New Orleans JAZZED about Engineering Education

Paper ID #15745

From Undergraduates to Ambassadors: The Impact of Engineering Ambassador Network Training

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Abstract

The Engineering Ambassadors Network Training is a two-and-a-half day intensive professional development event for students who have been accepted into an Engineering Ambassador program. The workshop format was originally conceived as a vehicle for training new ambassadors to deliver messages about the immense potential of engineering. Training focuses on creating outreach presentations that achieve maximum impact through advanced communication techniques. Post-workshop surveys reveal high levels of perceived confidence and readiness. However, deeper insights into the impact of the training have arisen from post-workshop interviews, in which participants report that the experience is transformative and that the Engineering Ambassador mission has much meaning for them personally and professionally. Articulating the nature and implications of such impacts is the focus of this paper.

The study described in this paper uses the Dynamic Systems Model of Role Identity (DSMRI) to analyze interviews with six purposefully diverse participants. The research was guided by three questions: How do components of individuals' role identities combine to inform the motivation to become an Engineering Ambassador? How does the training crystallize students' self-perceptions of themselves as professionals and ambassadors for the field of engineering? Which features of the workshop emerge as the most powerful experiences for triggering the formulation of an Engineering Ambassador role identity?

Analyses reveal students' substantial personal investment in their role as an engineering student and an emerging ambassador. The decision to participate is often driven by personal interests and experiences, and is tied to a deep sense of importance for the work. Similarly, choice of presentation topic is also often personal. Presentation skills reveal new courses of future action; ambassadors describe increases in confidence and many report using the skills immediately. Opportunities to meet other ambassadors are singled out as a major benefit, and students use newly acquired programmatic knowledge to shape the role expectations at their institution. Although not necessarily generalizable to each participating ambassador, the findings of this study reveal how Engineering Ambassadors Network training leverages the emerging professional role identities of engineering students. It offers insights into training program features that increase new participants' commitments to the mission of the organization and the field of engineering as a whole.

Introduction

To meet the challenges of a society that faces increasing global competition and a shortage of qualified individuals, today's engineers and educators must recruit and retain capable tomorrow's professionals and must equip them with excellent technical, communication, and leadership skills. However, many middle and high school students fail to develop the knowledge or else relinquish the passion needed to follow a STEM career path that involves engineering. Part of the problem is the public's misunderstanding and lack of interest in the work of engineers. Nearly a decade ago, the document *Changing the Conversation* [1] synthesized the "image" problem faced by the field of engineering, and designed a series of solution "messages" that were found to be effective in piquing the interest of diverse groups of middle and high school students. One of the calls to action in the document was for engineering outreach groups to meet with K-12 students and to frame their visits using the *Changing the Conversation* messages. Today, a critical part of the mission of many STEM outreach organizations is to teach students about the ways in which engineers contribute to society, solve problems, and work with others. Such programs have been shown to improve middle and high school students' knowledge of and attitudes towards engineering [2].

One such organization is the Engineering Ambassadors Network. A collaboration among more than 30 universities, the network is united by three goals. These are: to train undergraduate engineering students to effectively communicate their knowledge and passion for engineering topics and the possibilities that engineering brings; to diversify those ambassadors in order to provide role models for future generations of engineering students; and to provide outreach to middle and high schools so that students can learn more about engineering, and can experience *Changing the Conversation* messages infused into presentations about engineering and science topics.

Currently, there are nearly 500 engineering ambassadors enrolled in participating universities across the United States. A little more than half of them are women and one-third are of a minority ethnicity. The Network trains these students through a 2.5 day workshop. Pairs of students use their time to prepare their first formal engineering ambassador outreach presentation, which must be between 10 and 15 minutes in length and which can segue into a demonstration or hands-on activity. Workshop sessions include instruction in strategies for creating and delivering an effective presentation, multiple opportunities to practice and receive feedback that can informs subsequent versions of the presentation, and at larger workshops, opportunities to network with students from other universities.

This study represents an analysis of post-workshop interviews from a small sub-sample (n=6) of the 170 participants who participated in the 2015 annual northeast regional workshop. We were particularly interested in the impact that the training might have on students' emerging identities as engineering ambassadors. Identity formation is associated with the exploration and commitment to particular goals, values and courses of action. Thus, we sought to understand students' initial identities as undergraduate students, their experiences of the workshop in the role of participant, and their goals and commitments as ambassadors. Our findings are not intended to be representative of all participants, but are intended to offer insights into the

interplay among students' existing identities as students and future engineers, and their newly forming identities as leaders and ambassadors for the field of engineering.

Literature Review. The Engineering Ambassadors Network is a professional development organization with an outreach mission [3]. Although designed to provide services to the university and surrounding school districts, Network aims include the development of communication and leadership skills among its members. In addition to these skills, it may be that membership of the organization promotes students' professional identity development. According to Ibarra [4] professional identity includes a "relatively stable and enduring constellation of attributes, believes, values, motives and experiences" that students can use to "define themselves in a professional role" (p.2). Early phase professional identity development can influence the course of individuals' remaining careers [5] and some have called for professional identity development to be explicitly included in higher education curricula [6].

The degree to which an ambassador program can offer opportunities for professional identity development remains an underexplored question. Research on the impact of ambassador programs has tended to focus on changes in the perceptions and attitudes possessed by members of the outreach audience [2]. However, there is some evidence to suggest that ambassador membership does benefit the undergraduate students and their burgeoning sense of themselves as professionals, which involves a commitment to serving "the public with specialized knowledge and skills through commitment to the field's public purposes and ethical standards" [7]. For example, Anagnos and colleagues [8] surveyed students in two such programs and found reported benefits including exploration of career goals, a sense of belonging to the engineering community, and a perception that they were making a difference in the lives of others.

In engineering, it may be argued that individuals from minority groups (women, individuals of color) benefit especially from professional development opportunities that promote a sense of community and reveal the pro-social side to a profession [9-10]. Moreover, because adopting a professional identity requires assimilation of ways of acting, behaving and self-identifying according to a particular community or group of individuals [11], women and minority ambassadors may also benefit from experiences that strengthen their perceived integration into the field of engineering. Accordingly, they might crystallize strong and clearly identifiable professional goals, self-perceptions of competence and interest in engineering, and planned courses of action that will promote continued involvement in engineering. One study of women engineers 15 years post-graduation suggests that the degree to which women engineers can integrate and align their professional with other role identities explains differences between those who stay versus those who leave the profession [12]. Since activities that promote a sense of affiliation with the area of study and possible career options after graduation [9], it seems that professional identity development might play a role in both short and long term persistence in engineering, particularly for under-represented groups.

Theoretical Framework. The theoretical framework for the study is a socio-cultural and narrative approach to the study of identity. Specifically, we used the Dynamic Systems Model of Role Identity (DSMRI) [13] as a guide to understanding the complexity of the social roles that engineering students experience and hold during their training to become ambassadors. The theory assigned **role** as the primary unit of analysis. Role is a label that represents a formal (e.g.

engineer, advisor, teacher, student) or informal (learner, colleague, friend) social role. The role provides a meaningful organizing theme within the individual's narrative statements about their experiences. The DSMRI includes four identity components as the core of the role identity. One component is **self-perceptions** – aspects of the self within a particular role including self-described characteristics, abilities, preferences, interests, and knowledge. A second component is **purpose and goals –** expressions of a person's purpose for action in the role and the goals that might relate to that purpose. A third component is **beliefs –** knowledge and conceptions that are stated as being true about the world or about a domain, such as engineering. The fourth component is **action possibilities** – plans, intentions, strategies, and behaviors that the individual feels are possible or impossible in the role. These four components emerge continuously through social interactions in different contexts, and interact in a dynamic fashion among themselves, and with analogous components that belong to other important roles of the person.

The four components interact dynamically to form the basis for motivated decision making and action in the role. For example, a student might have a particular set of beliefs about the field of engineering such as it is misperceived by the public, or beliefs about others, such as the capacity of women and girls to participate and contribute to engineering fields. These **beliefs** might align with the student's personal and professional **goals** of becoming a professional engineer who can reach out to others about the nature of the field and the importance of broadening participation. The student might possess a **self-perception** as a champion of both pro-social applications of engineering activities and as someone who has overcome the odds to become a female engineering student. Her **action possibilities** might include joining the engineering ambassadors program in order to conduct outreach visits to middle and high schools to share her knowledge and passion for engineering.

Taking action as an ambassador might in turn impact her **beliefs** about how and why individuals decide to stay or leave the STEM pipeline in school. Actions might also impact her **self-perceptions** about her capacity to influence and lead others, thus strengthening her professional **goals** of achieving a leadership and mentorship position in engineering career. This might lead to further **action possibilities** of becoming a senior ambassador, and perhaps looking into engineering management as a future career goal. In this hypothetical case, all of these role identity components are in alignment. Moreover, different other roles, such as that of undergraduate student (and the imagined role of future engineer) are integrated with the role of the ambassador. Unlike a case when these roles are in tension with one another, in this hypothetical case they support one another and contribute to motivated decision making in all these domains.

Becoming and remaining an engineering ambassador may require effortful participation in time-consuming extra-curricular activities and motivation in the face of potential tensions among roles such as ambassador, student, friend, teammate, and part-time worker. The engineering ambassador role is most likely to persist, the model predicts, if alignment exists within a role identity and if integration exists across role identities. We therefore sought clues to the origin of students' motivation to participate in the program as well as clues as to how and why they might seek to integrate their new role as ambassador with existing ones by studying the four identity components within the presence of multiple roles: undergraduate engineering student, workshop participant, and engineering ambassador.

The Present Study. We characterize the training event as an instance of transition from undergraduate to engineering ambassador. To understand this transition, we seek to understand how the students negotiate their identities through their shifting roles from pre- to post-workshop experiences [14]. Our study is a multiple case study of experiences recalled from a naturalistic setting (the workshop). Case study, a frequently employed qualitative research technique, permits the study of a phenomenon within a context over which the researcher has little control, and when the phenomenon is studied within a real life rather than a laboratory setting [15]. The case study approach is particularly useful for program evaluation, which was the underlying context for data collection from the workshop events.

We approached the analysis of individual cases using directed content analysis [16] and model-derived deductive coding [17]. We used an inductive approach to generate themes and categories of activity in order to answer research questions about the areas of the workshop that were particularly meaningful for participants.

Our overall goal was to deepen our understanding about the impact of the engineering ambassador workshop on its undergraduate engineering student participants. Our research questions were threefold:

(1) How do components of individuals' role identities align to inform the motivation to become an engineering ambassador?

(2) How does the training crystallize students' role identities as professionals and ambassadors for the field of engineering?

(3) Which features of the workshop emerge as the most powerful experiences for triggering the formulation of an engineering ambassador role identity?

Method

Participants. A diverse sub-set of participants was selected, reflecting differences in gender (n=3 male, n=3 female); ethnicity (Hispanic/Latino = 1, African American = 1, Caucasian = 4) school type (large northeastern state universities = 3, mid-size eastern state university = 2, small, northeastern, faith based college = 1); engineering major (electrical engineering = 1, bio engineering = 1, environmental engineering = 1, general engineering = 2, material science engineering = 1); and maturity of EA program (existing program = 3, new program = 3). All but one participant was new to the Engineering Ambassadors program. The one participant who was beginning his second semester of participation was attending the workshop for the first time. Participants were of traditional college age for their semester standing.

Table 1. Participant Summary

Pseudonym	Demographic features
Alex	Male, Sophomore, Engineering with a minor in Robotics, Caucasian
Fisher	Male, Sophomore, Material Science Engineering, Hispanic
James	Male, Sophomore, Electrical Engineering, Caucasian
Carla	Female, Senior, Environmental Engineering, Caucasian
Hope	Female, Freshman, Bioengineering, African American
Martha	Female, Sophomore, Engineering, Caucasian

Procedure. After providing informed consent, participants were interviewed over the phone by the first author at a time within two weeks of the workshop. The call was audio-recorded and transcribed. The interview protocol was semi-structured. It included a series of open-ended questions with follow-up questions permitted for clarification purposes. The interview included the following questions:

1. How was it that you decided to become an engineering major?
    a. What was it about X that interested you?
    b. What do you see yourself doing in the future?
2. How did you choose X university/X program?
3. How did you become involved with the engineering ambassadors?
4. How did you prepare for the workshop?
5. Please tell me about your experiences of the workshop, from beginning to end.
    a. Prompts were provided if necessary, e.g. "What happened on Saturday?" and "Tell me more about your presentation topic."
6. What were some of the biggest highlights for you of the weekend?
7. What were some of the biggest challenges or dilemmas that you faced?
8. Moving forward into the school year, how do you see yourself in the role of engineering ambassador?
9. Do you have any feedback for the engineering ambassador leadership team?
    a. Is there any way that the workshop could be improved?
10. Do you have any questions for me?

Coding. The coding scheme for model-guided (deductive) coding was developed by the first two authors and represented an adaptation from an existing codebook utilized elsewhere [18]. Thorough reading of the six transcripts was used to establish and finalize the codebook. The coding scheme uses **role** as the unit of analysis – the label of a formal or informal social role that provides a meaningful organizational theme in the narrative and for which there are data for some if not all components of the DSMRI. Role identities were established by reading through each transcript several times and identifying the roles that were present in the narrative. In all six cases, the following roles emerged (1) Undergraduate Engineering Student (which included future professional or engineer) (2) Workshop Participant (3) Engineering Ambassador. The transcribed interviews were coded by the first author, with the second author acting as an auditor and reviewer. Within each role, statements were coded at the sentence level as representing components of a particular role identity (Table 2).

In addition to role identity coding at the component level, transcripts were examined for statements relating to the social context of the workshop. Statements were highlighted and excerpted from the transcript if they referred to interactions with students from the home school or other schools, interactions with mentors or facilitators, and observations of characteristics of other students or the programs that they represented.

Table 2. Codebook Excerpt

Component and Definition	Example
Self-perceptions: Statements that include reference to the self in relation to the role. This includes how the person defines him or herself in the role, what he or she thinks about herself in the role, and how he or she thinks about her own functioning in that role. These include self-perceived abilities, personal values and interests, personality attributes, and other self-characteristics.	**Self-perceptions in the role of student/future professional**: "When I went to high school they really didn't have a lot of math and science." (studying) "chemistry and engineering at the same time and I am absolutely loving it." **Self-perceptions in the role of participant**: "I wasn't real nervous…because we knew what we were talking about." "I felt a lot more confident in my presentation skills." **Self-perceptions in the role of ambassador**: "I like to give advice." "I really felt like there was a connection with other engineers from across the U.S."
Purpose and Goals: Statements that express the person's purpose for action in the role as well as goals that relate to that purpose. This category includes both general goals of the domain, personal goals, and specific objectives for particular contexts and situations.	**Purpose and Goals in the role of student/future professional:** "I want to work in nano industry" "I want to understand why they (precious metals) are so high priced" **Purpose and Goals in the role of participant:** "We wanted to do it (3D printing) so bad, that we didn't focus on anything else." **Purpose and Goals in the role of ambassador:** "really spark interest…even if it is not engineering at [university] if it is engineering in general, no matter where they go we want to give them an interest in engineering."

Table 2. (continued) Codebook Excerpt

Component and Definition	Example
Beliefs: Statements that indicate knowledge, beliefs, perceptions and conceptions regarding the role, those that concern knowledge and knowing and those that concern personal knowledge that the participant holds as true about the world.	**Beliefs about engineering (student/future professional):** "it's hard to read the description of engineering and understand it." "there are not many people who know what they (electrical engineers) do." **Beliefs about presenting (participant):** (eye contact while presenting) "really does make a difference in terms of presenting style." (for the presentation) "You have to choose something you like to do" **Beliefs about the EA program (ambassador):** "we are the engineering ambassadors so we're all community." "we all shared a common goal about wanting to help people in our professional careers"
Action Possibilities: Statements that indicate internal thoughts and external behaviors in relation to enacting the role. This includes practices and strategies that one is aware of as possibilities or impossibilities as well as practices that one has enacted.	**Action possibilities in the role of student/professional:** "this year we are designing a bike for a client that has cerebral palsy." "I might…go around from country to country or wherever doctors are needed and apply it and help people." **Action possibilities in the role of participant:** "you can use pictures and have a sentence or two" "how to make a border…how to critique someone" "I could definitely give a presentation (on the topic) because I learned a lot." **Action possibilities in the role of ambassador:** "we have plans throughout this month to go to schools…" "I am going to try to get some samples" (for hands-on activity)

Single Cases. After coding was complete for each role and identity component, a table was constructed for each individual participant. Columns of the table indicated roles and components of the role identity model formed the rows. Statements coded by role and component were then placed into the cells of the table to provide an organized matrix from which alignments and changes could be derived. The final row of the table contained a summary of the role and highlighted areas of alignment or tension between components. Thereafter, a synthesis statement was written. The statement mentioned all three roles and highlighted any indications of integration or tension among roles.

Cross-Case Analysis. The method used to conduct the cross-case analyses was driven by the research questions. It involved cross-case review of the individual participants' role by component matrices and, if needed, verification of the context or content of the statement by reference to the individual matrices and/or original transcripts.

In response to the first research question, "*How do components of individuals' role identities align to inform the motivation to become an engineering ambassador?*" themes and issues presented under the "problem statement" and "solution messages" sections of *Changing the Conversation* documents [1] were used as an organizing framework. This is because the messages are integral to the mission and the activities of the Engineering Ambassadors Network. Individuals' beliefs and goals across the three identified roles were then reviewed to establish (a) the degree to which some or all cases made statements congruent with either problems or solution messages and (b) to derive representative quotes that would illustrate the corpus of data from all of the participants.

To answer the second research question, "*How does the training crystallize students' role identities as professionals and ambassadors for the field of engineering?*" we examined the self-perceptions component of each role identity for each participant, and reviewed statements for evidence that students could imagine themselves in the role of professional, including professional communicator, and ambassador. We also looked for statements that might reveal continuity between roles, for example the role of undergraduate student with an interest in a particular engineering-related topic, and their role as a workshop participant creating a technical presentation about an engineering-related topic.

To answer the third research question, "*Which features of the workshop emerge as the most powerful experiences for triggering the formulation of an Engineering Ambassador role identity?*" we first reviewed each case for specific references to particular workshop activities, such as receiving instruction in presentation slide design or presenting in a critique session. Once a list of these had been created for each individual it became apparent that for all six of the cases, the same activities were mentioned but in slightly different ways. Thematically, these activities were then grouped into two types of activity: (1) developing and delivering a presentation, which included presentation instruction and critique/showcase opportunities to present, and (2) social aspects of the workshop, which included networking and mentoring from other ambassadors. As with the procedure used for the first research question, individuals were compared to one another to establish the degree to which theme saturation was present, and then illustrative statements were selected to highlight the diversity of ways in which individuals talked about the activities.

Findings

How do components of individuals' role identities align to inform the motivation to become an engineering ambassador? To become an engineering ambassador is to join an organization whose mission is to "change the conversation" about engineering in middle and high schools. This mission draws on the National Academy of Engineering's *Changing the Conversation (CTC)* initiative, which identified problems faced by the field of engineering and solution messages that promote a more correct and inclusive image about engineering. Problems include

engineering only being for those who love or who excel in math and science, public lack of knowledge or misunderstanding about what engineering is and what engineers do, and a lack of diversity from women and other represented groups. Solution messages to counter these problems include emphasizing that engineers impact people's lives in meaningful ways, that engineers help shape the future, that engineers solve problems and that engineers contribute to our health, happiness and safety (Changing The Conversation, 2008). The outreach presentations created and delivered by the Engineering Ambassadors are designed to provide middle and high school students with content knowledge about engineering and science as well as providing concrete illustrations of how engineers accomplish the activities in the solution messages.

We hypothesized that in their roles as engineering students and future engineers, participants' statements concerning their **beliefs** about the field of engineering and its representation to the public would echo both the problems and the solution messages. We found that three of the six participants in the present analysis talked about issues relating to the image and reputation of engineering. Each of them expressed beliefs that could be aligned with either the problems or the solution messages. For example, James, an electrical engineering student, stated "I feel like there is this understanding that just because engineering is hard or it is considered hard, that we lose a lot of people to it." Hope echoed this problem in saying "people when they think of engineering they think you're supposed to be a genius and it's all hard work and math." However, she also identified the problem that people "don't see how it is applied to help people." Helping people and contributing to the health, wellbeing and safety of society is a solution message. Carla connected the need for diversity, a solution message, to the engineering ambassadors program mission. She described the goal as

> Going out into schools and just helping other people to understand what engineering is, the different types of things to do as an engineer…just giving them a better understanding of what it is and why we need so many people, and diverse people, to be able to do this and just make the world a better place.

Using the main idea of the problems and the solution messages, we found that 5 out of 6 participants described **professional goals** that were aligned with *CTC* solution messages. Participants expressed a desire to make a difference in the world and to give back to their communities or help others. The one participant whose professional goals did not align directly with these messages did articulate goals within his role as an ambassador pertaining to remediating the problems and articulating the solution messages.

Hope stated that, given the skills and knowledge, she may "go around from country to country or wherever doctors are needed and apply it and help people…" Martha's professional goals included being able to "make a difference in either the environment or the public in general…to think my job would help someone..." Carla stated that she was "interested in water distribution or water quality…so something of that nature…I love to do mission trips." Alex's goals included being able to "use my skills…to help citizens in the community and give back."

In comparison to the prevalence of statements that are congruent with CTC messages concerning a positive societal impact for engineering, only one participant mentioned the

professional goal of seeking leadership opportunities or other opportunities for professional development as being a motivating factor in the decision to become an engineering ambassador. At this early stage of EA membership, participants did not perceive their own professional development as a primary source of motivation to participate.

How does the training crystallize students' role identities as professionals and ambassadors for the field of engineering? We examined statements made by participants that revealed their **self-perceptions** pertaining to the roles of engineering students, workshop participants, and engineering ambassadors. Self-perceptions include statements participants made about their knowledge, interests, and personality characteristics. With varying degrees of specificity, all of the participants were able to imagine themselves as a professional in the field of engineering upon completion of their undergraduate degree. For some, the area was defined but the exact work was vague. Fisher, for example, described an interest in precious metals and gems. He stated that he wanted to know "how we could use these materials to be cheaper and actually use them to produce something better overall." Other participants described very specific future roles. Hope articulated a desire to become a physician and to work in ways congruent with Doctors without Borders. James stated that he wants to "work in the nano industry…making components from the chemical perspective."

We found strong alignment between engineering students' self-declared prior knowledge and existing interests and their choice of presentation topic as workshop participants. Three of the six participants chose their presentation topic because it was strongly connected to prior areas of perceived expertise and interest, which were derived from their identities as engineering students and future engineers. Fisher chose 3D printing of musical instruments because he was a band member, James chose organic capacitors because he is working with a professor to conduct research in this area, and Carla chose bio sand filters because she had previous knowledge of them from a mission trip. Choices behind the presentation topic for two of the participants – Martha and Alex, whose presentation focused on 3D printing of inexpensive prosthetics – were grounded in beliefs about what high school students would be interested in (articulated by Martha) and the university's desire for presentations that map onto goals of community outreach and sustainability (articulated by Alex). Only one participant, Hope, entered the workshop with very little prior knowledge about the topic of her presentation. However, she was paired with James, who led the technical aspects of the process, and who helped her find a topic where she could make a contribution. The topic, it turned out, also leveraged her professional interest in helping others in under-developed countries.

Participants' **action possibilities** in the role of engineering ambassador revealed that plans for specific outreach activities had been made as a result of the workshop training. Examples of such plans are listed as action possibilities in the following table. Adjacent are excerpted statements that reveal the alignment between these and other components of their ambassador role identity.

Table 3. Action possibilities aligned with other components of the ambassador role identity

Participant	Action Possibility	Alignment with Ambassador Role Identity Components
Alex	"establish the EA network as a leadership opportunity" "I will probably be participating as a senior ambassador as a junior and senior." "will go out to the high schools in the area and give our presentations"	"our school wanted to do outreach in the community to make high school and middle school students really consider engineering as an option (G) because we really need to growth the profession in general (B)…if it is not engineering at [university name] if it is engineering in general, no matter where they go we want to give them an interest in engineering." (G)
Fisher	"an awesome opportunity to learn how to make a presentation, give a presentation and how to critique someone giving a presentation…"	"I run the tour program right now as a co-director, and some of the presentations, nit-picky things I didn't know about, and now I can actually do this (SP) and critique people and actually make them a better presenter and actually make presentations. (B)"
James	"try to get samples from advisor" (to develop the hands-on activity) "we are going to be trying to go into one or two schools in the next few weeks"	"I kind of agree with the whole message of the program (SP)" "I feel like going to schools, especially specific neighborhoods around here (that need) some redevelopment and I feel like there is probably plenty of smart kids and a job in engineering could probably help them out quite a bit or people might not have even thought about it and they probably could help make the next big thing (B)…more people need to know about it. I feel like it is important (B)."

Table 3 (continued). Action possibilities aligned with other components of the ambassador role identity.

Participant	Action Possibility	Alignment with one or more components of their Ambassador Role Identity
Carla	"a big takeaway…being involved as much as we can." "get out there and see what big schools are doing in their engineering program that we could be implementing at our school…" "we definitely do plan on using them" (the presentations)	"what can we do at our school to try to make this program grow.(G)" "going out to schools and just helping other people to understand what engineering is, the different types of things to do as an engineer…I think just giving them a better understanding of what it is and why we need so many people, and diverse people, to be able to do this and just make the world a better place."
Hope	"we have plans throughout this month to go to schools outside."	"if I got into this program and I create a presentation to go out and help talk about engineering that helps them (students) think that it (engineering) is an option (G), and they may like it, so why not"
Martha	"we want to present our topic to the freshmen and hopefully get them interested and recruit them to become a part of the network and hopefully next year I will be a senior ambassador and I will mentor all the new ambassadors. Hopefully by next semester we can actually go out to local high schools and middle schools and present our topics." "It is like all the new ways of presenting to them (high schoolers) and like what is appropriate and know what are the best ways to make presentations."	"It is not just about math and science but…having the passion to help others (B)." "I just really hope that it gets students excited (G). It's not like another boring presentation coming in. I want them to be having fun and have a good activity with me and just get them interested in the field of engineering (G)." "Our teacher actually wants us to show it to the President of Engineering and like get that started and we will probably present it to the freshmen class so they can hopefully sign up for the EA network and yeah I would love to show this to high schoolers and just get them interested in engineering and show them all the cool stuff about it."

Which features of the workshop emerge as the most powerful experiences for triggering the formulation of an Engineering Ambassador role identity? Asking participants to recount their experiences at the workshop "starting at the beginning" resulted in descriptions of the activities and their impact. All six participants commented on features of the workshop sessions in which they were given either direct instruction in presentation skills and techniques or, through critique sessions, feedback on their own presentations. However, one participant mentioned the direct instruction portions of the workshop but did not highlight the critique sessions. Table 4 presents quotes from each participant that reveal the impact of this aspect of the workshop on their role identities as presenters and as engineering ambassadors. Most commonly, impacts were evident for self-perceptions and/or action possibilities as presenters.

Table 4. The impact of presentation development work on participants' role identities as presenters and engineering ambassadors

Participant	Comment about Presentation Development	Primary RI Component(s)
Alex	"We sat through a presentation on public speaking…and how we organize a presentation that was great. I really loved that because that gave me a new perspective on formatting a presentation that can get the topic across to the audience without distracting or boring them."	AP, Presenter
	"I felt a lot more confident in my presentation skills to be honest. I feel accomplished…By the end of the workshop, having a presentation that was really geared towards high schoolers and can really get them interested in engineering. I was really proud to be a part of that."	SP, Presenter & Engineering Ambassador
Fisher	(before) "I didn't know what was the mapping slide. Assertions, I know how long it has to be, how to insert a video…"	AP, Presenter
	"awesome opportunity to learn how to make a presentation, how to give presentations, and how to critique someone…I actually used it yesterday"	AP, Engineering Ambassador
James	"I learned about my strengths and weaknesses as a presenter…I am very passionate but I also learned I have a tendency to get way into it…Being aware of my shortcomings I increased my confidence…because I know what to avoid and I know I can turn it around."	SP, Presenter

Table 4 (continued). The impact of presentation development work on participants' role identities as presenters and engineering ambassadors

Participant	Comment about Presentation Development	Primary RI Component(s)
Carla	"how to make this presentation as good as you could before you would take it out and actually present it to a group of students…I would say getting more comfortable presenting it…we kind of saw our presentations didn't measure up to the other ones and we were able to present it…just getting more confidence, we were able to go out and do this and do it well."	SP, Presenter & Engineering Ambassador
Hope	"I learned that you don't need a lot of words to make someone understand what you are saying." "You can use pictures and have a sentence or two…you also have to rehearse in your head…you have to choose something you like to do."	AP, Presenter
Martha	"they gave us a lot of time to work on it (the presentation) and I just felt really prepared and I thought the workshop really boosted my confidence in public speaking because I am not the type of person who loves public speaking but you know after the presentation on Sunday I felt really good about myself and how I presented."	SP, Presenter

Participants also routinely made comments about the social context of the workshop. Social context included comments about talking and networking with students from other schools, and interacting with the senior ambassadors. Four out of six participants spontaneously commented on their experiences talking and networking with students from other schools. For three of these students, their experiences impacted **action possibilities** in their role as either engineering ambassadors who develop and deliver presentations, or engineering student/future engineer. Carla commented that the senior ambassador she worked with

> was really helpful…she helped us to organize our thoughts…how we would actually organize this presentation into three different parts that we could give it to a school…helping us to make things better before we even presented it.

As a graduating senior but founding member of the EA program at her school, Carla was impacted by the workshop's social context because it revealed features of programs elsewhere. Talking with other students and observing features of their programs led to a goal of trying to improve her own program. She said,

> It was good to see and get out there, out of the small college and get more involved and see what especially big schools like [university name] are doing in their engineering program that we could be implementing at our school, just trying to learn as much as we can I guess from these schools…it was helpful to see what kinds of programs they have…even though we are a lot smaller,

> just trying to be more involved…just get our program better for other students that are still coming through.

For Alex, interactions with senior ambassadors related to his plans to seek a summer internship. He stated, "I also liked meeting the senior ambassadors because they had a lot of expertise…they actually had experience in a professional engineering internship. I am looking to apply for a few internships this upcoming summer and I liked to hear their experienced with the companies they interned for."

Two participants described gaining a sense of community and shared goals from interacting with students from other programs. Alex stated that he "loved meeting new people…loved seeing the other engineering programs around the country." When he sat with other students they "compared and contrasted our engineering programs" but while their programs differed,

> we didn't have much differences…when I talked with other students from different universities, we all shared a common goal about wanting to help people in our professional careers and gain skills to just make the world a better place.

Fisher stated that a highlight of the workshop was "getting to meet some of these people (other students)…we all have something in common…get people to learn about STEM projects and trying to become better presenters and better people in the STEM community, ourselves." However, the social context and the broader experience of the workshop seemed to have a deeper impact on his self-perceptions and his professional goals. In response to a question about what he would take away from the weekend, he described that he had gained new skills, saying

> I run the tour program right now as a co-director, and some of the presentations, nitpicky things I didn't know about, and now I can actually do this and critique people and make them a better presenter and actually make presentations.

However, when asked about his future role as an engineering ambassador at his school during the upcoming school year, he revealed how the workshop and his experiences afterwards had impacted his goals. He said,

> That's a complicated question. I really don't know…I joined the ambassadors because I was first interested in the program. I didn't know how big engineering ambassadors was and I got to meet the people actually inside the program and outside in the engineering ambassadors community…I guess this workshop helped me pinpoint what I want to do, it's kind of different from what I first wanted to do and I'm thinking of becoming a teacher…I like to give people advice and I guess I like to be there for a person and try to make them a better person, like lead them to success and if I

> can do that with teaching or as an engineer in general, in the industry, that's what I want to do.

Fisher pointed to an experience afterwards, revealing that he thinks of the engineering ambassadors as a community. He said,

> I was just talking to a couple of junior engineering ambassadors, they're new, freshmen, and I was talking to them about their personal life and how they see college and they see me now as a role model, as a mentor. It's funny how that all works out and through engineering ambassadors…some people come on tours later on…they ask us questions and just seeing their expressions, that they give off…in their e-mails it's like they want to learn more, it's like their actually want to become part of this community we have created.

Discussion

This small scale multiple case study examined the role identities of engineering students who participated in an event designed to orient them and train them to become Engineering Ambassadors. The study was guided by the theoretical framework of the Dynamic Systems Model of Role Identity [15]. We used the model to analyze participants' navigation and narrative re-telling of their experiences at the workshop event, and to understand their self-perceptions, goals, beliefs and action possibilities in relation to existing and newly emerging social roles. Post-workshop interviews with each of the six cases revealed the existence of role identity components in the roles of: engineering student who will one day become an engineering professional; workshop participant; and (emerging) engineering ambassador. Guided by within and cross-case analysis using these roles and their respective identity components, we tackled three research questions.

The first research question investigated how components of individuals' role identities aligned to inform the motivation to become an engineering ambassador. Becoming an ambassador entails a commitment to extra-curricular tasks that are aligned with solution messages included in *Changing the Conversation,* including conscious efforts to reach young audiences and under-represented groups in order to educate and excite them about the field of engineering. We found that five out of the six individuals articulated professional goals that were congruent with these messages, such as using their skills to benefit others, and working in a professional setting that would allow them to contribute to the health, wellbeing and safety of others. The solution messages are designed to overcome noted problems faced by the field of engineering, including misunderstandings about what engineers do and lack of interest in pursuing engineering as a career option. Three of the six participants spontaneously articulated these problems as being issues that engineers had to overcome, and one of them mentioned that he had repeatedly experienced misperceptions of his chosen field (electrical engineering). Finally, all six participants expressed either a desire or a commitment to pursuing an engineering-related career. Together, these three factors – their existing professional goals, their

beliefs about problems faced by engineers, and their emerging commitment to pursuing an engineering-related career, were all evident in the role of undergraduate student with an imagined future as an engineer. That is to say, their existing goals, beliefs and self-perceptions were congruent with the mission and activities of those fulfilling the role of engineering ambassador.

The second research question concerned the way in which the training contributed to students' role identities as professionals and ambassadors for the field of engineering. We found evidence of integration between the participants' role identities as undergraduate students and their role identities as ambassadors. Specifically, it was typical to find that students' content area expertise and interests as undergraduate engineering students (e.g. bio sand filters, 3D printing of musical instruments, organic capacitors) became the topic of their outreach presentations. Thus, students were leveraging their existing identities as undergraduate students to shape their work as engineering ambassadors.

Participants made statements about their planned activities in their new role as engineering ambassadors. Aligned with these plans were goals about what they and their peers could accomplish as ambassadors, and beliefs about the importance of the work of the ambassador. Thus, their action possibilities were in alignment with their goals and beliefs. However, most participants did not spontaneously describe qualities of themselves as ambassadors. It is not clear whether this was an artifact of the interview protocol or whether it was simply too early in their ambassadorial role for the students to articulate personal qualities that could be coded as self-perceptions as an ambassador.

One caveat to our finding that participants' ambassadorial self-perceptions were not significantly impacted by the training may be if we consider self-perceptions in the role of presenter. Participants spoke of their new skills and confidence in their abilities to present information. Conceivably this could be within the role of undergraduate student, ambassador, research assistant, intern, engineer, etc. All of the students made statements about how the training impacted their perceived ability, confidence and in some cases their self-awareness in relation to strengths and weaknesses they possessed. Positive impact on students' self-perceptions about presentation skills was evident when participants were asked to relay highlights or successes from the workshop.

Other features of the workshop were similarly described as being highly meaningful. Students' statements about these aspects were used to formulate responses to our third research question, which was to identify the features of the workshop that were the most powerful triggers in terms of formulating a role identity as an ambassador. Through an inductive analysis we identified that instruction on presentations and opportunities to present and receive feedback were correlated with the development of specific action possibilities in the role of presenter and the role of engineering ambassador. Similarly, students' action possibilities in relation to their home institution's program and their own future career were impacted by the opportunity to network with students from other institutions. The experience of learning how to create and deliver a presentation and how to critique others within a social context of shared goals about the purpose of the engineering ambassadors program seemed to spur two participants to form short

and long term goals about becoming a senior ambassador and becoming a mentor within the field of engineering respectively.

Limitations. Due to the small number of interviews that were included in the analysis, it is worth noting that the findings may have limited generalizability to other participants. In addition, we are aware that participants' statements represent self-report data and that statements were not triangulated with behavioral observations, nor were we able to conduct member checking [19] or interviews with others with whom the participants interacted. Finally, we caution the reader against the assumption that the statements necessarily predict future behavior. However, follow-up work will begin during 2016 to re-interview the individuals to establish any changes or developments in their role identity components and to find out more about their ability to follow up statements of intention regarding their involvement in the ambassador programs at their respective universities.

Conclusion

The Engineering Ambassadors Network established itself as an undergraduate engineering professional development organization with an outreach mission [3]. The findings from this small scale, multiple case study provide insights into the students' perceptions of the professional development provided during the initial workshop training. Students perceive that the training provides an opportunity to gain technical communication skills and the confidence to be able to fulfill the mission of the EA network, which is to deliver outreach presentations to middle and high school students. Students also perceive the workshop as an opportunity for networking with individuals from other universities. Structured and informal interactions increase students' sense of a community among engineering ambassadors and, for those with new programs, provide a vision for what an established program looks like. Third, the training seems to both leverage and impact the students' burgeoning professional identities as future engineers and as engineering ambassadors. Pre-existing self-perceptions and personal and professional goals become aligned with self-perceptions and goals as engineering ambassadors. Through new action possibilities the training offers students strategies for effectively communicating their knowledge and passion for particular topics.

Acknowledgements

We wish to thank the National Science Foundation for their support of this work. In particular, the on-site workshops, the online materials developed for the Engineering Ambassadors, and the assessment discussed were supported by Type II TUES Grant 1323230 from the National Science Foundation. Finally, participation in the NSF I-Corps curriculum and the online materials developed for the broader STEM audience were supported by the 2015 NSF I-Corps Project.

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