Promoting Science Identification and Learning through Contemporary Scientific Investigations Using Practice-Focused Instruction

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Abstract: With major policy documents making 'the practice turn' in science education, this paper foregrounds how learners come to engage in scientific practices through immersion in learning environments that build upon prior interest and identity and focus on these strands of learning in relation to conceptual and epistemic knowledge development as youth participate in disciplinary practices. Scientific practices, conceptualized as a subset of social practices, are arrangements of comprehensible and comprehensive ways of knowing and doing. The links and separations between the social practices present in learning environments serve to structure the nexus of practices and allow for the tracing of engagement, participation and learning (Bell, et al., 2012b; Dreier, 2009). I report on analysis of students' practice-related artifacts.

Introduction and Rationale

The *Framework for K-12 Science Education* (NRC, 2012) calls for the focus on science and engineering education to be learning in practice. The release and subsequent state-level adoption of the *Next Generation Science Standards* (NGSS; NGSS Lead States, 2013) bring forth to need to understand how all youth learn through practice. What types learning environments support learning in practice? What resources do students and teachers need to support their engagement in practice-focus instruction? This shift to focus on scientific practices in science education can be used to support an educational equity agenda. Broad inequities in science achievement exist for youth from non-dominant communities. And yet, all youth should be to use science and scientific thinking in their everyday lives and, if they choose, in pursuit of science, technology, engineering, and mathematics (STEM) careers. Sociodemographic diversity in the STEM fields do not mirror the diversity of our society—although we know that broadening participation in STEM will improve the scientific knowledge that is produced (NSF, 2008). There are broad-scale challenges associated with improving opportunities to learn for all youth, especially those coming from non-dominant communities.

In learning environments, specifically schools, this means promoting powerful, inclusive science learning experiences for youth. Sociocultural and sociocognitive theories of learning (Vygotsky, 1986) have identified educational design principles that can be productively used to cultivate powerful learning environments. We know from sociocultural research that all significant learning involves identification processes as people participate in social practices (Lave & Wenger, 1991). This perspective on learning – often referred to as "the practice turn" in science studies foregrounds how learners come to engage in scientific practices.

Theoretical Framework: Designing from Multiple Structures of Social Practice

Practices are collective actions that exist within a nexus of contexts that people and artifacts travel across and they are affected by the instructional and historical natures of those contexts. Practices have norms, tools, and resources and are interconnected in localized networks that change and are altered by participants over time. Dreier's theory of social practices situates practices in the in the complex interactions of people in the social world, across the contexts of their lives (Dreier, 2009). People live and participate in multiple diverse contexts and these contexts are socially and materially arranged to allow for particular practices to occur within them, together the contexts are separated or linked from other practices in a "comprehensive structural nexus of social practice" (Dreier, 2009, p. 196). This work maintains a focus on social practices in learning experiences. Students' participation is contextualized within in four sets of partially aligned and competing bundles of social practice present in the learning environment: (1) contemporary professional scientific practices, (2) school practices, (3) youth and community practices, (4) the practices of relevant social domains. The framework approaches practices as patterns of activity that are influenced by the contexts of the performers, the goal of the interaction in which the practice takes place, and the interactions with other practices (Rouse, 2007).

Methods and Data

This study is design-based research analyzing one project-based unit that is part of the year-long introductory Biology course. The educational intervention consists of a yearlong introductory Biology course designed around five project-based instructional units delivered on a social media technology platform. During the beginning stages of development, units were piloted individually in a collaborative co-teaching model with researchers in the classroom each day. This analysis is of the pilot of the DNA barcoding project that lies within the eight-week long genetics unit. The study consists of four analyses: (1) quantitative analysis of pre- and post-test scores and student-reported engagement data, (2) analysis of practices over the course of the unit, (3) analysis of student work, and (4) two case studies of groups of students across the cascade of practices that unfolds in the unit. A subset of the analysis of student work is presented in this poster. The analysis is from the full Spring 2012 data corpus for this unit that includes: student work and class performance data, approximately 31 hours of video, student artifacts from 11 groups (4 students per group), one student focus group, and interviews with four students and one teacher. This enactment of the unit took place with five biology classes in a public, urban high school in the Pacific Northwest.

Analysis and Findings

Analysis of student work occurred through coding based on key constructs from the literature (e.g., performances of scientific practices, statements of relevance), as well as other written statements I identified as important to performance of practices (e.g., instances of connections between practices). Analyzing the conceptual theme representations allows us to understand the prevalence of the practices as mirrored in the student artifacts. I interpreted the patterns of indicators present for student engagement in scientific practices, school practices, everyday practices, and their referencing of relevant social domains.

The curriculum was designed to engage students in specific epistemic practices of science in ways that were motivated by the investigation they were conducting. The scientific practices that students clearly engaged in as they completed the two documents were Planning and Carrying Out, Investigation and Obtaining, Evaluating, and Communicating Information, and Constructing Arguments from Evidence. Not surprisingly, this strongly fits with the instructional design focus of the unit. Unlike traditional school science investigations, however, these practices co-occurred and students employed the outcomes of one practice to inform their engagement in another practice. For example, students decided what type of investigation they would pursue, agreed on a focus to that investigation, obtained and evaluated information related to their investigation, reflected on how that information informed or brought up questions or concerns about their investigation, and continued to search for and cite information in their proposals for continued funding.

Conclusions and Scholarly Significance of the Work

By engaging in extended investigations that required participation in the epistemic practices of science, students were able to engage in a sensible ‘cascade of disciplinary practices’ (Bell et al., 2012a). There were significant linkages and separations between the bundles of practices in play in the learning environment. This work contributes to helping understand how to take the practice turn in ways that are personally compelling to youth and connect them to more authentic forms of work of professional science. This is a new instructional model for the field that cultivates powerful learning environments in formal education and explicitly focuses on science identification.

References

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