Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #47888

BOARD # 401: NSF CAREER: Engineering Pathways for Appalachian Youth: Design Principles and Long-term Impacts of School-Industry Partnerships

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

Introduction

Broadening participation in engineering and technical careers remains a national priority (Sciences et al., 2017), particularly in rural Appalachian communities where systemic barriers persist (Ardoin, 2017; Carrico, 2013) and students are underrepresented in engineering (Carrico, 2013). This project continues to address these challenges by fostering partnerships with educators, regional stakeholders, and industry leaders to create sustainable pathways for K-12 students. Over the past year, the focus has been on implementing needs-informed professional development opportunities, strengthening educator relationships and regional collaborations, and designing initiatives that connect classrooms with real-world engineering applications.

Project Overview

This CAREER project initially aimed to explore engineering career pathways for students in rural Appalachian communities, particularly in Southwest Virginia, by building on prior initiatives. The original goals focused on understanding how engineering interest develops over time, from middle school through post-secondary education, and utilizing programmable microcontrollers to sustain this interest. These efforts were designed to involve partnerships with educators and industry stakeholders in the region. However, the COVID-19 pandemic disrupted these efforts, halting relationship-building with educators and delaying the project's progress. Since then, the work has centered on rebuilding school-university and school-industry partnerships, while gaining a deeper understanding of the unique challenges of rural education in Southwest Virginia. While creating widespread engineering and technical career pathways for Appalachian youth remains challenging due to broader systemic issues, recent work has addressed teacher professional development related to engineering, as well as increasing support for integrating engineering into K-12 classrooms in Southwest Virginia. Research efforts over the past year have focused on:

1. Creating a data-informed summer engineering workshop for teachers, focused on integrating systems thinking, data science, and programmable microcontrollers into the classroom
2. Strengthening regional collaborations
3. Partnering with university and industry personnel to offer continued professional development based on needs expressed by teachers

The following sections detail these current focus areas and outline future directions for this CAREER project.

Data-Informed Summer Engineering Workshop

Informed by the results of a needs assessment conducted in early 2024, a two-day professional development workshop was held for 16 educators from 10 counties in Southwest Virginia in June 2024. The needs assessment identified specific barriers and opportunities K-12 teachers in Southwest Virginia experience while integrating engineering into their classrooms. These needs guided both the format and content of the workshop. Participants expressed a strong desire for practical, adaptable tools and resources that could align with their existing curriculum and for greater exposure to engineering career pathways.

The workshop addressed these needs through several hands-on activities. For instance, one session focused on systems thinking and explored the interconnectedness of systems and their application in various subjects. Another session included a data science activity that used regional datasets to demonstrate the local relevance of engineering problems. Additional sessions included programmable microcontrollers, lab tours, using generative artificial intelligence (AI), and faculty-led discussions on educational needs and skills to major in engineering. Educators also connected with local engineers who provided insights into career pathways and industry demands in the region. They also had the opportunity to connect with faculty from various organizations at Virginia Tech, including the College of Engineering and School of Education.

As a direct outcome of the workshop, eight participating educators have elected to continue working with the project team. This ongoing collaboration has already resulted in field trips, including one that brought 36 high school students to Virginia Tech for lab tours and discussions with faculty. Additional field trips and in-school workshops are being planned, focusing on systems thinking, engineering careers, and other STEM topics.

Strengthening Regional Collaborations

Partnerships with Virginia Tech's Center for Educational Networks and Impacts (CENI), and other regional stakeholders have played a critical role in expanding the project's reach. The CENI Educator Liaison Network has been particularly valuable, facilitating connections with school systems across the region and identifying opportunities for deeper engagement. Weekly meetings with this network have allowed the project team to remain responsive to the evolving needs of educators and to build relationships that are essential for long-term impact.

Engagement with regional initiatives, such as the Great Opportunities in Technology and Engineering Careers (GO TEC) program, has further supported the project's mission. These partnerships introduce middle school students to strategic sectors like robotics, automation, and healthcare technologies, aligning with the broader goal of preparing students for STEM careers.

Participation in regional events, such as the Future of Talent Summit at Roanoke College, has further strengthened connections with key stakeholders. These discussions have highlighted the

importance of aligning workforce development efforts with community needs and have reinforced the project's commitment to supporting rural pathways to engineering.

Expanding Professional Development Opportunities

Building on the success of past workshops and the strong collaborations formed with regional stakeholders, the project will continue to expand professional development offerings for educators. Future workshops will address emerging technologies and teaching practices, such as integrating artificial intelligence (AI) into classroom instruction and utilizing 3D printing technologies for hands-on STEM learning. These workshops will be designed to equip teachers with practical tools and resources that can be directly applied in their classrooms, enhancing their ability to teach engineering concepts and engage students in real-world applications.

In addition to the professional development workshops being created, the project has expanded its outreach efforts to include tailored support for educators and direct engagement with students. Customized STEM activity kits have been distributed to schools, providing hands-on resources that align with classroom needs. In-class workshops focusing on systems thinking and engineering career exploration are being developed as part of ongoing partnerships with educators.

Connecting the Research and Future Directions

This year's research efforts focus on sustaining and expanding support for rural teachers in Southwest Virginia as they incorporate engineering concepts into their classrooms. Building on the success of the initial summer workshop, we are maintaining engagement through ongoing feedback and tailored resources. These insights will shape the planning of a second workshop in summer 2025. To refine its content and structure, we will conduct focus groups with past participants throughout the spring semester, using their feedback to enhance the program and better address teachers' needs. Additionally, we will recruit a new cohort of 16 teachers, further growing the community of practice among engineering educators in the region. Through these efforts, the project aims to foster long-term collaboration, support, and the integration of engineering education across Southwest Virginia.

Future work will focus on expanding professional development offerings, strengthening networks among teachers, and deepening collaborations with CENI Educator Liaisons to reach a broader audience. We also plan to conduct research on teachers' pedagogical decisions when integrating engineering into their classrooms and collecting data on their perceptions of engineering and attitudes before and after the summer workshop. In addition, we will continue to cultivate connections with industry partners across the region, ensuring that educators have access to local career opportunities and real-world applications of engineering. This research and strategic approach aims to equip teachers with the tools and support they need while fostering sustainable growth in the local STEM workforce and raising awareness of engineering career pathways for students in rural communities.

Acknowledgments

This work is supported by the National Science Foundation under Grant No. 1943098. Opinions, findings, and conclusions are those of the authors and do not necessarily reflect the views of the NSF.

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