 1. “Cascade of representation” of children’s chlorophyll data

Movement between objects and symbolic representations can be challenging for children and adults alike (Roth, Pozzer-Ardenghi & Yan, 2005). Two categories of teacher actions that supported this movement were identified: reversing the “cascade of representations” and mathematizing the data. Both teacher moves were crucial in facilitating students’ understanding of the “big ideas” and engagement with the practices that Latour describes. Through these parallel practices and specific teacher supports, children were aided in making numerous complex comparisons between the plant and environmental data in different biomes, connections that would be extremely challenging to make at the botanical gardens themselves or back in the classroom without these transformed inscriptional charts and teacher supports.

Conclusions

Latour’s observations of scientists at work provides a powerful framework for conceptualizing elementary school science that embodies the knowledge-building practices of science and meaningfully integrates phenomena into science instruction. Analyses of children engaged in this module reveal rich interaction with phenomena and engagement with the representation transformation process, in many ways echoing the scientists’ activities documented by Latour. By providing children with multiple opportunities to interact directly with complex phenomena, inscribe their observations, and transform these inscriptions through a “cascade of representations” - both outside and inside the school walls - this module supports a more synergistic and epistemologically authentic relationship between phenomena and knowledge building in the elementary science classroom.

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