The effect of engineering summer camps on middle school students interest and identity

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Introduction

A persistent problem in engineering is an insufficient number of students interested in pursuing engineering as a college major and career. Under enrollment in engineering is highest for underrepresented groups [1]. Student interest in engineering at the K-12 level has been shown to predict whether students of all backgrounds pursue engineering as a college major and career [2, 3]. Middle school is a critical time where student interest, identity, and career choices begin to solidify [4, 5]. Social cognitive scientists [6, p. 79] have developed a framework based on social cognitive theory [7] for understanding three factors that are critical in career pathway development in late adolescents and early adulthood, namely, "(1) Formation and elaboration of career-relevant interests, (2) Selection of academic and career choice options, and (3) Performance and persistence in educational and occupational pursuits". They also point out that social and economic factors affect the level and content of career choices.

The National Academy of Engineering and National Research Council emphasize the importance of engineering education at the K-12 level [8]. Since states have been slow to adopt the NGSS (Next Generation Science Standards) and to include engineering curricula in their K-12 classrooms [9, 10], many universities with engineering programs have implemented informal STEM outreach programs for students in elementary, middle and high schools. However, there is a need for a better understanding of the ways in which these outreach programs influence middle school students choice of engineering as a major and career. Specifically, "Increasing the interest of K-12 students in the sciences rests on university outreach efforts and improved K-12 instruction" [4, p. 6]. This report as well as [5] point to middle school age as the critical age when students start forming interest in careers and hence the population on which studies should focus. There is a need to better understand the ways in which outreach programs like engineering summer camps influence engineering interest and identity in middle school students and subsequent choice of engineering as a major and career.

To develop engineering-specific theories of how engineering identities are formed, this paper describes the methodological plan for understanding interest and identity development of three middle-school populations participating in engineering summer camps offered by the College of Engineering at the University of Nevada, Reno, NV: (1) women in engineering (2) first generation students and, (3) open-enrollment engineering camps. The research design leverages existing quantitative surveys along with focus groups and observations based on a selected set of questions from these surveys.

Research Design, Methods and Instruments

The research design for this project is based on guidelines provided by Creswell [11]. Specifically, a convergent parallel mixed methods approach will be utilized in this study. The research questions that will be addressed are: (1) How strongly are engineering identity and interest linked to the pursuit of engineering as a major in college and as a possible future career? (2) Which specific activities in the summer camps lead to a change in identity and interest in engineering? (3) To what extent and in what ways do the qualitative participant focus group

interviews and observations of participants engaged in camp activities contribute to a comprehensive understanding of the quantitative data obtained via pre- and post-surveys?

Description of summer camps/participants

Three summer camps are the focus of this project. They each cater to different middle school populations: The Young Women in Engineering camp is all female; the First-Generation camp is for students who will be the first person in their immediate family to attend college and the Introduction to Engineering (Open-Enrollment) camp admits any student who applies on a first-come first-served basis.

The camps are identical in content and designed with the goal of increasing understanding of different engineering fields and careers. The only difference between the three camps is that the women-focused and first-generation camps involve participation of guest speakers and role-model mentors appropriate for the camp populations. The camp activities include building an electric speaker, blasting off bottle rockets, testing self-made towers on a miniature shake table, and visiting a local engineering company. Field trips and campus tours introduce students to local engineering landmarks and engineering companies. University faculty and graduate students lead camp sessions. Camp information is disseminated to students through e-mails to teachers, campus supporters, and mail flyers to middle and high school mathematics and science teachers. The three camps are extremely popular and have filled up quickly since they have been offered. The goal is to have 25 students in each camp participating in the research study. Thus, there will be 75 participants in each year of the two-year study with a total of 150 participants. The following is a description of the three camps:

***Introduction to Engineering Camp*:** introduces students to various engineering disciplines through fun, age-appropriate activities. The intent of the camp is to develop the students' curiosity in Engineering and promote a lifelong interest in the field.

***Young Women in Engineering Camp*:** is designed for young women only and introduces them to engineering including lessons, hands-on activities, and mentoring from professional female engineers, university faculty, alumni, and current engineering students. At the end of the camp, students attend a mentoring luncheon with local female engineering professionals. Students mingle and interact with many of the top female engineers in Reno.

First Generation Engineering Camp: is a free, introductory camp which is open only to students who will be the first person in their immediate family to attend college. Students attend a luncheon with guest speakers from minority-serving university organizations.

Plan for data collection:

The project will proceed in one phase with two data streams. Quantitative data will be gathered in Phase 1 that will be done twice, first when students register for the summer camp (pre-survey) and the second at the end of the summer camp (post-survey). The survey questions will be from the Friday Institute survey [12], an instrument that has been tested and validated [13]. Qualitative data in the form of in-depth focus group interviews (on day 5/5) with 7 - 8 participants per focus group and observations of camp activities during the five days of the summer camp will be implemented. The semi-structured focus group protocol will use the same constructs as the quantitative data collection. The open-ended focus group questions will be a select subset of the questions on the pre- and post- surveys. Observations of participants involved in camp activities

will also use a semi-structured checklist based on this subset of questions. The focus group interviews will be digitally recorded and transcribed.

Grounded Theory

The qualitative analysis will utilize Grounded Theory [14 – 16]. The steps included in the qualitative data analysis are: (1) Organizing and preparing the data, i.e. transcribing the focus group interviews and observations of camp activities, and typing up the notes taken during observations; (2) Reading all the data to obtain a sense of what general responses the participants are giving and the tone in which they are given; (3) Coding of the data, i.e. organizing the data by segments and deciding on a descriptive word to represent a topic category; (4) Alphabetizing of the codes; (5) Developing a preliminary codebook; (6) Using the codes for generating five to seven themes that will eventually be the findings of the research; (7). Developing a narrative to describe the findings of the analysis with figures and tables; (8) Interpreting the results.

Conclusions and future work

The data gathered from the convergent parallel mixed methods approach used in this research project and the resulting grounded theory analysis of three different populations of middle school students participating in engineering summer camps, will address the relationship of engineering identity and interest to pursuit of engineering as a major in college and a possible future career. Moreover, the project will also identify engineering camp activities that lead to changes in identity and interest in engineering for these three populations of middle school students. It is planned as future work to follow up on whether the students participating in the study do choose engineering in college.

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