

Leveraging Educative Approaches to STEM Disciplinary and Instructional Practices

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Abstract: This symposium addresses teacher learning and agency as teachers adapt existing curriculum and instructional practices to promote student learning through Science, Technology, Engineering & Math (STEM) disciplinary practices. Each study in our symposium aims to foster student learning of STEM disciplinary practices as an overarching goal. We focus on educative curriculum models that support teachers' identity development and disciplinary expertise by cultivating their pedagogical content knowledge for disciplinary practices in concert with student learning (Davis & Krajcik, 2005; Shulman, 1986). The multiple research projects in this symposium document practices in various learning environments that: a) broaden science participation through teachers' and students' authentic interactions with disciplinary practices, b) recognize multiple epistemologies in STEM environments for all participants, c) honor teachers' expertise in adapting curriculum for their diverse contexts, supporting equitable and authentic implementation of science practices (NRC, 2011).

Introduction

This symposium brings together threads of research related to teacher learning and agency as we focus on how teachers adapt existing curriculum and instructional practices to promote student learning through STEM disciplinary practices. Each study in our symposium aims to foster student learning of STEM disciplinary practices as the larger goal, while recognizing that teachers need to be grounded in the disciplinary practices of their content area if they are to effectively teach them. We aim to develop educative curriculum models (curriculum for students that also contains elements of instruction for educators) that situate teachers within STEM-related communities of practice to support their identity development and expertise in these fields by cultivating their pedagogical content knowledge for disciplinary practices in concert with student learning (Shulman, 1986; Kind, 2009; Davis & Krajcik, 2005).

Methodologies of these works are diverse, but their goals are similar: to bi-directionally bridge theory with practice, and further, take curricular adaptations and innovations to scale. We document practices in a variety of learning environments that allow us to investigate and make recommendations in order to: a) broaden science participation through teachers' and students' authentic interactions with disciplinary practices, b) recognize multiple epistemologies in STEM environments for all participants, c) honor teachers' expertise in developing and adapting curriculum for their particular contexts. Our work promotes collaborative expertise among teachers in STEM content areas and situates teachers within disciplinary-specific communities of practice, enabling equitable and authentic implementation of the Next Generation Science Standards (NGSS), as envisioned in the National Research Council *Framework for K-12 Science Education* (NRC, 2011).

In the coming years, as districts transition from state-based standards to the NGSS, they will be charged with adapting their existing curriculum materials and tools to meet not only the new standards, but also new practice based-approaches to scientific inquiry (NRC, 2011; Achieve, 2013). These approaches will require teachers to become familiar with the disciplinary practices of their content area, and to develop new pedagogical knowledge and skills around teaching these practices. There is widespread agreement that teacher professional development is critical for the success of standards-based reform in U.S. schools (Committee on Science and Mathematics Teacher Preparation, 2001), and that educative curriculum is a powerful tool for this type of reform (Kind, 2009).

Practice-Based Approaches to Teaching

There is currently limited research on how teachers implement practice-based approaches to STEM instruction. Penuel (2009) found teachers preferred adaption over strict implementation of designed curricula. However, teacher adaptations most often build on subject matter knowledge and pedagogical content knowledge (PCK), with no instances of adaptations specifically structured around PCK for disciplinary practices (Davis & Krajcik, 2005).

Curriculum materials have the potential to support teachers in complex work such as engaging students in scientific practices (Brown, 2009). However, teachers' enactment of curriculum materials, including teachers' support for science practices, varies (e.g., McNeill, 2009) since teachers are engaged with curriculum in a participatory relationship (Remillard, 2005). Teachers' diverse experiences and backgrounds enable them to draw on the resources in curriculum materials in varied ways and adapt the resources differently for use within the contexts of their classroom (Brown, 2009, Remillard, 2005).

Scholarly Significance of the Symposium

Theoretically driven by the cultural process of learning (Lave & Wenger, 1991), teacher learning within a community of practice (Grossman, 2005), and influenced by the interrelationships between educators and their curricula (Remillard, 2005), this symposium uses diverse methodologies to investigate the ways that teachers engage with scientific practices. Papers discuss engagement in STEM practices through research bridging grade levels 3-9, pre-service and experienced teachers, and formal and informal learning settings. Considered together, these papers show that teacher learning during adaptation of practice-centered instruction is highly context-dependent. This symposium offers insights regarding successful adaptation of curricula for disciplinary practices.

Designing Educative Curriculum to Address Controversial Issues in Science

Elaine Klein and Veronica McGowan, University of Washington

When scientific content has the potential to be controversial in the classroom, practice-based approaches to inquiry (as advocated for by the NGSS and the *Framework*; NRC, 2011) are integral to engaging participants via multiple pathways that facilitate their deeper knowledge of concepts and theories (Bang, Warren, Rosebery, & Medin, 2012; Kelly, Carlsen, & Cunningham, 1993). Recent work in a diversity of academic disciplines has begun to question the historically dominant assumption in science education that presenting empirical evidence alone will shift learners' understanding of potentially controversial topics; in contrast, equitable science instruction will explicitly engage students about their worldviews, as a way to foster their understanding of content (Collins & Pinch, 1993; Langen, 2004; Nisbet, 2009; Saunders & Rennie, 2011; Verhey, 2005). In terms of what actually transpires in classrooms, however, recent work in this field (Berkman & Plutzer, 2011) reveals the "cautious 60%" of public high school biology teachers from across the United States that utilize strategies to avoid controversy when teaching about evolutionary concepts. With this context as a backdrop, this study investigates public high school biology teachers' attitudes and approaches to teaching about evolutionary biology, which was identified by all participants as a controversial topic within their communities. We then use these findings to propose an educative curriculum framework that advocates for surfacing multiple epistemologies and ways of knowing within the scientific community, and offer tools and strategies to help teachers adapt this framework for their particular classrooms.

Conceptual Framework and Study Design

The philosophical underpinnings of the issues described above have led many science educators and researchers to consider whether the goal of science education, especially around potentially controversial issues, is to *understand* or to *believe* scientific concepts (Cobern, 1994; Smith, 2009; Southerland, Sinatra, & Matthews, 2001). There is extensive work (Evans, Legare, & Rosengren, 2010; Legare, Evans, Rosengren, & Harris, 2012; Long, 2011), however, that affirms the capability of non-exclusivist people to move beyond this simplified binary and occupy a "Both/And" position in regard to accepting evolutionary concepts and/or timescale, while also holding theistic beliefs of some kind, even within the professional sciences (Cunningham & Helms, 1998; Doolittle, 2009; Gauch, 2006). Further, the strategies of utilizing authentic scientific practices and explicit discourse on the nature of scientific knowledge have been found to improve students' conceptual understanding of natural selection and evolution (Sandoval, 2003; Sandoval & Morrison, 2003; Sandoval & Reiser, 2004). An important clarification is that these scholars do not call for actively teaching about beliefs in science classrooms, but, rather, for teachers to foreground these conversations as a mode of engagement to move students towards conceptual understanding, especially for potentially controversial issues.

This DBR study (Design Based Research Collective, 2003) is situated within a year-long, high school biology curriculum design project called Educurious. We take the sociocultural stance that learning is explicitly a cultural process (Lave & Wenger, 1991), and recognize that engaging teachers' and students' subjectivity and

varying cultural experiences as social capital, is a powerful technique to shift their own epistemological conceptions of science (Nasir & Hand, 2006; Bang & Medin, 2010). Throughout implementation of the Educurious evolutionary biology unit, we collected and compared daily agendas, teacher-created materials, and online adaptation tracking logs for each teacher to gauge the type and degree of adaptation of this course for each classroom. We conducted semi-structured interviews with each teacher to gain a deeper understanding of their past experiences teaching about evolutionary biology, and their motivations for making content-specific curriculum adaptations to the evolution unit, and used this information to guide biweekly online discussions with the teachers. We then transcribed all of these discourse interactions, and used iterative, open coding to allow for emergent themes in the data to guide coding schemes, analysis, and theory development (Creswell, 2007); we also employed critical discourse analysis (Gee, 2011) to draw meaning and patterns from teachers' interviews, talk during meetings, and written accounts.

Findings

Davis & Krajcik (2005) suggest that we need to “characterize teacher practice” before we can develop effective educative curriculum models that meet teachers' needs. In each of the teacher interviews, participants framed evolution as a controversial topic. Within their discourse, teachers posited evolution as controversial specifically because of some students' beliefs, but responded through their practice in diverse and complex ways. Some teachers expressed their own non-exclusivist worldviews, and discussed how they revealed this to their students, in order to model that this stance is tenable.

In regards to adapting curriculum, we found that teachers had overwhelmingly positive views and experiences with curriculum adaptation, and actually preferred adaption over strict implementation of designed curricula. Teachers most often drew on subject matter knowledge and pedagogical content knowledge when adapting for their classes; however, our research suggested that teachers do not identify with the disciplinary practices of their content areas. This suggests that an educative curriculum model should develop partnerships between teachers and disciplinary experts to help them contextualize the real-world applications of the key theories in evolutionary biology and bring authentic disciplinary practices into their classrooms.

Implications for Engaging in Controversial Science Topics

The goal of all standards and curricula should be to broaden scientific participation and opportunities for students from diverse backgrounds and cultures within an equitable framework (NRC, 2011; Calabrese, 2003), yet prescribed curriculum models rarely produce the same learning gains once they are scaled up and enacted across diverse settings (Taylor, 2012; Squire et al, 2002; Penuel, 2011, Coburn, 2012), and do not cater to the specific needs of individual teachers, classrooms, and students. At their foundation, scientific disciplines exist within a broader human and cultural framework, in which individuals, including scientists, hold non-exclusivist stances around controversial ideas. Surfacing this complicated reality will help teachers to leverage their own and their students' non-exclusivist thinking within their classrooms to create personally relevant instruction for their students. This work strives to advance the essential discussion about how high school biology teachers actually teach about evolution in the complicated social ecology of their classrooms (cf. Eilam, 2009). Our educative curriculum model incorporates tools and strategies that utilize authentic scientific practices and explicit discourse on the nature of scientific enterprise and multiple epistemologies to support teachers' development of PCK for disciplinary practices as they adapt designed evolutionary biology unit for their local classrooms (Sandoval, 2003; Sandoval & Morrison, 2003; Sandoval & Reiser, 2004; Davis & Krajcik, 2005).

Teacher Learning of Disciplinary Practices

Philip Bell, Tana Peterman, Kerri Wingert, and Jeanne Chowning, University of Washington

Through an ongoing partnership of educational researchers, practitioners and STEM professionals, we investigate questions relating to shared researcher and teacher learning through collaboration around scientific practices. Our posture is responsive to practitioners' curricular and collaborative goals and learning needs using design-based implementation methodology (Penuel, 2011; Design Based Research Collaborative, 2003). Research questions include:

- How and why do teachers shift their teaching towards practice-focused instruction?
- How do teachers share problems of practice, resources and teaching knowledge with others?
- How do the practitioners in the school leadership team collaborate with educational researchers?

Research Focus

This research examines the networks and cultural pathways (Palinkas, 2009) that teachers utilize as they continue improving their practices. We will offer solutions to the persistent gap between research and practice in K-12 STEM education, consistent with ways this gap has been addressed in medicine-related fields through the developing work of “translational research” (Woolf, 2008). During the 2013-14 school year, we have

extensively documented authentic collaborations with local science teachers in grades 3-8, through which we continue to work to solve problems practitioners face in implementing disciplinary STEM practices.

Conceptual Framework and Study Design

Translational research suggests that the gap problem between research and practice should not only be addressed but reframed. Implicit in the notion of adaptation is a bi-directional process of cultural exchange in which both researchers and practitioners come to understand how the knowledge products of each field can strengthen the professional activities in the other (Coburn & Stein, 2010; Palinkas et al., 2009; Penuel, et al., 2011). We have been studying an adaptation site, in which practitioners from two school districts, educational researchers, and scientists from the Institute for Systems Biology collaboratively develop and enact curricular adaptations aligned to STEM disciplinary practices.

This collaboration, orchestrated by the school districts, asks educators to engage students in disciplinary practices to support their learning of STEM. This comes in response to the new teaching and learning expectations from the recently adopted Next Generation Science Standards (NGSS; Achieve, 2013), which is based on the Framework for K-12 Science Education (NRC, 2011). The adaptation site work is focused on collaboratively adapting curriculum and developing relevant strategies and tools to support both teachers' and students' learning of STEM through engagement in the disciplinary practices, specifically focusing on the practices of engineering design and scientific explanation and argumentation. We work with teachers to develop and analyze what curriculum materials should be provided for teachers, how curriculum materials help teachers understand the disciplinary practices, and how teachers could expand the implementation of the practices throughout the curriculum at a larger scale (Davis & Krajcik, 2005; Coburn & Stein, 2010). We fully document the process consistent with design-based implementation research.

Sources of Data

Through the Adaptation Site, we are gathering several types of qualitative data with teachers as they iteratively develop educational tools and knowledge in response to STEM educational improvement efforts. Data collection is in the form of video, audio, and pre- and post-year surveys on the structure and impact of individual teacher networks. Teachers will also engage in focus groups and informal conversations to inform our understanding about their learning throughout the adaptation and implementation process. Most importantly, we will observe and participate in classroom activity with teachers as they adapt, plan, and implement their instruction. Planned data analysis will include discourse analysis of student talk, teacher talk, and talk among educational professionals, network analysis of teacher cultural learning pathways, measures of teacher content knowledge, and qualitative analysis of adapted curricula. Data collection will continue through three years, beginning with the 2013-14 school year.

Implications

This research illuminates the ways that a partnership between universities, school districts and local professional organizations supports the flow of research ideas to the benefit of teacher practice and professionalization. Our DBIR approach (Penuel *et al.*, 2011, Design-Based Research Collective, 2003) will enable us to document the full process of teacher learning: from cultural exchange to professional learning to shifts in practice to strengthened STEM learning opportunities for K-12 students. Our research will result in recommendations for helping adapt curriculum to include STEM disciplinary practices at scale, with direct connection to student outcomes. This research elucidates the ways that teachers improve their own science instructional practices through their collaborations and social networks as well as the ways that they seek and create agency in response to new standards.

Using Educative Curriculum Materials to Support Teachers in Engaging Students to Justify Predictions

Anna Arias, Annemarie Palincsar, and Elizabeth A. Davis, University of Michigan

As part of a larger research project looking at the use of educative curriculum materials to support elementary teachers' and students' learning of science practices integrated with science content, this research looks closely at teachers' use of educative features added to an existing kit-based science curriculum to support students in justifying their claims, an aspect of scientific argumentation. Using a qualitative, case study analysis approach (Miles, Huberman, & Saldana, 2014; Stake, 2000), we investigate how teachers interact with and adapt educative curriculum materials to provide learning opportunities for their students and consider how patterns within the student work connect to these opportunities. We ask:

- What evidence exists that the teachers drew on the educative features of the unit to support their students to justify their predictions?
- How do teachers describe drawing on the curriculum materials to support students in justifying their predictions?
- How does the students' justification of their predictions on a pre- and post-assessment connect to the teachers' enactment of the unit?

Research Focus

Scientific argumentation, defined as the justification of an explanation, model, or prediction through the coordination of evidence and theory (Duschl & Osborne, 2002), does not happen often in elementary classroom, despite evidence that elementary children can engage in aspects of this disciplinary practice (e.g., Herrenkohl, Palincsar, DeWater, & Kawasaki, 1999). We hypothesize that educative curriculum materials might support the use of justification of predictions to serve as an entrée for both teachers and students to engage in science argumentation, broadening their participation in authentic practice.

While elementary students are often encouraged to make predictions in many subjects, including reading literature, typically, all predictions are welcomed and students are not held accountable to support their predictions with reasoning or evidence. However, science emphasizes providing justification for one's claim. This disparity in how "prediction" might be used in the elementary grades makes it a particularly interesting scientific practice to study in elementary classrooms. The goal of our investigation is to study how educative curriculum materials might facilitate the development of teachers' abilities to engage students in providing justification for a claim in a prediction and thus begin to move toward scientific argumentation.

Conceptual Framework and Study Design

Teachers' work with curriculum is a participatory relationship in which the resources, stances, and perspectives of the teacher and the features and resources of curriculum materials interact (Remillard, 2005). Teachers adapt curriculum materials for use in their classrooms differently in part based on their diverse experiences and backgrounds (Brown, 2009, Remillard, 2005). For example, McNeill (2009) found that science teachers drew on educative curriculum materials in different ways when supporting students to engage in constructing explanations.

As part of a large quasi-experimental study looking at the effects of educative curriculum materials, this paper centers on three fourth-grade teachers (Ms. Jay, Ms. Rosser, and Mr. Decker) teaching an Electric Circuits unit over the course of three months. We enhanced an STC kit-based, inquiry-oriented unit for Electric Circuits (National Science Resources Center, 2004) with educative features intended to promote teaching, learning, and use of science practices and content (see Davis et al., in press). We designed the educative features drawing on literature and our earlier empirical work to support teachers in integrating science practices and content. Certain features foregrounded science practices, including making predictions with justification. The educative features included: (a) overviews describing the science practice, providing a rationale for teaching the practice, and gave possible teaching moves for supporting students applicable across multiple lessons, (b) targeted, *lesson-specific suggestions* for supporting students engaging in the science practice, (c) reminder boxes that were inserted into the procedure section of lessons and intended to highlight important aspects of science practices, (d) a *rubric and examples* feature for analyzing and understanding students' written predictions, and (e) narratives describing a teacher working with students on justifying prediction.

Findings

Each of the teachers seemed to draw on the educative curriculum materials in their teaching, yet their enactments showed differences in the learning opportunities they provided. For example, how each of the teachers discussed what predictions are and how to justify a prediction varied significantly. Ms. Jay and Ms. Rosser's explanations were clear and drew directly from the educative curriculum materials. Both teachers defined prediction as "a forecast of future events based on data already collected," a statement provided in the educative features. Both teachers also discussed the importance of justifying one's claim. For example, Ms. Rosser discussed that "predictions require a claim about what is being predicted and justification based on reasoning or previous observations or experiences". Mr. Decker's explanation of the practice of prediction, on the other hand, was convoluted and did not reflect the ideas in the educative curriculum materials. Mr. Decker did not focus on drawing on prior knowledge or observational data to support why one might make a particular claim as described in the educative features; instead, he emphasized how the students could see if their predictions were correct through an investigation. Similar differences across classrooms appeared in the students' work. More than 90% of students in Ms. Jay's and Ms. Rosser's justified their predictions on posttest, which was an increase from the pre-test; however, fewer students justified their predictions on the posttest than on the pretest in Mr. Decker's classroom.

The three teachers also varied in their perspectives regarding using the educative features to support student engagement in prediction. In the interviews, Ms. Jay pointed to how the curriculum materials facilitated her ability to engage students in justifying predictions and encouraged her to consider more closely students' thinking across multiple subjects. She also discussed using specific educative features such as the rubric to support students' predictions. In contrast, Ms. Rosser and Mr. Decker did not often point to using specific educative features when teaching about predictions. Ms. Rosser did discuss using sentence stems to support students in constructing explanation and justifying their predictions, which was suggested by the educative features.

Implications for Teaching Practices of Prediction and Argumentation

This study adds to and extends the research base by highlighting areas of strengths and challenges that might occur as teachers interact with and adapt educative curriculum materials to support elementary students in scientific prediction and argumentation. The teachers' varied integration of the disciplinary practice of justifying predictions into their instruction points to areas of teacher learning as well as challenges, adding to other research on designing educative curriculum materials for elementary science classrooms (e.g. Davis *et al.*, in press; McNeill, 2009). Ms. Jay's positive response to, and uptake of, the educative features' focus on justifying predictions suggests that such features can help elementary teachers learn more about how to engage students in complex science practices. In contrast, Mr. Decker's struggle to understand how the educative features were defining *justification* suggests that some teachers may need additional and more explicit support from educative features or extra time to adapt suggestions in the curriculum materials for use in their classrooms. These findings have implications for designing educative curriculum materials and considering how to support teachers to use and adapt these materials within their classroom. The findings also point to the need for further research on how facilitating teachers' engagement of students in justifying prediction may serve an entrée into the authentic practice of scientific argumentation in elementary classrooms and encourage a greater focus on student thinking in teaching.

Teacher Identity Development through an Afterschool Club: Science STARS as an Educative Learning Environment for Adaptive Science Teaching and Learning

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Teaching and learning experiences that foreground science culture and practices are rare in current science classrooms, especially given the intense pressures of accountability tests and teacher accountability measures (Marx & Harris, 2006). This reality is especially problematic for preservice practitioners who are just beginning to form their fundamental beliefs and build their competencies related to effective and equitable, student-centered science education. If our newest professionals have few opportunities to develop professional appreciations for, understandings of, confidence with and commitments to the fundamental principles and goals for reform-based science teaching, it is highly unlikely that school science will soon become a place for youth to participate in the culture of science and thus build positive identities with science. This study seeks to understand ways learning-to-teach in informal spaces can be structured through a practice-based curriculum to provide novice educators meaningful, ongoing and supported opportunities to marry their disciplinary expertise with youth voices in service of the development of teachers' own reform-based professional identity.

Research Focus

The focus of this research examines ways in which preservice teachers took up and modified a structured, practice-focused science curriculum for urban girls in out-of-school settings called Science STARS. The core STARS curriculum outlines benchmark performance events (proposal writing, pilot study, community advisory, inquiry meta-map, and final public conference) and shared curricular goals across inquiry groups (author an empirically based science investigation or engineering design and develop girls' positive identities in science).

Though these events and goals serve as the skeletal structure of the club experience, teachers are explicitly charged with and supported in completing the unit's instructional design by marrying their personal disciplinary expertise with youth voices through twice-weekly lesson plans, implementation and reflection. In this study, we learn from the experiences of eight preservice science teachers working individually and collectively to develop a professional identity through investigations co-developed with urban youth related to the physics of high heels, the science of baking a chocolate chip cookie, the chemistry of craving, and the science of classroom focus. Given one's own team of urban teen women for 20 consecutive sessions, each preservice teacher in a cohort balances agency and accountability to plan, implement and evaluate Science STARS' twice weekly club meetings toward a final public performance of long-term authentic inquiry. This study explores novice science

teacher learning as normative, core and personal identity development (Cobb & Hodge, 2011) evidenced in ongoing (written and oral) self-critique and goal setting framed by the following two research questions:

- How did teachers' celebrations and self-critiques reveal their developing identities - normative (who I should be) as well as personal (who I am in this situation)?
- How did participants take up and modify the structural elements of a practice-based curriculum as they moved with their "students" through a unit?

Conceptual Framework and Study Design

Science teacher education programs like the one involved in this study advocate for a particular vision of science teaching and learning that is grounded in learning sciences research. Included in this vision is the co-construction of a classroom culture that engages all participants in "productive disciplinary engagement" where youth and instructors intentionally problematize scientific ideas, youth are given authority to define and conduct inquiries, participants (youth and adults) hold each other accountable to scientific (and other) standards, and all have access to essential resources for this co-constructed work (Engle & Conant, 2002). I have argued elsewhere that identity is an essential lens for science teacher learning as these professionals take up the charge to enact changes required to nurture youth learning of the disciplinary practices (Luehmann, 2007). This teacher learning as identity development is supported through opportunities to integrate one's autobiography, consider and integrate experts' voices with one's own, reflect on practice connected to but separated from practice, engage in critical inquiry-based reflection and engage in community-based interactions (Darling-Hammond & Hammerness, 2005).

STARS was designed to offer teacher-learners uncommon (and much needed) opportunities to do this work within the community of learners of their own cohort and university faculty in spaces separate from the institution of schooling, thus allowing for instructional experimentation and interpretation toward aims that are complementary to (but often missing from) school learning goals. Agency with accountability, fun with focus, and exploring with explanations are criteria for success made explicit by the program's leadership team as well as taken up in various ways by the preservice teachers.

As part of a four-year ethnographic design-based research study looking at learning and identity work of teachers and youth in a structured, out-of-schooling learning context, this paper explicitly considers the balance of agency and accountability for novice teachers in this semester-long project. Throughout the project, perspectives and experiences of all members of interrelated communities of learners (youth, teachers and researchers) informed ongoing programmatic and research-based decisions.

Sources of Data

Twice weekly, across 20 weeks, each of eight preservice teachers authored lesson plans toward a final performance - a public engagement of youth's and teachers' "significant narrators" (Sfard & Prusak, 2005) centered on their scientific work of the semester. This instructional design, implementation and reflective work was done with significant, ongoing support including participation in a graduate-level methods course, written feedback on each lesson plan more than 24-hours before the lessons were taught, collaborative debriefing after each session, and weekly cohort-based video critique around a core science teaching practice (e.g. developing scientific explanations). Though a wide variety of data sources inform this study, primary data sources include written plans and reflections, as well as audio recordings of collaborative debriefs. Specifically, these data include:

- Pre-service teachers' written plans (weekly) and reflections (twice weekly) including practice-based goals, individual youth's achievements, strengths and thoughts about future work, and evidence of four key components of productive disciplinary engagement (problematizing content, giving youth authority, accountability standards and resources.)
- Transcriptions of cohort-based oral daily debriefs (twice weekly) of perceived strengths and future goals from four science teachers and two university personnel.

Preliminary findings reveal a disconnect for particular preservice teachers' between their normative and personal identities with respect to the sophistication of their understandings of both science concepts and practices. This disconnect between identities extended to related risk-taking, personally and instructionally. These same teachers differed from their peers throughout the semester in their abilities and willingness to capitalize on structured aspects of STARS (proposal writing, protocol advisory) - expressing fear, frustration or disinterest over curiosity and enthusiasm.

Implications for Fostering Teacher Identity Development

Learning to teach in out-of-schooling contexts not only offers teacher-learners ongoing safe and supported opportunities to try, fail, succeed and learn (Gee, 2003) with significant university mentorship; these

experiences privilege and foreground a set of research-based proficiencies for teachers of science that are complementary to and missing from aspects of teaching and learning that are prioritized by state testing and teacher performance assessments. Included in these proficiencies are practices intentionally designed to nurture urban youths' science identities- a core aspect of equity (Cobb & Hodge, 2011). This study provides insight into innovative ways to scaffold preservice teachers' abilities with and commitments to facilitating productive disciplinary practice within the culture of science.

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