

Examining the Interactions Related to Role Modeling in an Elementary Outreach Program (Work in Progress)

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Abstract

University-based outreach initiatives are a major driver in K-12 engineering education, reaching approximately 600,000 K-12 students in the United States annually. It is widely believed that university outreach programs can increase and broaden participation in engineering study and careers by introducing youth to undergraduate students as engineering role models. However, little research has been done on how students select role models and how to optimize the interactions between young students and university students to increase role model uptake. This paper presents preliminary data and analysis from Role Models in Elementary Engineering Education, an NSF-funded research project that is examining the dynamics between undergraduate students providing outreach and elementary school student participants. This case study of a 5th grade classroom focuses on how dynamics related to sharing personal information, engineering identity, and other interests interact with elementary school students identifying undergraduate engineering students as role models.

Introduction

University-based outreach initiatives are a major driver in K-12 engineering education. In the United States, an estimated 600,000 K-12 students participate in university-led engineering outreach annually [1]. Reaching students as young as elementary school is important as students form their interests and impressions in engineering and other STEM disciplines early [2], [3], [4], [5] and those interests often decline in middle school [5], [6], [7], [8]. It is widely believed that university outreach programs can increase and broaden participation in engineering study and careers by introducing youth to undergraduate students as engineering role models. To this end, university engineering students are often positioned as role models for the K-12 students they work with. However, to date, little research has been done on how elementary students select role models and how to optimize the interactions between young students and university students to increase the likelihood that they will be taken as role models.

The Role Models in Elementary Engineering Education study (NSF DRL-1657519) aims to:

1. Understand the mechanisms that support or thwart elementary students, particularly female students, in taking up engineering outreach providers as role models,
2. Understand the impact of that role model connection on engineering career interest, and
3. Develop resources for university-based engineering outreach programs to support interactions among undergraduate ambassadors and elementary students which promote role model development and uptake.

Role model selection is under-researched for this age group; however, work with adolescents suggests that youth choose role models based on their assessment of the potential role model as a representative of engineering [9], [10], as similar to them in some way [2], [10], as appealing [11], [12], and as embodying attainable characteristics [13]. That is, in order for youth to choose undergraduates as engineering role models, these young people must recognize the undergraduates as appealing, emulable representatives of engineering.

Role Models in Elementary Engineering Education leverages an existing engineering outreach program, Tufts STOMP. In STOMP, pairs of undergraduate engineering students (henceforth referred to as *engineering ambassadors*) collaborate with classroom teachers to develop and facilitate weekly hands-on engineering design challenges in elementary classrooms. We present preliminary data from one of the classrooms participating in this study.

Methods

We took a mixed-methods approach, utilizing quantitative survey instruments and qualitative analysis of interviews and videorecordings of classroom activities. Over one semester, the research team videorecorded the weekly engineering activities, using multiple cameras and audio recorders to capture varying perspectives in the classrooms. We made field notes focusing on interactions between engineering ambassadors and elementary students, and used these field notes to select video segments for close analysis. We administered a Draw an Engineer Test adapted from Knight and Cunningham [14] at the beginning of the semester to capture students' baseline impressions of engineers and engineering. We administered the Engineering Identity Development Scale [15] at the end of the semester to gain information about students' knowledge of the nature of engineering and to gauge their interest in engineering as a career. We examined video and audio recordings and began classifying interactions between undergraduates and elementary students. Finally, we conducted semi-structured interviews with a convenience sample of ten elementary students (based on consent and attendance on the interview date) to understand their choices of role models, career interests, and impressions of the undergraduate engineering ambassadors.

Findings

Draw an Engineer Test and Engineering Identity Development Scale

All consenting students in the class completed the Draw an Engineer Test and the Engineering Identity Development Scale ($n=15$). The responses suggested that the students in this class had realistic conceptions of engineers and engineering careers. On the DAET, twelve students drew and wrote about an engineer doing engineering, two students' responses were ambiguous (e.g., "the engineer is looking at the wires"), and one student drew and wrote about a non-engineering professional. The Engineering Identity Development Scale responses also indicated that students in this class were knowledgeable about the nature of engineering and engineering careers. Many students in this sample responded "Yes" to prompts asking if engineers solve problems that help people (10 "yes" responses), work in teams (8), use mathematics (10), use science (13), are creative (13), and if there is more than one type of engineer (14). However, no students stated "Yes," they would like to be an engineer, and only one student said they would like to work on a team with engineers. These results suggest that in this case, knowledge of engineering careers does not correspond with engineering career interest. Although students in this class know what engineering is and what engineers do, survey responses suggest most of these students are not inclined to choose engineering careers at this point.

Student Interviews

Interviews with students allowed us to dig into some of the nuances of students' career interests, and suggested greater interest in engineering careers than indicated by EIDS and DAET survey data. We describe three students' responses in detail to show how the pieces of their responses fit together. All names are pseudonyms.

Sample Interview Summaries and Intersections with Surveys

Melissa is considering an engineering career; in her interview, Melissa stated she would like to be an inventor when she grows up. She named two family members and Ellie, an engineering ambassador to her classroom, as role models. Asked why she considered Ellie to be a role model, Melissa said, “She was so enthusiastic about all of the projects and...the inventions. And [Ellie was] so positive.” Melissa also noted that the engineering ambassadors “were very nice and kind to us” and “helped us” and that “I’m somebody who likes to invent stuff and they’re similar like me.” In the DAET Melissa drew a female-appearing engineer, suggesting Melissa envisions engineering as a possible career for women and by extension, herself.

Gloria is open to engineering, but it’s not her primary career goal. She would like to be a visual artist when she grows up, and her role model is a family member who inspires her to improve her artwork. Although on the EIDS Gloria wrote that she did not want to be an engineer, in her interview she said that she would consider engineering because she is good at fixing things. Fixing things seems to be part of Gloria’s conception of engineering; on her DAET, Gloria drew a female-appearing engineer “fixing the wires on a building being made.” Gloria said the engineering ambassadors are like her because they are people who suggest ways to fix problems and help people. Gloria stated that engineering design challenges are one of the most interesting things she does in school.

Theo is keeping the door open to engineering. Theo demonstrated knowledge of the nature of engineering in his DAET and EIDS, drawing a biological engineer making prosthetic limbs and identifying engineering career elements. Although Theo responded “not sure” to the EIDS prompt asking if he wanted to be an engineer, in his interview, Theo said he wanted to be a biological engineer if his athletic ambitions didn’t come to fruition. Theo specifically mentioned the engineering ambassadors as role models, saying, “They were role models to me...I respected them. They always knew how to help me. They always knew what materials we needed.” He added that he looks up to people who demonstrate and advocate for kindness toward other people. Theo also said that he considered himself similar to the engineering ambassadors because he and the ambassadors had engineering knowledge. Theo’s interview responses suggest that Theo sees the engineering ambassadors as appealing, as emulable, and as representatives of engineering, making it possible for Theo to see them as engineering role models.

These three sample interviews exemplify our finding that in general, students in this class considered engineering as a possible career more positively than suggested by survey data. Interview responses also provided insights into students’ motivations for choosing engineering as a possible career. Overall, we conducted 10 student interviews and identified three general themes in the student interviews related to role model selection and career aspirations: family influence on career goals, personal interest in specific careers, and impressions of the engineering ambassadors. Below, we unpack each of these themes and their relevance to role model selection and interest in engineering as a career.

Family Influence

Several students (6) named a family member as a role model and / or indicated that they intended to follow a relative’s career path or career advice (4). This finding is consistent with studies of adolescent role model development and career interest which suggest that youth often identify

family members as role models and often show interest in pursuing careers similar to the careers of family members [16], [17]. Our findings complement this work and suggest that youth as young as ten years have already begun selecting role models and possible career paths.

Personal Interest

All youth we interviewed readily named one or more careers they aspired towards or would consider, including engineer, athlete, chef, doctor, fashion designer, performing artist, and teacher. The interview responses complemented, but did not completely align with responses on the EIDS surveys. For example, although no students responded “Yes” to the EIDS prompt “When I grow up I want to be an engineer,” in interviews, when asked what kind of job they’d like to have as adults, one student’s second stated career choice was biological engineer, one student’s first stated career choice was game designer (which could be considered computer science and therefore an engineering career), and a third student’s first stated career choice was inventor (which is arguably an engineering selection). When directly asked if they’d like to be an engineer, two additional students said they might want to be engineers. The interviews provided greater opportunity to probe and understand the nuances of students’ career intentions. In interviews, students gave detailed reasons for why they were or were not considering engineering careers. Students spoke about their personal interests, their academic strengths and learning styles, and the kind of work environment they preferred. Overall, interview results suggest that students’ personal interests and families factor into their stated career interests.

Impressions of Engineering Ambassadors

When asked what it was like to work with the engineering ambassadors, students described the ambassadors as “nice.” Students’ explanation and elaboration of this assessment fit into three themes: ambassadors valued and affirmed the students’ design ideas, ambassadors helped students expand on their own design ideas, and ambassadors treated the students kindly or respectfully. Additionally, students described the ambassadors as knowledgeable and enthusiastic about teaching and doing engineering..

Classroom Dynamics

In addition to the individual quantitative and qualitative student data, the project has collected video data from classrooms about the interactions between the engineering ambassadors and the elementary students. Our a priori lens uses role model theory to look for evidence of where interactions between ambassadors and elementary students might support the positioning of the role model as an appealing, emulable, attainable adult. In addition, drawing from our interviews we sought to understand how the students’ perceptions of the engineering ambassadors as “nice”, “enthusiastic,” and “knowledgeable” played out. Below, we present example interactions between elementary students and engineering ambassadors which we believe represent moments in which elementary students could have been evaluating the engineering ambassadors as “nice”, “enthusiastic,” or “knowledgeable,” and therefore as appealing potential role models.

Ellie, one of the two undergraduate engineering ambassadors in this classroom, frequently affirmed student ideas by recognizing specific engineering practices. For example, here Ellie acknowledged a student group’s collaborative idea generation: “Cool! Did you guys come up with that idea together? That's awesome!” Additionally, Ellie attended to student ideas in ways that conveyed enthusiasm for their ideas and for engineering. For example, on the final day of a

multi-week design challenge, Ellie asked a group: “So, this is the elevator that you guys just added here? Can you show me how it works?” After the pair demonstrated and explained their design for close to a minute, Ellie said, “Awesome! Think about what you want to say when you present [your design to the whole class]....It looks great.”

In the following exchange, Clark, the second undergraduate engineering ambassador in this classroom, affirmed a student group’s design idea. He implied that the students were doing good engineering work by saying, “I like the dome idea...it’s actually very structurally sound.” He further endorsed their work through asserting his identity as an engineer, adding, “It’s the engineer side of me.” Clark later encouraged this group to add to their design, which affirmed the students’ ideas and supported the students to build on their own ideas.

Clark: “Whatcha guys building?”

Student: “I’m making a palace.”

Clark: “Solid! I like it! I like the dome idea...it’s actually very structurally sound. It’s the engineer side of me. Are you thinking you can maybe add anything to the...design?”

Student: “We’re gonna add a fence around the barn...”

Clark: “That’s a good idea! ...Think about what you want to do for the fence.”

Engineering Ambassadors as Representatives of Engineering

In interviews, students referred to the undergraduate ambassadors as both knowledgeable and enthusiastic about engineering. We believe students picked up on moments when ambassadors shared their identities as engineers, at times in ways that highlighted ambassadors’ knowledge of engineering and at times in ways that highlighted their enthusiasm for engineering. For example, a student pair asked for help fastening part of their design, and Clark helped them secure it with minimal tape. In this moment, Clark called out his identity and values as an environmental engineer, saying, “Sometimes it’s more wasteful to go all the way [across with the tape], so sometimes you can just break [the tape] up, like that....I like [your] use of water bottle recycling. I’m an environmental engineering student, so I like saving the environment and recycling.”

Discussion and Next Steps

In this class, students had ample knowledge of engineering careers and the nature of engineering. However, for these students, knowledge of engineering was not enough to ensure interest in pursuing engineering as a career. Student interviews suggest two competing factors for students’ career interests: their interests in other careers and their affinity for their parents and their parents’ careers. This data supports career interest studies which suggest that, in order to select a career, youth need not only knowledge of that career, but also a role model in that career [11]. Many students in this class expressed positive impressions of the engineering ambassadors, and some named the engineering ambassadors as role models for them. Ellie and Clark provided students in this class with many opportunities to perceive them as “nice”, “enthusiastic,” and “knowledgeable” representatives of engineering. We are redesigning the STOMP outreach program to amplify the engineering and personal identities of the engineering ambassadors and to strengthen personal connections between the students and the engineering ambassadors. We anticipate that these changes will help elementary students perceive the engineering ambassadors as appealing, relatable, emulable representatives of engineering and encourage participating youth to consider engineering careers.

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