Virtual Professional Development for Informal STEM Educators
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Introduction/Project Overview

Typically, STEM (Science, Technology, Engineering, and Mathematics) educators teaching in informal, out-of-school environments are provided with one-time trainings largely designed only to address logistical matters around the safety and basic needs of the children enrolled in their programs, without significant time spent addressing how to support learning through research-based science teaching practices. The purpose of the proposed study is to co-design and implement professional development for the summer instructors working for CU Science Discovery, and to examine the ways in which instructor participation in these camps informs their work in helping children learn science. The proposed work builds on a pilot project currently funded through CU Outreach in collaboration with Brian Jernigan and Anjali Maus at CU Science Discovery. By building on an established professional development model and prior studies of how individuals learn and collaborate in virtual spaces, this project will examine how readily-available Web 2.0 tools can help instructors separated by space and time. Working in partnership with CU Science Discovery staff, I propose to co-design professional development to support informal educators in developing higher-quality science teaching practices.

The Chancellor's Graduate Fellowship will support development and study of quality long-term professional development for informal science educators, hosted online, and that will serve to support and improve CU Science Discovery's STEM education programs. At the same time, it will contribute fundamental understandings in the area of informal science education where, to date, few studies have been done on any kind of professional development for informal science educators.

Background and Literature Review

Professional development with informal science educators does not have a robust research history. The body of research around informal learning spaces largely addresses student and/or family learning in out-of-school contexts (Falk & Dierking, 2013), pre-service teacher beliefs around informal science institutions (e.g. Kiseil, 2013), or formal teacher professional development opportunities in informal science institutions (e.g. Melber & Cox-Peterson, 2005). The existent literature on informal science educators themselves focuses on instructor-student interactions such as teacher talk or goals (e.g. Tran, 2007; Zhai & Dillon, 2014), rather than on opportunities for professional development.

Thus, I draw on existing research in supporting classroom teachers in formal educational contexts. Teaching in the US has long suffered from the so-called 'egg crate' problem, in which individual teachers work in isolated classrooms behind closed doors without opportunities for interaction and sharing of practice (Lortie, 1975). Alternative models of professional development have combatted this problem by creating communities of practice among teachers that emphasize collaboration around problems of practice (Hammerness et al., 2005). Research has indicated that teacher satisfaction and retention are bolstered when teachers have the opportunity to participate in such communities (Ingersoll & Smith, 2004; Whitcomb, 2013). Unfortunately, this model of professional development only works when teachers have regular access to other teachers working in the same discipline or content domain, a situation common at schools, but not the case when working with informal science educators, many of whom come from widely varied backgrounds and are typically not employed full-time as science educators.

This isolation may be ameliorated through participation in sociotechnical environments enabling individuals and groups of people to interact across space and time using computers and networks. These environments require co-design of social and technical systems, and are intended to serve groups of people (Fischer & Sugimoto, 2006). The advent of free, widely-available collaborative tools on the internet marks a new era in which web 2.0 tools might be used to mediate collaboration among communities of teachers. These sociotechnical tools have increasingly made it possible for teachers to share lesson plans and resources with each other (Tomassini, 2013).

Theoretical Framework and Literature Review

This study is situated at the intersection of literatures on STEM learning in informal spaces, science teacher learning in professional communities, and computer-supported collaborative learning. It draws upon both cognitive and situated theories of learning, with the cognitive perspective enabling us to foreground individuals and the ways in which they construct meaning. The situated perspective enables us to explore the social and tool-mediated interactions of these individuals in communities, as well as the participant structures or patterns of interaction in which multiple components of systems (such as human and nonhuman) coordinate their behaviors as they participate in a joint activity (Greeno, 2006; Herrenkohl & Guerra, 1998; Phillips, 1972).

Supporting Science Teacher Learning in Communities

Practice-based approaches to professional education create opportunities for teachers to collaboratively explore the problems and challenges they face in their daily practice (e.g. Ball & Cohen, 1999; Horn & Little, 2009; Cochran-Smith & Lytle, 1999) with the support of tools and artifacts that represent and support those practices (Little, 2002). This approach has been shown to be successful when teachers have routines for in-depth interactions around their practice (Horn, 2010). Unfortunately, participation in such compelling learning experiences is impossible for informal educators working in isolation, both physically and socially. Informal science educators are often employed to teach 1-2 independent sessions that are sometimes located at a central site, but can be located at satellite buildings or off-site nature settings. As such, collaboration in on-site teacher learning communities is not feasible for these informal science educators.

Computer-Supported Collaborative Learning

The field of Computer-Supported Collaborative Learning (CSCL) studies how individuals learn together with the assistance of computers (Stahl, Koschmann, & Suthers, 2006). CSCL is "centrally concerned with meaning and the practices of meaning-making in the context of joint activity, and the ways in which these practices are mediated through designed artifacts" (Koschmann. 2002, p. 18). While online communities of practice have been developed for teachers (e.g. Schlager, Fusco, & Schank, 2002), they have often focused on asynchronous discussion boards (e.g., computer-mediated communication, Scherff & Singer, 2008) or synchronous interactions using chat room functions. Similarly, MacLeod (2010) found that the presence of a facilitator was key to the overall experiences of inservice teachers' participation in an online professional development. Blitz (2013) identified the following as common foci for professional learning communities for educators: development of lessons, gains in student achievement due to instructional practices, and to identify professional learning needs.

Approaches from CSCL are relevant in both in- and out-of-school learning environments. For example, CU Science discovery runs many programs through the summer but because instructors are drawn from populations of undergraduate and graduate students, practicing teachers, former scientists, and occasionally other fields, it is difficult to get them all together in one place for training. As such, the proposed work will draw on literature from CSCL and professional development in teacher education to better understand how an interactive training system could be developed to connect these instructors across space and time, and to explore how this training informs their CU Science Discovery teaching. Specifically, I will study the design and enactment of online professional development for CU Science Discovery instructors, and examine how this experience informs their work in supporting children to engage in STEM in summer camps.

Proposed Method

Design

The proposed study is a design-based implementation study which will feature a partnership between CU Science Discovery and researchers in the School of Education at the University of Colorado Boulder. Design-based implementation research involves long-term, mutually beneficial relationships that focus on persistent problems of practice, a commitment to collaborative design, and concern with sustaining change in systems (Penuel et al., 2011a).

Study Context

CU Science Discovery serves the community of Boulder and the surrounding counties with 235 K-12, STEM-based classes each summer, hiring approximately 70 instructors and teaching assistants. These courses range in duration and topic, from engineering with Legos to creating nature notebooks. Camps and classes occur at a variety of sites on and around CU Boulder's campus including at Science Discovery's building on East Campus, in the Idea Forge located in the Fleming Law building, and out in natural environments like Chautauqua Park.

In the Spring of 2015, with the support of CU Outreach, I have performed interviews with Science Discovery staff and instructors, as well as parents of children from previous summer camps, and have drawn on these interviews to design and facilitate a pilot consisting of four online professional development meetings. My proposed Chancellor project builds and extends this work into a full study in 2016-2017.

Participants

The proposed study will engage the corps of approximately 70 CU Science Discovery instructors and teaching assistants in a series of online, small-group meetings of between 8-10 participants centered around problems of practice in teaching in informal STEM learning environments. While I will work with Science Discovery to roll out the professional development for all of their instructors, I will focus my data collection on a small group of 10-15 focus instructors. I will co-design agendas with Science Discovery staff and former instructors, and then facilitate small group professional development sessions myself, and train CU Science Discovery staff to run additional small groups.

Design for Learning Environment

The proposed study will begin with a series of meetings with CU Science Discovery staff to co-design a series of meeting agendas based on the outcomes of the current pilot study. The pilot study suggests that topics of the meetings will likely include: nature of science, scientific literacy, curriculum development and resources, classroom management practices, content area discussion, and others to be identified. Building on prior studies indicating that some combination of active learning and explicit instruction is most helpful for teacher learning in professional development (Penuel et al., 2011b), these meetings will include discussion of problems of practice around focal topics, as well as more guided learning around readings and other more structured activities. The professional development meetings will take place in an online Web 2.0 environment, likely using the Google suite of tools (e.g. Google Hangouts, Google Drive, Google+).

Sources of Data

To respond to the research questions guiding this work, I propose to collect a number of sources of data. In keeping with the DBIR approach to this study, these sources of data will be continuously analyzed through the project to improve, through iterative cycles of design, the professional development meetings to best prepare the instructors for their work in Science Discovery camps. Given the complicated nature of learning environments, a variety of data will be collected and analyzed.

- *Videorecordings of the online professional development meetings.* Videorecordings will be collected from each PD meeting using Quicktime screenrecording.
- *Design team meeting notes.* Design team members will take notes to record the course of the conversation in the design meetings.
- *Field notes from the professional development meetings.* Facilitators will take notes during the course of the PD meetings to supplement videorecordings.
- *Field notes from observations of teaching on-site.* Researchers will visit summer camp classes and observe instructors in their teaching practices.
- *Interviews with focus instructors throughout the study.* Researchers will conduct semi-structured interviews with a focus group of instructors to hear about their individual experience with the professional development. Interviews will be audio-recorded.
- *Instructor Artifacts:* Through the course of the professional development, instructors will share curriculum they are developing for summer camps. Researchers will gather these artifacts digitally to help draw links between proposed and enacted teaching practices.

I organize these sources of data according to elements of my overarching research questions, along with my proposed analytic approach, in the table below.

Aspects of Research Question	**Data**	**Analytic Approach**
What happens during the professional development	Videorecorded meetings	Reduce recordings to 5-minute segmented content logs, code

meetings? What work do instructors do, and how do they participate?		for speaker, goals, resources, and teaching practices
	Field Notes	Triangulate with content logs and teacher artifacts
	Teacher Artifacts	Triangulated with coded content logs and field notes
What teaching practices do instructors engage in?	Observations of teaching on-site	Coded for resources and teaching practices
How do instructors reflect on their participation?	Interviews with focus instructors	Transcribed and coded for goals, resources, and teaching practices

Timeline

The proposed work will take place during the 2016-17 school year, all looking toward preparing instructors and teaching assistants for summer camps occurring in 2017. Due to the design-based nature of the study, data will be collected and analyzed concurrently through the course of the study to inform subsequent steps.

- Fall 2016: Design team meetings and module development, participant recruitment, school-year program site observations, ongoing professional development with current focus group.
- Spring 2017: Implementation of professional development for all CU Science Discovery Instructors.
- Summer 2017: Site visits to summer camp programs

Outcomes/Impacts

Through partnership with CU Science Discovery, the proposed research has several built-in benefits to multiple STEM stakeholder communities:

- *CU Science Discovery* will benefit through co-designed, long-term professional development modules and strategies tailored to its community, and based upon the research base on STEM teacher learning. After completing my data analysis, I will present a set of finished facilitation guides, activities, and other instructional materials to CU Science Discovery that may be used in subsequent years.
- *CU Science Discovery Instructors* will benefit through access to ongoing professional development to improve the quality of their science instructional practices
- *The Boulder Community* will benefit by improving the quality of science learning of children attending science summer camps.
- *The informal learning community*, often embodied in informal science institutions and other out-of-school time programs, will benefit from new research that can inform professional development for informal science instructors.

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