



Using Blended Modalities for Engineering Education Professional Development: Supporting Elementary Teachers' Development of Community-Focused Engineering Curricula

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Using Blended Modalities for Engineering Education Professional Development: Supporting Elementary Teachers' Development of Community-Focused Engineering Curricula (NSF Grantees)

Abstract

This paper presents an overview of teacher professional development work conducted as part of a National Science Foundation Research in the Formation of Engineers project. The overall goal of the project is to increase awareness and preparedness of rural and indigenous youth to consider and pursue engineering and engineering related careers. To reach this goal, we are working with elementary pre and in-service teachers in rural and reservation communities to connect local funds of knowledge with classroom curriculum. The first summer professional development focused on two items: (1) training elementary teachers and pre-service teachers in ethnographic methods and photo journal elicitation, and (2) introducing teachers to different ways to integrate engineering instruction into their teaching. The current paper focuses on the second summer professional development phase. During this second professional development phase, which was designed to build upon the foundation built during the first summer, the emphasis was on supporting participating teachers' development and implementation of community-focused engineering curricula.

The second summer teacher professional development was presented in a blended manner using both asynchronous and synchronous meetings platforms to support collaboration. Participating teachers came to the synchronous meetings with a list of potential topics that could be used to connect engineering to their local school community. During the synchronous sessions, teachers worked with project team members to further develop these ideas and plan for lesson implementation the following academic year.

Introduction

Connecting the engineering curricula with the local community to build relevance and authenticity has been a central focus of this project. Correspondingly, place-based perspectives have largely informed the study and curriculum development process. "Teaching and learning always are placed endeavors" (Eppley, 2015, p. 69) because place influences the context in which knowledge is generated and applied. Place shapes culture and identity (Gruenwald, 2003) and place-based learning connects individuals to their communities (Woodhouse & Knapp, 2000), allowing for disciplinary engagement (Theobald, 1997). Further, connecting classroom curriculum to the local context can provide opportunities to transform students' perceptions about science and engineering (Avery, 2013; Avery & Kassam, 2011) as well as "shape identities and possibilities" in positive ways (Eppley, 2015, p. 70). To that end, *The Framework for P12 Engineering Learning* (ASEE, 2020) asks teachers to consider place and look "to their students' communities for examples of projects and applications of engineering learning that can intentionally teach desired engineering concepts" (p. 43).

Despite these calls to consider place in classroom instruction, curriculum developers, teacher educators, and policy makers often neglect the role of place within education (Eppley, 2015).

Teacher educator programs often make use of generic education approaches that prioritize the needs of suburban and urban schools (Barter, 2008), which can leave teachers particularly ill prepared to teach in the unique contexts of rural and reservation schools (Goodnough & Mulcahy, 2011; Moffa & McHenry-Sorber, 2018). To address this concern, our research project focuses on providing pre and in-service teachers with training and support for connecting classroom engineering activities to local contexts within participating rural and reservation communities.

Project Overview

The overall goals of this three year NSF project is to increase engineering awareness in rural and indigenous youth and to help them develop identities as engineering learners and possible future engineers. To reach these goals, we are working with elementary pre and in-service teachers in rural and reservation communities to develop classroom activities that connect local funds of knowledge (Moll et al., 1992) with engineering. During the first phase of the program (Hammack et al., 2021) we worked with participating teachers in developing their abilities as ethnographers so that they could purposefully learn about the cultures of their students. During the first phase, we also introduced participating teachers to engineering design-based teaching (Hammack et al., 2021). The participating teachers then piloted different engineering lessons during the academic year between the first phase and the second phase. These pilot experiences provided teachers the opportunities to practice engineering design-based teaching and more deeply explore how they might connect engineering to their local communities. The second phase of the program (currently underway) consisted of a summer professional development focused on how to integrate local contexts and knowledge within engineering lessons and provided participating teachers with support as they developed and implemented their designed lessons within their classrooms. This paper describes the first summer professional development and provides an overview of the teacher-developed engineering lessons that are currently being implemented.

Participants

Participants included four elementary teachers from three different school districts – two located on the same Native American Reservation and one located in a small town. Research was conducted under the guidance of university and tribal institutional review, with each participant consenting to be included in the study. To maintain anonymity, each participant was assigned a pseudonym.

Courtney. Courtney is a white, female with 30 years of classroom teaching experience. She currently teaches 5th grade at a rural school located on a Native American Reservation, approximately 60 miles from the small city where she lives.

Kerri. Kerry is a white female with 15 years of classroom teaching experience and currently teaches 4th grade in a small town approximately 10 miles away from the large town where she lives.

Sherry. Sherry is a Native American female with 24 years of classroom teaching experience. She is a registered member of the same Native American Nation as her 4th grade students who attend a rural school located on a Native American Reservation. She lives in a small town approximately 35 miles away from the school where she teaches.

Sonya. Sonya is a Native American female with 2 years of classroom teaching experience. She is a registered member of the same Native American Nation as her students and lives in a rural town approximately 25 miles away from the school where she teaches. She teaches 5th grade at rural school located on a Native American Reservation.

Summer Professional Development

Teacher professional development was presented in a blended manner, consisting of asynchronous work and synchronous online meetings. The asynchronous work used the Seesaw Classroom platform, a web-based app that allows teachers and students share work and assignments. The synchronous work used the WebEx videoconferencing platform to afford virtual space for the participating teachers to meet with the research team. During the two weeks prior to the Webex meeting, participants completed work in Seesaw Classroom to (1) reflect on both the challenging and rewarding aspects of the recent school year and (2) used Padlet, a collaborative brainstorming application, to begin sharing ideas for “a STEM curriculum for our 2021/22 classrooms that is authentic in our communities.” The Webex session began with a debrief over the prior academic year during which teachers shared their experiences with implementing an off the shelf engineering curriculum while dealing with COVID-19 protocols. Following the debrief over the previous academic year, we revisited the Padlet and shifted focus toward designing curriculum for the upcoming year. Between the four teachers, a total of twelve STEM project ideas were submitted, offering teachers an opportunity to inspire one another as they designed their own unique lesson plans. The most prevalent theme among the teachers’ ideas was water and waste management, of which seven of the twelve projects made a central focus. Other proposed ideas included robotics, greenhouse gardening, and aeronautics. Further resources were provided in the Seesaw Classroom such as news clips pertaining to local students’ STEM projects and a video interview with a local elementary school teacher with extensive experience teaching STEM. This repository of brainstorming allowed teachers to imagine their own students developing a project they had not considered before.

A collaborative hour plus conversation ensued that allowed the teachers to shape their initial ideas for the upcoming school year into STEM projects that were engaging, practical, and authentic to their students’ communities. In order to add structure to their project ideas, teachers were invited to detail their thinking in a 5E lesson planning template. The 5E lesson plan template was adapted from the BSCS 5E instructional model (Bybee et al., 2006). With their initial project ideas still growing, teachers were asked to consider how they would engage students in the project, explore the underlying concepts, explain key features, elaborate on the project’s connection to their communities, and evaluate student growth. At the conclusion of the Webex work day, teachers were asked to continue to work asynchronously on fall implementation plans for their individual classrooms and submit their lesson plans and a materials list for their chosen projects so that items could be prepared before the beginning of the school year.

Lesson Plan Overviews

Air Filtration. Wildfire smoke has been of particular concern in the state where this study took place, with the air quality index reaching unhealthy on many summer days. This became a particular concern when a winter wild fire broke out in the town where Kerri's brother lives. While the town was a few hours away from the Kerri's school, the students understood the issues of wildfire smoke due to their personal experiences the previous summer. They also wanted to help out their teacher's brother and his community. As a class, they built box fan air filters to send to the town's residents to help them remediate the impacts of the dense smoke that was polluting the air. The students' efforts were also highlighted on the local news, which resulted in a visit from the state's representative to the US House, who issued a citation to the class for their work.

Flooding Prevention. Ice jams are a frequent occurrence along the state's rivers, particularly from January through March. In fact, when ice jams warnings were issued on two rivers located near one of the participating schools just weeks apart from each other, the teacher decided to frame an engineering opportunity around the issue of flooding caused by ice jams. She created a five day instructional sequence that started with a day focused on building background knowledge specific to ice jams through information readings and videos. Then, a local engineer who works on flooding prevention visited the classroom to share about the types of problems he works on. Next, students built a model flood plain and used it to test how water flow was interrupted by ice jams. Finally, students developed and evaluated their own flood remediation plans to keep the homes in their model flood plans safe in the event of ice jam related flooding.

Access to Clean Water. Access to clean water is a major concern on the reservation where two of the participating schools are located. Further, water is considered a living thing on the reservation and holds an important place within cultural activities. All of the teachers on the reservation chose to center their lessons around water.

Drought and Irrigation. One school focused on issues related to drought, a concern for farming and ranching communities on the reservation and in many rural areas of the state. It is also of concern with many families who grow their own food gardens. Students used sensor technology to monitor moisture levels in the classroom garden and design sensor based irrigation systems to conserve water and ensure healthy plant growth.

Water Filtration. One school focused on potable water because the water at the schools is not safe to drink due to unsafe levels of contaminants. The students learned about different measures of water quality and how to test water quality using tests such as dissolved oxygen, pH, and turbidity. They also examined water samples under magnification to identify microscopic organisms in their water samples. After participating in water testing, students learned about different methods for filtering water and designed their own water filters.

Future Plans

Next steps will include analyzing data to determine the impact of the summer professional development and academic year implementation on the teachers' conceptions of engineering, teaching efficacy, and identity work as teachers of engineering. For this first phase of the larger study, multiple data sources were collected from participating teachers, including demographic

information, written assignments from the Seesaw Classroom platform, and reflections. All synchronous professional development sessions were video recorded and transcribed for analysis. COVID-19 protocols were different in each participating district, which resulted in the research team only being able to physically be present in Kerri's classroom during implementation. The research team was only able to join the other classrooms virtually. We did collect teacher lesson plans and video of classroom implementation, as well as student work samples. We will also conduct exit interviews and collect post-survey data from each teacher when the academic year ends. Lesson plans, video, and teacher interviews and survey responses will undergo thematic analysis (Braun & Clark, 2012), with codes being compared across data sources and merged to allow for triangulation (Flick et al., 2004).

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