Board 61: Insights from the First Two Years of a Project Partnering Middle School Teachers with Industry to Bring Engineering to the Science Classroom

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Holly Larson Lesko is the Program Director for the VT PEERS (Partnering with Educators and Engineering in Rural Schools) program at Virginia Tech. This NSF funded program is housed in the Engineering Education Department and provides contextual, culturally relevant engineering curriculum and support in partnership with educators and local industry in three targeted rural schools systems in Virginia. Ms. Lesko leads the implementation team for VT PEERS and facilitates relationships with the educational and industry partners in the project. Her past research focus on rural and vulnerable community development through art and collaborative narrative praxis and influences her current engagement and practice. She has worked to address policy needs in community at the local level and to seek partners at the state and federal level to address the needs of her home community in central Appalachia and supports work throughout Virginia and the US with storytelling, collaborative facilitation, and grant seeking. Ms. Lesko has worked with communities and organizations in the New River Valley region and across the Commonwealth for the past 27 years and her focus in community development is on creating spaces and processes to enhance new ways of viewing and approaching issues and concepts through inclusive and diverse engagement.

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Introduction

Despite limited success in broadening participation in engineering with rural and Appalachian youth, there still remain many challenges such as misunderstandings around engineering careers [1], misalignments with youth's sociocultural background, and other environmental barriers [2]–[4]. National calls to address these problems situate schools and teachers to shoulder much of the burden without much of the resources. Engineering content may be particularly difficult to decode [5], [6], requiring the intentional development of teaching support programs and structures. While single interventions such as a professional development workshop for teachers or a career day for students are unlikely to cause major change, engagement over time appears promising for making lasting impact in these areas.

Project overview

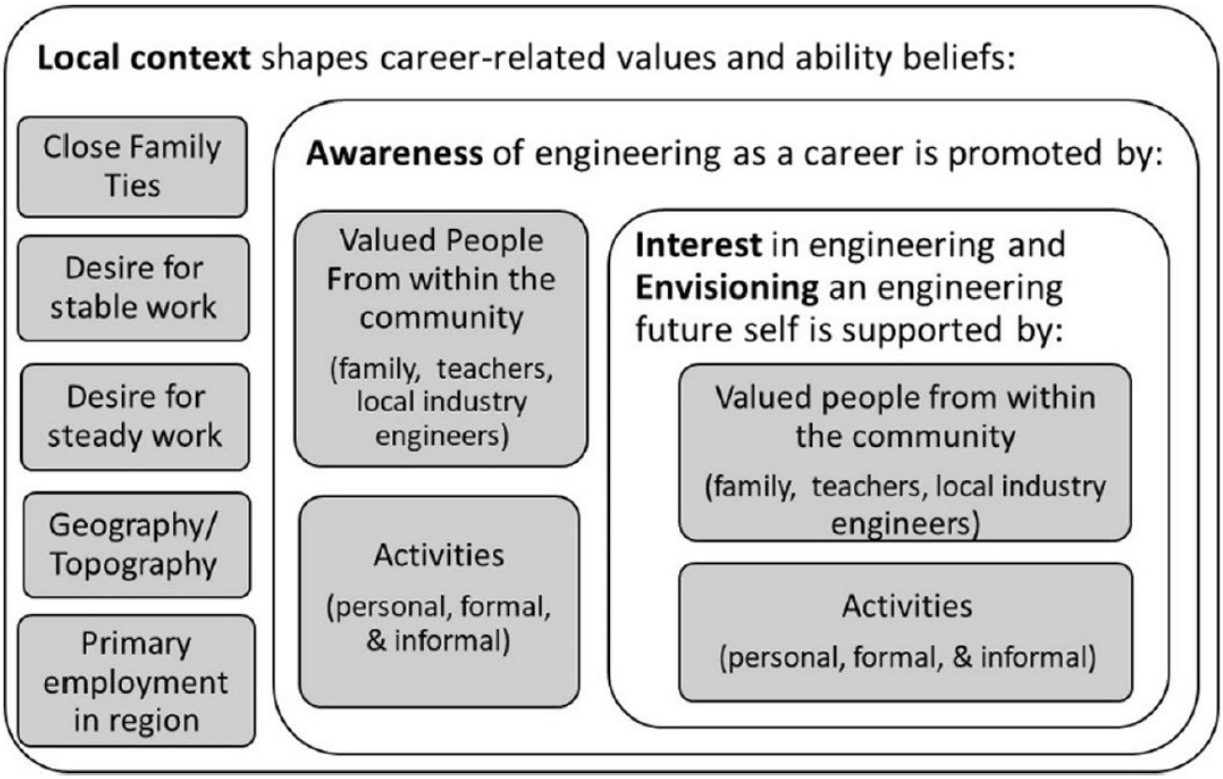
To address these challenges, we have undertaken our NSF ITEST project titled "Virginia Tech Partnering with Educators and Engineers in Rural Schools" (VT PEERS). Through this project, we seek to improve youth awareness of and also preparation for engineering-related careers and educational pathways. We hope that through regular engagement in engineering-aligned classroom activities and culturally relevant programming, we may also spark an interest that aligns with their backgrounds. Moreover, by engaging with schools over time as opposed to single interventions, we aspire to promote sustainability by continual integration within the typical curriculum once the project comes to an end.

In the first year of the project, we partnered with nine 6th grade science teachers across seven schools, three companies focused on science and engineering, and every 6th grade student in that year, totaling over 500 students. Now in year two, we have expanded to include the 7th grade science teachers and students. Though guided by the university team, curriculum is developed in conjunction with teachers and industry partners to create engineering-themed science lessons aligned with Virginia Standards of Learning and the Next Generation Science Standards [7]. Curriculum development is adapted from guidelines from Cunningham and Lachapelle [8] including scaffolding a student-centered approach, providing *locally relevant* real-world context for the learning activities, developing design challenges that are authentic representations of engineering work, and instilling the notion that engineering is everywhere and everyone has the potential to engage in it.

Research and programmatic frameworks. The VT PEERS programmatic and research efforts are guided by several distinct frameworks around action research, the study of career choice, and organizational behavior. Using an approach grounded in design-based implementation research (DBIR) methodologies [9], [10], the VT PEERS project engages partners through a cycle of research and practice around student, teacher, and collaborative outcomes. This approach is also guided by the conceptual framework of our Promoting and Supporting Engineering Career

Choices (PSECC) model shown in the figure below [11]. This model combines theories that have been historically applied to the study of choice including Social Cognitive Career Theory [12], Expectancy Value Theory [13], the four-phased model of interest development [14], and Future Possible Selves [15]. Together, these theories allow us to develop relevant, forward-looking curriculum and conduct research through the interpretive lens that engineering-related career choices are rooted in individuals within their sociocultural and historical environment.

PSECC Model [11]



While the structure of DBIR provides an approach for the overarching project, and the PSECC model provides a lens with which to design curriculum and study teacher and student outcomes, frameworks of organizational behavior are utilized in this project to explore how we might promote sustainability of these activities by considering the collaborative processes involved when public and private organizations come together towards a social goal. These works provide a language around the structures and processes of collaboration to explore how we can mitigate challenges in relationship building, share benefits, and build credibility among partners [16]–[19]. Combined with the careful consideration of the context in which these organizations and the partnership operate, we use these frameworks both to study collaboration and promote sustainability.

Research questions. Guided by our frameworks, we seek to address the following research questions around student and teacher outcomes as well as the collaborative processes:

> **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?

Research and evaluation methods. To address the research questions, this mixed methods longitudinal work encompasses both quantitative and qualitative approaches. For both youth and adults, participation in the research is decoupled from participation in the programmatic activities, though the majority of participants in the program chose to participate in the research. Data collection for this project includes pre-year and post-year semi-structured interviews with stakeholders in the project from each of the partner institutions including teachers, administrators, university affiliates, engineers, scientists, and other industry employees. Before their interviews, these participants complete an online survey with questions around collaboration [19] and engineering self-efficacy [20] which serves to prime them for the interview and provide data for triangulation of findings. Similarly, at the start and end of each intervention period, students complete a paper survey consisting of the Draw an Engineer Test [21] and questionnaire around engineering identity development [22]. Additionally, artifacts around classroom activities such as student reflections and other worksheets are collected for evaluative purposes. Newly in year two of the program, reflections have been transitioned from a paper activity to a whole class discussion facilitated by the classroom adults to mitigate some of the writing communication challenges discovered in the first year [23].

Current status

Engagement with teachers and youth. Data collection for year one of the project has come to an end, and data collection in year two is currently underway. Considering student and teacher outcomes to address research questions 1-3, analysis of the year one data has begun. For teachers, findings suggest improvement around teacher confidence in teaching engineering as well as challenges that still remain. Teachers primarily identified their role in the collaboration as supportive to the university. At the end of the year, many of these thoughts about their position in the program remained the same although there were indications that the relationship teachers had with the content improved. In year two, we have begun to scaffold 6th grade teacher independence while providing a similar level of support to 7th grade teachers for classroom activities. Although formal analysis of student survey results is not complete, early findings would suggest improvements in student outlook on engineering careers.

Partnership building. Progress has also been completed towards addressing research question 4. Scoped to the first year of the project, we applied the framework from Thomson et al. [19] to

develop an understanding of the collaborative processes at play. Emerging from this analysis is the implication that regularly reflecting on process may mitigate some of the negative perceptions of progress. Beyond individual reflection, it was unsurprising that emphasizing regular and transparent communication, possibly funneled through particularly engaged individuals, can facilitate relationship building. Strong relationships are based on not only this mutual understanding but also trust built over time. It became apparent that establishing this trust was critical to negotiating tensions between day-to-day operations and collaborative commitments as well as mitigating concerns over relative contributions to the project.

Next steps

As we finish year two and plan for the third year of the funded programming, bridging the findings between teacher and student outcomes and collaborative processes will become more important. At the end of year one, we were able to bring together individuals from our partnership organizations at a summer summit to engage in collaborative curriculum development. Although the university still had a heavy hand in finalizing the classroom activities for year two, this model of engagement allowed for more teacher buy-in with the material, consistent with our goals for sustainability. Another summit is planned for the end of year two and, informed by our preliminary research findings, we seek to further scaffold classroom responsibility to shift towards a teacher-led model and empower partner organziations to interact with each other outside of university mediation.

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