Authenticity Matters: Youth and Science Participation in Design-Based Learning Environments

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Abstract: This paper reinterprets the notion of the "competent outsider" (Feinstein, 2010) through the lens of authenticity. We present a three-pronged conceptual framework about authenticity: to the domain, to the world, and to students. Data from Project COOL and the Knowledge In Action Project raise questions about power and ownership of "authentic" science. Findings suggest considering these multiple aspects of authenticity can help in design and instruction of formal and informal science learning environments.

Major Issues Addressed

When educators and designers of learning environments ask kids to take on the task of solving problems in Science Technology Engineering and Mathematics (STEM) disciplines, we are also asking them to choose to participate in particular ways. The ways that we frame problems for youth, the tools we offer them, the authority we grant, and the ways we hold them accountable are all influenced by our ideas of what it means for students to be or become a version of themselves that can participate in the real world. These ways of participating are housed within the domain and linked to a variety of disciplinary practices, thus when we think about authentic disciplinary practices we need to consider the types of authentic problems, practices, and identities that we are asking students to take on/ become. Learning in practice raises questions about the kinds of practice-linked identities that youth are encouraged to take on (Eisenhart, 1996; Nasir, 2002; 2013).

Youth might understand themselves as doing science practices but still not feel they are being scientists (Barab & Hay, 2001). van Eijck & Roth (2009) traced the trajectory of a young man from the Salish tribe to explore the impact of "authentic science experiences" on his scientific literacy development as well as his science career choices. Even though he participated in experiences that would be considered authentic based upon disciplinary and scientific measures, he did not persist in the field. In a related study (van Eijck, Hsu & Roth, 2009) the researchers while exploring the relationship between youth's experiences of science practices and how they translated them into images of science practice, discovered that engagement in science practices can serve to calcify youth's images of science. A longitudinal study conducted in the UK around youth identity and STEM participation highlighted a "mismatch between popular representations of science, the manner in which it is taught, and the aspirations, ideals, and developing identities of young adolescents" (Archer et al, 2010). This paper approaches this mismatch between science practices and students lives through the lens of authenticity, looking at authenticity in science, authenticity in the real world, and in students' worlds. This paper leverages data from two empirical studies to answer the research question: How do students' perceptions of authenticity within project-based curricula influence their disciplinary participation?

Potential Significance

Understanding the ways that youth experience authenticity in their lives is an important consideration for designers of learning environments. Our data suggests strong links between youth engagement, sense of authenticity, and choices to increase or sustain participation. These findings raise new questions for educators and designers of learning environments that seek to involve youth in STEM practices. This raises many questions: To what end? To whose end? What is the goal of STEM education? Is it transfer into everyday practices? Are we trying to create scientists, or competent outsiders? Feinstein (2010) argues for a re-imagination of the utility of science, based in the everyday lives of students. Feinstein calls scientifically literate citizens "competent outsiders" and advocates for student voice and connections to relevant everyday settings. We leverage Feinstein's ideas and reinterpret them through the lens of authenticity, considering authenticity of problems, practices, roles, and settings. We offer a three-pronged framework for thinking about authenticity: authenticity to the domain, authenticity to the world, and authenticity to students. We suggest ways, through examples from data, in which these three types of authenticity can be used in educational design and instruction.

Theoretical Framework

To explore the ways youth participate in authentic project-based curricula we have used Productive Disciplinary Engagement (PDE) (Engle & Conant, 2002) as our theoretical lens. Engle and Conant define PDE as making intellectual progress or getting somewhere (productive), a connection between what the students are doing and the practices and discourse in the discipline (disciplinary), and making substantial coordinated contributions that include emotional displays and spontaneous re-engagement over time (engagement) (Engle & Conant, 2002, p. 402). PDE is linked to authenticity in that when students are productively engaged in the discipline, they are

pursuing the same authentic practices and tasks as disciplinary experts. In our analysis we specifically look at youth conceptions of what constitutes productivity. The discipline of science has defined and evolving definitions of what is productive in the discipline. We were interested in exploring students' goals, and thus their concepts of productivity, as they engaged in the discipline.

By exploring students' concepts of productivity, we can also see also see what is valuable, relevant, and authentic to students. In this paper we suggest that authenticity is not a property of a learning space but rather an ever-changing practice around which components of social learning can be organized. This is true for all three prongs of authenticity we consider in this paper. Just as the discipline is in constant change, so to is the world at large and students' worlds, meaning that what is authentic to any of these domains is also in flux. We conceptualize authenticity to students as in what is considered authentic and relevant to them. Though a nuanced point, we believe that authenticity to students requires projects or activities to leverage students' out-of-school lives, but not necessarily integrate their out-of-school lives into the projects. Previous research on contextualized scenario-based learning has demonstrated ways in which students can feel an activity or simulation is authentic because of the authentic roles they are given or the authentic performances required at the end (Cognition and Technology Group at Vanderbilt, 1992; Rivet & Krajcik, 2008). Put another way, we consider authenticity to students as what 'feels real' to students, looking at the ways this form of authenticity connects to what disciplinary experts believe is authentic to the discipline and what teachers, mentors, and designers believe is real to the world at large.

Project Descriptions

The two projects in this analysis are both design-based research projects which leverage project based learning. The Knowledge In Action Project is a project-based Advanced Placement (AP) Environmental Science curriculum. Chemical Oceanography Outside the Lab (COOL) is a self-choice, afterschool chemical oceanography program for middle school youth. Designed environments focused on project-based learning have particular affordances for being and becoming in practice. The two projects for this analysis were chosen because both offer students opportunities to participate in projects and activities that are authentic to the Science discipline and the real world. The two projects were also chosen to represent a school setting (Knowledge In Action) and an out-of-school setting (COOL). Finally, the projects were chosen so we could explore authenticity across a larger sample of qualitative data (Knowledge In Action) and a single case study (COOL).

AP courses are typically known for the vast amount of information that students are asked to learn for the AP test taken at the end of the year. The Knowledge In Action Project proposed that by putting students in roles and asking them to tackle challenging, authentic projects that they would do as well or better on the AP test and, compared to conventional AP courses, would connect what they learned to their out-of-school lives.

COOL is a design-based research study focused on approaches to broadening participation in the geosciences for youth from groups traditionally underrepresented in STEM disciplines. COOL proposed that hybrid learning environments designed to have youth and STEM mentors work collaboratively would provide youth with models of participation and create opportunities for explicit conversations between youth and mentors about ways of navigating into new discipline-linked identities. In this learning environment, mentors' interactions with youth occupy a hybrid space between academic and interpersonal relationships. COOL sought to leverage these hybrid relationships to bring youth and mentors together to engage in authentic STEM practices. Here authenticity means projects that simultaneously hold personal, community, and disciplinary relevance for all participants.

Data and Analysis

Data for this paper were pulled from larger Design-Based Implementation Research projects on student learning and engagement. Specific data for this analysis were chosen based on previous work in each project. We chose data that highlighted the link between authentic contexts or activities and student participation. The Knowledge In Action Project used data from youth individual interviews, youth group ("fishbowl") interviews, and teacher interviews across three years. Project COOL used data from youth and mentor interviews and video observations. All data Video and audio records were transcribed verbatim and then collected in a hermeneutic unit in computer programs for qualitative analysis. There were two distinct phases of analysis. In the first phase, research teams on each project utilized a grounded theory approach, focusing on student engagement and identification with the discipline as foundations for beginning codes. Then each research team included an initial set of code categories based on each research group's research questions, including codes around *engagement, identity, transfer, disciplinary thinking, identification with the domain, positioning, stance, and citizenship.* Coding was iterative and collaborative, with research group members proposing new codes and code categories, negotiating codes and their definitions, and co-producing analytic comments and memos. Analysis proceeded until no new codes were needed to characterize the data. Patterns for The Knowledge In Action Project included student reports of transfer, proposed solutions to environmental science problems, and identification with certain disciplinary practices. Patterns for Project

COOL included deepening participation in STEM practices, identification with the domain of science, and sharing chemical oceanography information with new communities i.e. home and school.

In the second phase of analysis, the authors reanalyzed sections of data across the two projects through the lens of productive disciplinary engagement and the three prongs of authenticity. We analyzed the projects proposed goals and curriculum for opportunities for authentic practice. We then identified moments in the data where the participants talked about their perceptions of the authentic opportunities provided them. These moments were coded using open and theoretical codes based on Productive Disciplinary Engagement (Engle & Conant, 2002). Patterns in the data were explored using discourse analytical techniques and, when applicable, connecting perceived patterns with video of youth participation in the Project COOL. Discourse analysis included exploring language around agency and identity and the contexts and scenarios referenced during those instances. Patterns across data sets included students' perception of authenticity of tasks extending beyond tasks only being authentic to the discipline. Tasks that were authentic to the real world and students' worlds increased perceived relevance and identification with certain disciplinary practices.

Findings

We present data from the two projects, exploring the ways in which authenticity to the domain, to the real world, and to students' worlds were present and how these forms of authenticity impacted the students' STEM engagement and identification. The Knowledge In Action Project highlights student responses to a redesign of an AP Environmental Science unit that asked students to use authentic disciplinary practices and thinking to address real world problems within the context of their home lives. Project COOL was chosen as a comparison because it presents a close analysis of the mechanisms of sense of authenticity as it related to the student's identification with the domain of chemical oceanography. In both projects students use practices and thinking that designers saw as authentic to the scientific disciplines. Both projects also asked students to tackle authentic real world problems around human's impact on the environment. Finally, students from both projects saw the project activities as authentic to their worlds as students. In The Knowledge In Action Project students used data from their own lives to address the real world problem of sustainability. In Project COOL the student saw the activity as personally authentic because it was a performance that mattered. These two cases, taken together offer a broad picture (APES) and a close analysis (COOL) of the impacts of sense of authenticity on student's participation.

Authenticity in the Real World — Authenticity in Students' Worlds

In The Knowledge In Action Project AP Environmental Science (APES) course the projects begin locally, with students analyzing environmental science issues in their own lives. The projects then grow in scope, until, at the end of the year, the students are looking at environmental science on a global scale. In contrast to more hard sciences, Environmental Science focuses far more on citizen science or how to be a scientifically informed sustainable citizen. This is particularly the case in the project-based APES curriculum, which contains a course master question of "How can we live more sustainably?" With a focus on sciences and sustainability in the world, authenticity within the course typically refers to authentic scientific practices and authenticity to the real world. Authenticity to the real world encompasses a number of project qualities: authentic real world roles, authentic challenges, authentic overarching questions (master course question), and authentic real world problems that the students are asked to tackle in the projects.

In previous analysis however (Nolen et al., 2013), the authors have seen that the part of the APES course that is the most memorable to students and has the strongest impact on their daily lives is the one in which they do not take on a role, but analyze their own practices. In the first project of the AP Environmental Science course, titled "Ecological Footprint", the students are asked to analyze the daily habits of themselves and their families. This starts with the students calculating the number of earths that would be needed if everyone on the planet lived the way they do. Then, analyzing different areas of consumption such as transportation or electricity use, the students propose a change to their family.

In our analysis of the first year of the Ecological Footprint cycle we saw the ways in which the project impacted the students practices outside of school. One female student from the second year of the course implementation talked about the relevance to her life:

> I feel as if the things that we're learning really relate to me, especially like the mobility analysis, the water usage, and the electricity usage. I can totally see how that relates to me, and how that impacts my life because I can see, 'Oh! This is how much gas I use. This is how much I don't walk (November 14, 2011).

The authenticity real world problem of sustainability connected directly to the student's life and practices. This is contrasted with the first year of the curriculum, where, for the Footprint cycle, students were put in an authentic real world simulation (planning an eco-friendly wedding) that did not relate to their own authentic

lives. One student commented on that version of the cycle: "I didn't see the connection to that and anything that I could take away from that and to the future. It was very irritating" (May 10, 2011). The first year version of the cycle seemingly contained authenticity to the domain, incorporating various scientific thinking and practices and it was authentic to the real world, with the authentic problem of sustainability and the authentic real world context. However, it was not until the second year, when the cycle was redesigned to also include authenticity to the students' worlds, that the impact of the cycle was felt. A male student in the second year of the project discussed the connections between science practices, the real world problem of sustainability, and his own life.

> [In class] we had to write down… a whole list of electrical appliances that we might use, and so we put in how long each day they're used or plugged in. And then we put it in this Excel sheet and got the math of how many kilowatt-hours are being used from that, and then we printed it out and made a pie graph. I immediately showed that to my mom and she was amazed and right off the bat we just started changing the way that we use stuff, and started to unplug stuff when we weren't using them (October 31, 2011).

By connecting authentic citizen-scientist practices with the students' lives the project became authentic to not just the real world, but also the students' real world. The Ecological Footprint cycle introduced numerous authentic scientific concepts and practices, such as collecting, analyzing, and interpreting their own data (NAP, 2011), however, the authenticity of the project rested on the reality of issue of sustainability in the world and the students' day-to-day practices. In thinking about the ways students adopt authentic scientific practices into their daily lives and into their developing ideas of what it means to be a citizen and a scientist, it may be useful to think about the ways authentic scientific practices connect to authentic experiences in students' lives.

Authenticity in Performance Spaces — Authenticity in Students' Worlds

In the second year of Project COOL, one of the young women in our study- Kelly (pseudonym) stood out as a case of how sense of authenticity can lead to deepening participation in STEM contexts. As a context COOL gave her opportunities to engage with "real" data, participate in scientific communication, discover new things, and to be trusted in places where her actions could have real consequences. Kelly, commented on the sense of newness she felt within COOL and went on to explain, "the school doesn't teach us this types of stuff and just because a lot of the experiments that we did, they were stuff that you guys didn't know either. Whereas at school we're learning stuff but it's experiments and the results that the teacher already knows" (2011). Kelly mentioned a field trip we took to the ocean sciences department of a local university in her follow up interview demonstrating that place was also an important component of her sense of authenticity: "Especially the sterile area it shows like, like how, how little you can do to mess up to like, the littlest thing can destroy a whole science project over something that people have been working on for months" (Kelly, 2011). For Kelly, visiting the sterile area and understanding that "the littlest thing can destroy a whole science project" was crucial. This was an important place she had been trusted to enter. These experiences helped Kelly develop a sense of authenticity, she felt empowered to step into a leadership role when faced with obstacles to participation. She did so in the face of a challenge by other members of her group, pushing everyone to step up and get their work done for the group's final project.

> I remember I did take charge and say something about what we should do and why everybody was actually there. Like the reason they were there wasn't just to be there for after school. Because if it was just after school, they could have joined another something else or were they there for science and actually learning something (July, 2012).

Kelly described herself as someone who was "there for the science." She saw her work in COOL as meaningful because her experiences had allowed her to create a storyline of someone who was "there for the science." Her sense of the actions and discourse as connected to authentic science shaped her perception of what she was learning. It shaped her desire to make sure that the final project was completed. This case study illuminates the ways that a sense of authenticity developed during a young woman's interactions with a set of designed sociomaterial arrangements (Bell et al., 2012). Kelly's sense of authenticity within the COOL Program led to deepening participation in STEM practices. The challenge to educators, designers, and theorists is to figure out how to create and sustain sense of authenticity within all learning environments.

Relevance to the Conference Theme

The processes of being and becoming in practice are directly related to the ways that youth experience the connection between the things they are doing and the practices of disciplinary experts in the real world. The ways that youth perceive these connections are sometimes even more important than the observable links that teachers or curriculum designers intend. Our data suggests the possibility that youth's perceived connections

between their lived experiences and disciplinary practices impact their identification with the discipline, and whether they choose to deepen participation in the discipline. The three prongs of authenticity intersect in important ways as students engage productively with the science domain, developing identities as scientists and citizen scientists. In year one of The Knowledge In Action Project, the course was authentic to the science domain and authentic to roles and problems existing in the real world, however it wasn't until the addition of authenticity to students' worlds that students began reporting identification with the domain and the transfer of practices out of school. Similarly, Project COOL was constructed to be authentic to the domain of science and to the real world, but also to include authentic performances and roles. These three prongs of authenticity worked in concert to help the case study youth participate in the practices of contemporary science. Future research could explore ways the three prongs of authenticity intersect, authenticity as a changing practice, and ways to integrate authenticity into learning environments, materials, and teacher pedagogical practice.

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