VT-PEERS: Virginia Tech Partnering with Educators and Engineers in Rural Schools – An Executive Summary of Findings from the First Year

Introduction

Broadening participation in engineering remains an important focus of national attention, particularly as research indicates barriers such as students not knowing or misunderstanding the nature of engineering work [1]. An additional barrier noted is that people associate engineering as being very difficult and needing an affinity for math and science [2]. Isolated outreach events are unlikely to help most students see an engineering career as a viable option. Best practices suggest that more effective efforts should be designed to (1) maintain and expand situational interest, and (2) integrate with individual and community values.

Challenges to broadening participation in engineering are further complicated as research indicates that factors such as outcome expectations are more important than interest alone in the career choices of underrepresented groups [3-6]. In particular, for Appalachian youth, past research from members of our team showed that a desire for consistent local employment and aligning one's future in accordance with family values and pressures were important factors in career choice. [7-9]. Thus, for our target population which seeks to improve outcomes for rural and Appalachian youth, we must focus on both individual students and the broader community context in which they live and go to school.

Project Overview

To focus on individual- and community-level factors, we have undertaken an initiative funded by NSF titled, "Virginia Tech Partnering with Educators and Engineers in Rural Schools (VT-PEERS)." The goal of our project is to create a sustainable collaborative engagement between industry partners, teachers, and university affiliates to develop a series of culturally relevant lessons activities for classrooms in rural areas of Virginia. Our lessons and activities are grounded in theory and empirical research on career choice processes and pathways among Appalachian Youth. Our collaborations are guided by the antecedent-process-outcomes framework [14, 15].

Our Frameworks. VT-PEERS is a design-based implementation research project which prioritizes multi-stakeholder collaborations to improve education and systematic inquiry throughout to answer broader research questions about engineering education and inter-organizational partnership. VT-PEERS is theoretically grounded in a prior NSF-funded study on Appalachia students, and employs the Promoting and Supporting Engineering Career Choices (PSECC) model [19]. The PSECC brings together elements of social cognitive career theory (SCCT) [12], future possible selves (FPS) [13], expectancy value theory (EVT) [14], and the four-phased model of interest development [15] that are relevant to rural Appalachian Youth.

The key components of the model are (1) an awareness (developed formally or informally) of engineering as a career possibility, (2) a culturally appropriate venue for a sparked interest in engineering to become a sustained interest, and 3) a vision of the self as an engineer. Throughout this process, it is important for the learning experiences to be culturally relevant and supported by trusted others [7-11].

At the same time, we have adopted the antecedent-process-outcomes model [16, 17] to guide the collaborative lessons and activities to ensure the key characteristics of our theoretical framework are implemented and sustainable. For us, this is a functional model that supports establishing effective collaboration. This model suggests that effective collaboration depends on pre-existing capacity and contextual characteristics of stakeholders and their institutions.

Project Timeline. Our project iteratively builds across three years such that year 1 cohorts have at least two participating teachers per county who teach 6th graders. The year 2 cohort will add 7th grade teachers from the same schools and year 3 cohort will be designed during year 2. Because the project adds new teachers from a consecutive grade level each year, we will have students participating who represent a mix of new to the lessons and activities as well as longitudinal. This combination will be leveraged in the research plan to study impacts of the lessons and activities throughout the project. The actual facilitation of the lessons and activities is designed to be a collaborative endeavor depending on the specific expertise of our teachers, industry partners, engineering educators, and researchers from our team. We have currently completed our first year, with two sequential years left.

Preliminary Research and Findings

The questions driving the research aspect of the overall project are as follows:

RQ 1: How do participants conceptualize engineering careers? How and why do such perceptions shift throughout the project?

RQ 2: What elements of the targeted intervention affect student motivation towards engineering careers specifically with regard to developing competencies and ability beliefs regarding engineering?

RQ 3: How can strategic collaboration between K12 and industry promote a shift in teacher's conceptions of engineers and increased self-efficacy in building and delivering engineering curriculum?

RQ 4: How do stakeholder characteristics, perceptions, and dynamics affect the likelihood of sustainability in strategic collaborations between K12 and industry stakeholders? How do prevailing institutional and collaborative conditions mediate sustainability?

To answer these questions, we will collect a variety of qualitative and quantitative data over the life of the project. In this paper, we present preliminary findings of the first semester of lesson and activity implementation (referred to as "interventions" in the research questions). Thus, our

preliminary findings are related to the first part of research questions one and four and research question two. We will focus on three qualitative measures: teacher pre-academic year interviews, observations of classroom activities, and student reflections of the classroom activities.

Preliminary Findings. Because our research is in early stages, our analysis and findings to date have focused on helping us revise, adapt and improve our classroom activities and relationships within our developing partnership. We are analyzing data by summarizing notes and through formal coding process. Overall we are taking an approach consistent with Miles and Huberman (1994) [18].

Teacher Interviews: Prior to the start of the academic year, and prior to the first in-class activities, we interviewed all eight participating teachers. The interviews provided our team with baseline information on the teachers' expectations of the project, how they currently viewed engineering careers, and how they envisioned their role in the project. Note that these interviews were separate from conversations held by the VT-PEERS curriculum team which sought to understand activity topics and in-classroom timing. Overall, the teachers expressed an enthusiasm to begin the project, indicating that they believed it was going to be a positive experience for the students and themselves. Regarding integration of engineering into their curriculum, teachers thought including hands-on activities could help students learn the more difficult standards of learning (SOLs) and were interested to learn what activities were planned. Most indicated they had not integrated engineering into their classes.

However, we have also noted a need to focus on working with teachers to develop culturally relevant understandings of engineering careers. This finding is consistent with current literature [20]. When asked for a definition of engineering, several teachers indicated not having a clear idea or acknowledging they knew little about engineering. A few provided definitions related to what engineering is or a generic description of what some engineers do for a living, but most indicated they were unfamiliar with engineering and/or did not know any engineers. In addition, most of the teachers think their students know very little about engineering as a career choice, do not know any engineers, and or do not know of engineering job options in their area.

Teachers were asked their expectations of the project; who may benefit and how they might contribute. In general, teachers expect the students to be the primary beneficiaries by both understanding SOLs better and learning more about engineering and what engineers do in their jobs. In addition, teachers are hopeful to learn more about engineering and to gain ideas for adding hands-on activities into their curriculum. Most teachers indicated a role of learning from the activities, "as a learner like the kids", and a willingness to help if asked. Most teachers also indicated a role of helping the curriculum team know which SOLs to target for the activities and to review supplied curriculum.

Classroom Observations: Through the lessons and activities, the enthusiasm of the students was notable as they worked hands-on with the VT-PEERS curriculum. There was no shortage of

hands raised and willingness to participate at any point during the lessons and activities from the students, as excited statements were overheard while they were working and after they finished.

We also saw variations in how teachers and industry partners engaged in the classroom lessons and activities. We noted a general increase in classroom participation by industry partners over time. At the same time, we have realized a need to focus on how we can better engage teachers in the curriculum development process in support of increasing engagement in the classroom activities. Generally, a build-up of positive rapport between all the participants was apparent.

Important to our project goals, we noted that students outwardly made connections from the material to their personal lives, citing culturally relevant examples of their experiences with hunting, fishing, and mountain roads. Seemingly small, these connections are unique to the students living in this area, and showed a personal connection with the lessons and activities. Not all students outwardly expressed a personal connection, but many of them were eager to share personal stories pertaining to the curriculum to each other, the industry partners, and the VT-PEERS implementation team.

Student Reflections: At the closing of all lessons and activities, students are asked to reflect on what they learned about the content and about engineering in general. Unfortunately, these often became rushed in many of the sessions. While an open-ended questions generally invite the greatest variety of answers, we learned that it also provides difficulties in extracting answers from 6th grade students. Some of the challenges included the reading and writing level of students, the time allotted for students to write their reflections, and the understanding of the reflection question itself. While some student answers showed a direct connection from the lessons and activities to engineering, some left the reflections blank or connected engineering with a different aspect of the activity. As a result of this preliminary finding, we redesigned our approach for the Spring semester to include intentional, facilitated, oral reflection.

Conclusions

Our preliminary findings indicate that our classroom activities are having a positive impact on the students within the classroom. Evidence through observations has shown that students are indeed engaged during the observations, and are participating with each other, industry partners, and the VT-PEERS implementation team during the school visits. At the same time, we see many avenues for improvement particularly with regard to developing the partnerships between researchers, educators, and industry partners to enable more engagement by all. In addition to the changes we are making as we go, we are planning a summit for the summer of 2018. The summit will be an opportunity for all stakeholders to collaborate and improve curriculum for 6th grade classrooms and develop curriculum for 7th grade classrooms.

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