Work in Progress: Framing Engineering as Community Activism for Values-Driven Engineering

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Abstract

This work in progress paper describes results from a NSF Research in the Formation of Engineers grant. The overarching objective of this research is to understand how framing engineering as an altruistic profession affects the engineering identity development of low socioeconomic status (SES) African American 8th - 10th grade students from an urban area within a predominantly rural Southern state. While there has been significant focus on increasing STEM knowledge and career interests for underrepresented minority (predominantly African American) low SES students from rural regions of these states, less focus has been paid to engineering specifically and to urban areas in this region. Little is known about how the intersections of race, poverty, local environment, and regional culture affect this group's perceptions of potential engineering career pathways. This research seeks to understand the effects of different interventions on students' self-efficacy and interest in engineering. In the first part, the effects of an existing Saturday STEM program were investigated. In the second part, the effects of a camp and mentoring program which highlights the positive societal impacts of engineering are being investigated. This paper highlights the structure of these programs and findings to date.

Keywords

Altruism, Grand Challenges, Community, Innovators

Introduction

This research is focused on contrasting a Saturday STEM Education program that uses traditional STEM engagement strategies to a summer camp and mentoring program focused on the altruistic aspects of engineering. We are studying the effect of each program on the engineering identity development among urban African American Youth from a low socioeconomic status region in the southern United States. Specifically, the research has three primary goals: 1) Expand knowledge of career identity and values as they develop among urban, low socioeconomic status (SES), predominantly African American 8th-10th grade students; 2) Expand understanding of how interventions focused on altruistic engineering and goal congruity influence these students' identity development and career exploration; and 3) Understand the effects of serving as an engineering role model, and participating in altruism focused activities, on the identity of undergraduate engineering students from similar backgrounds as the participants.

Activities and Methods

The first year of the grant consisted of two key activities. First, intensive research was conducted at a regional STEM enrichment program that focuses on traditional STEM content without a significant emphasis on altruism. This effort was focused on better understanding how African American students from a southern, urban, low-income area expressed their career identity and values and how these attitudes changed as a result of traditional STEM enrichment programming. We sought to understand if and how these students identified with STEM related disciplines and what their specific STEM interests were. Using the theoretical frameworks of Social-Cognitive Career Theory[1], we sought to explore how family orientation, values, career aspirations, and community involvement influenced student identity development and career interest. We tried a number of methods to gather rich information about students. These included:

- Quantitative surveys adapted from previous work[2]
- Observations using the Dimensions of Success protocol[3]
- Semi-structured interviews
- "Me in STEM" poster art and interviews
- Guided video reflections

The original research plan evolved throughout the year while working with Alabama STEM Education (ASE) students to focus more on creating artifacts with the students such as "Me in STEM" posters and reflection videos that could then be used in interviews to gain more insight into the students' worldviews and values. The methodologies and results from this portion of the effort were then used to guide the development of a summer camp program with content and assessment tailored to this population. The summer program enrolled students who had *not* previously been engaged in ASE activities. Of the 20 summer camp participants, just one student had previously attended ASE events.

Based on findings from the ASE-based research, the Tomorrow's Community Innovator (TCI) summer program was designed to focus on the positive societal impacts of the engineering profession and provide role models to students from the same area as the STEM program. Recruitment for TCI focused on identifying students who were interested in improving their communities, but did not explicitly focus on STEM themes. The program began with a week-long residential summer camp at Auburn University. Minority undergraduate students from the university served as camp counselors and mentors.

Both surveys and one-on-one interviews were conducted pre- and post-camp. The quantitative surveys included measures of science and engineering interest, self-efficacy, and utility-value adapted from tools created by the MSP-MAP project.[4] Students also rated their career and life values on a survey instrument commonly used for career planning. The interviews asked students about those values and their perceptions of their careers. The semi-structured interviews included these questions:

- Think about your life and future career. Have you thought about what you would major in at college? What are your goals for your adult life?
- Do you know any engineers? Scientists?

- What is engineering? What does an engineer do?
- What kinds of engineering or science things do you find interesting?
- Have you considered engineering or a field of science as a future career? What do you think that career would be like?

After each camp event, the students rated the activities in terms of how interesting they were, if the student felt they could be successful doing that kind of engineering (a measure of efficacy), and how much that type of engineering helps people.

Each day had a specific engineering theme: introducing the Grand Challenges of Engineering[5], providing access to clean water, making solar energy economical, and restoring urban infrastructure. On Monday, the morning activity focused on a brainstorming session where students identified problems in the community and collectively identified the most important problems they felt society needed to solve. On Tuesday, the morning activity focused on the challenge of providing access to clean water and involved building a water filtration system to remove large particulates from contaminated water. Students then used filters with silver nanoparticles to further filter the water and test the quality of the filtered water using test strips and a multi-day test of bacterial content with petri dish cultures. On Wednesday, students tested and then built their own solar panels to learn about the challenges of economical solar energy. On Thursday, students learned about urban infrastructure by working as a team to gather information from community stakeholders (the mentors acting assigned roles such as town mayor or economic developer) and then planning a city block and using their limited budget to place necessary buildings and roads. Afternoon activities focused on learning to code using App Inventor, and app and robotic activities related to the solar, water, and infrastructure themes.

In addition to the formal content, students participated in lunches with role models from industry, Engineers without Borders, and the Auburn University Black Student Union. They also participated in fun activities such as icebreakers, kickball, a football stadium tour, and a movie night. On Friday morning a graduation ceremony was held to celebrate the students' accomplishments and inform them about future opportunities to be involved in ASE programs and Auburn University's Summer Youth Programs.

As a follow-up to the camp, the mentors will meet with the students at the ASE Center in Bessemer, AL. The participants will also be brought to Auburn University's engineering Open House in February and have the opportunity to enroll in the program for another year by attending one of the camps already offered by Auburn University. The effect of the mentoring experience on the undergraduate's engineering identity is being evaluated.

Conclusions

The first year of this effort provided insights into the value of a range of quantitative and qualitative methods for understanding the engineering identity of African American youth from a low socioeconomic status, urban location in the southern United States. We found that students in both the traditional and altruistic-focused programs had strong interests in serving their communities and several had clear career goals related to engineering. Almost all had parents who specifically encouraged them to enter a STEM career path. Their career values were also more altruistic than individualistic. Comparing the programs, the altruistic-themed engineering

program led to increased positive perception of the impact of engineering on society. Students especially perceived activities related to "providing access to clean water" as interesting and promoting their own engineering self-efficacy. The hands-on lab activities also were found to promote the attitude that engineering helped solve important societal challenges. Ongoing research will provide insights into how different experiences affect these students and their undergraduate engineering mentors.

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Edward Davis

Dr. Edward Davis' research focuses on the use of anisotropic nanoparticles in biomedical applications. Applications include advanced cancer therapies, remote activation of shape memory behavior, and 3D printing of advanced multifunctional materials. He worked in the commercial plastics industry for 11 years, including positions with Shell Chemicals in Louvain-la-Nueve Belgium and EVALCA in Houston TX. He joined the faculty at Auburn University in the fall of 2007. In 2015, he began his current position as an Assistant Professor in the Materials Engineering Program.