Board 272: Engineering Pathways for Appalachian Youth: Design Principles and Long-term Impacts of School-Industry Partnerships

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Introduction

Given the ongoing calls and priorities to broaden participation in engineering, this CAREER project specifically focuses on rural, Appalachian communities and students, populations which are underrepresented in higher education broadly but engineering careers specifically [1], [2]. Engaging students in opportunities to explore engineering and related career pathways before they graduate from high school is important not only for educational access, but also for economic resilience in these communities. The Appalachian Regional Commission [3] describes the need to engage youth more deeply in their communities and their education, as well as the need to invest in workforce development in various industries.

However, addressing these needs can be challenging given more broad systemic factors. For example, with the introduction of the Next Generation Science Standards, teachers in rural schools face a number of challenges. As Zinger [4] described, rural science teachers sometimes do not have the same opportunities to engage in professional development due to geographic isolation of their schools and it can be difficult for rural schools to provide professional development due to various resource constraints. In addition to teachers, guidance counselors at rural schools are stretched very thin, and one guidance counselor can be responsible for the entire student body [2]. Various scholars have identified difficulty with attracting and retaining teachers and other school personnel in rural places [2], [4], [5]. Additionally, rural students often do not have the same access to various extracurricular activities in engineering [6] and informal learning opportunities at museums [7] as their peers in other places. Many of these challenges are heavily impacted by public school funding, which is often based on the tax-base in school districts [8] and the population density in certain areas [9]. Given that some rural communities experience poverty and are relatively small in size, this often means that schools do not receive sufficient funding.

On the other hand, rural places, communities, and schools are often said to be tight knit, which can provide a wealth of opportunities to engage in unique ways. For engineering and STEM education, this is particularly important. For example, connecting students with local experts can provide relevance to concepts students learn in the classroom while fostering their interest in a STEM field [10]. Other scholars identified that a sustained interest in engineering, for example, is important for students as they make decisions about their careers [11].

Project Overview

Taking this context into account, this CAREER project originally focused primarily on exploring engineering career pathways in rural, Appalachian communities in Southwest Virginia, building on previous efforts described in other sources [12]. The original goals of the project sought to more deeply understand the longitudinal development of engineering interest from middle school through post-secondary education, and sought to utilize programmable microcontrollers to aid sustained engineering interest. These efforts would involve partnering with educators and industry partners in Southwest Virginia. Though the COVID-19 pandemic has been a major disruptor of programmatic efforts, three areas of research emerged as the primary focus of the grant work thus far:

1. School-industry partnerships in COVID-19 in the Southwest Virginia region
2. Development of a conceptual model for engineering education research and engagement in rural places
3. Systematic review of systems thinking assessments in K-12 education

The following sections describe each area of research, ending with future directions of this CAREER project.

School-Industry Partnerships in COVID-19

This research area specifically focused on how multi-institution partnerships continued instruction to prepare students for the skilled technical workforce (STW) during COVID-19, when most in-person instruction in K-12 schools was paused [13]. Targeting the Southwest Virginia region, interviews with career and technical education directors, STEM coordinators, school counselors, career coaches, and workforce development coordinators were conducted to determine how barriers presented by COVID-19 were navigated to continue instruction. The first finding, the importance of emphasizing partnership logistics and infrastructure for maintaining partnerships, deals with how leaders shifted focus to communication, funding, and utilizing industry networks to support efforts to continue to prepare students to enter the STW [13]. The second finding, the importance of individuals in maintaining relationships and connections, deals with how individual educators were able to leverage their networks to continue to provide meaningful experiences for their students [13]. The findings from this study point to the importance of collaboration and partnerships across organizations to support K-12 faculty and staff and STW education, particularly in rural areas [13].

Conceptual Model for Engaging in Rural Places

This research area specifically focused on the development of a conceptual model informed by literature in P-12 engineering education, rural education, assets-based education, and theories related to rural contexts and spatial justice. This conceptual model primarily focused on the

importance of place to engineering education research and engagement efforts, and the assets individuals and rural communities possess and how to highlight these assets in curriculum and engagement. These areas of focus are important given how important local contexts are underemphasized or ignored in curriculum. The focus on place, individual knowledge and experiences, and community assets can serve to strengthen efforts from the engineering education community as they seek to partner with K-12 schools anywhere, but specifically rural schools, to both conduct research and meaningfully engage with students to foster their interests in engineering.

Systems Thinking Assessment in K-12

This research area specifically focused on identifying and mapping the tools used to promote and assess systems thinking in K-12 settings. Systems thinking is an area of interest due the skills it can build in an effort to address ill-structured, societal problems which often involve sociotechnical aspects. Introducing and utilizing systems thinking in K-12 settings can better prepare educators and students to grapple with complex problems. A systematic literature review was conducted to identify existing tools to assess systems thinking in K-12 settings, including formal and informal learning spaces. Findings from the systematic review suggest that there are tools used to assess systems thinking across a variety of disciplines, but that the systems thinking skills being assessed are often hyper-specific to that discipline (e.g. chemistry, environmental science). The results identified an important gap in the need for a more comprehensive tool that is not tied to a specific discipline and a tool that can be applied outside of STEM contexts.

Connecting the Research and Future Directions

The overarching theme tying together the research in this project is based on the importance of community in various K-12 contexts, ranging from training for the STW to curriculum for engineering efforts in rural schools. For example, leveraging partnerships and community connections is crucial for overcoming barriers presented by systemic disruptions while also being incredibly important to leverage in classrooms to ground engineering in contexts that are both local and relevant to rural students. Furthermore, systems thinking can help students engage more deeply in complex sociotechnical problems, some of which their communities might be facing.

Future work on this project will focus on the development and validation of a comprehensive systems thinking tool that is both appropriate for K-12 contexts and incorporates elements related to grappling with problems and challenges students might see in their communities. Additionally, future work will focus on understanding the various career pathways into engineering that exist in the region– from engineering technology certifications to four-year

engineering degrees. From a programmatic standpoint, meaningful connections to existing structures in the community will be leveraged to continue research and outreach.

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