Chapter 24
Preservice Teachers Exploring the Nature of Science in Simulated Worlds

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ABSTRACT

This article reports an investigation of preservice teachers' interactions with a computer simulation designed to allow them to explore the nature and practices of science. Participants included 188 preservice, secondary-level, science and mathematics teachers who were enrolled in one of seven consecutive semesters in a professional development course as part of the teacher certification program at a large research university. Artifacts, including articles published in an online journal, responses to focus questions, reflections on the activity, as well as audio and video recordings of the activities themselves, were analyzed following a grounded approach. The simulation activities qualified in many respects as authentic science as identified by Chinn and Malhotra (2002). Further, what these activities revealed about student beliefs in regard to the nature and practice of science correlated with their reactions toward the simulation and their views of how it might be used in high school classes.

INTRODUCTION

Science education standards provide a clear mandate for students to understand the nature of science (National Research Council, 1996). There is, however, no consensus on what the nature of science (NOS) is, nor are the standard surveys typically used to assess it necessarily reliable in measuring student understanding of this multifaceted construct (Abd-El-Khalick & Lederman, 2000). Such measures tend

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to identify declarative knowledge of the nature of science, but fail to assess students' ability to generate knowledge using the accepted practices of science, i.e., their ability to construct and critique scientific claims through a socially embedded process (Ford, 2008). This work embraces a view of NOS as more than the nature of scientific knowledge; in this framework NOS includes the nature of scientific *practice*, i.e., what working scientists do. The more students engage critically with how scientific knowledge is generated and disseminated, the more scientifically literate they will become. *Benchmarks for Science Literacy* (AAAS, 1993) puts it this way:

When people know how scientists go about their work and reach scientific conclusions, and what the limitation of such conclusions are, they are more likely to react thoughtfully to scientific claims and less likely to reject them out of hand or accept them uncritically... The myths and stereotypes that young people have about science are not dispelled when science teaching focuses narrowly on the laws, concepts, and theories of science. Hence the study of science as a way of knowing needs to be made explicit in the curriculum. (p. 3)

Following Ford (2008), "knowing" in the statement above is interpreted here as a verb rather than a noun – coming to know, rather than the nature of the inert knowledge itself. Ford presents an existence proof that it is possible to develop this 'grasp of practice' in sixth-grade students through properly designed curriculum activities, inviting further exploration into how instruction interacts with students' understanding of the nature and practice of science, and how technology might influence that interaction.

Coming to understand NOS is arguably especially important in the case of students who are preservice teachers, and whose views will undoubtedly affect the instruction they will implement in their own classrooms. Teachers have reported that they do not view understanding the nature of science to be as important as other learning objectives, a view that is often reflected in district standards and assessment, and that they do not have the time, resources, or knowledge for the extra effort needed to infuse NOS into their curriculum (Abd-El-Khalick, Bell & Lederman, 1998; Posnanski, 2010). As Edelson (1998) notes:

Traditional training for teachers has not prepared them for new roles in which they must engage students in uncertain science, help them to formulate and refine research questions, identify resources and tools that will allow them to expand their understanding, and foster authentic scientific debate. Providing scientific resources, tools, and techniques for use by students requires the modification of facilities designed for expert scientific practitioners to allow students to ask questions and pursue them in ways that are similar to those of scientists. (p. 320)

Thus teachers need a support system to scaffold the authentic process of science, one that they can experience as valid in their own right. Technology can be a resource in this regard and "can place a greater range of tools and resources at the disposal of teachers and students, and… increase the opportunities for the social interchange that is at the heart of authentic science practice" (Edelson, 1998, p. 317). The NOS simulation offered by Epistemological Engineering (EEPS, 2015) provides such a resource. See Big Time Science (2015) to use the beta version of the simulation. Developed with funding from the National Science Foundation, the simulation lets students take on the role of scientists 'writ large' in a limited amount of class time, while still developing some specific science content ideas.