Developing a Role Identity as an Ambassador through Hands-On Activities

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Work in Progress: Developing and Inter-Relating the Role Identities of Engineering Ambassadors through Hands-On Outreach Activities

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Abstract

In response to the need for a diverse, highly skilled STEM workforce that can work collaboratively and communicate effectively, colleges of engineering have developed diversity-focused recruitment, retention, and outreach efforts. Many programs have also begun to emphasize technical communication skills. A national organization that integrates these priorities is the Engineering Ambassadors Network (EAN), which trains undergraduates to raise awareness of what engineers do and how they contribute to society. Typical ambassador activities include the delivery of a presentation and a hands-on activity to middle or high school students. Currently, there are an estimated 634 EAs in the United States. For many, the ambassador role begins during a large, multi-institution workshop. Post-event surveys reveal high levels of ability, confidence, and preparedness to create and deliver outreach presentations. Post-workshop interviews reveal that the training offers a platform for role identity development. The ambassador role aligns career-related motivations, resonance with messages contained in the National Academy of Engineering's *Changing the Conversation* report, beliefs about the mission of the EAN, and plans for fulfilling the Network's mission. After the initial training, students' role identities reflect an integration of their undergraduate engineering student role with the new role of ambassador, with the intermediary role of an effective presenter serving as a bridge. The workshop targets the need to improve students' communication proficiency, and focuses sparingly on the hands-on activity component of ambassadorship. Consequently, little is known about whether learning to create and facilitate a classroom activity impacts what ambassadorship means to students, and how these perceptions are integrated into existing ambassadorial or professional future role components of self-perceptions, goals, beliefs and action possibilities. The present study focused on two questions. 1. For students in an ambassador role during an outreach visit, what is the purpose of the hands-on activity? 2. How do ambassadors approach the development of a hands-on activity? The case study with embedded units arose from a five-day intensive training at a small, engineering-focused university. Training involved 30 students, and a purposefully diverse sample of 8 students was obtained. All students had recently completed the national-level workshop. Post-training interviews were conducted with 4 junior and 4 senior ambassadors and elicited a narrative about the student's experiences at both the national and local training events. Local training required students to develop both a presentation and a hands-on activity. Two researchers coded the interview transcripts. We present findings thematically to discern several outcomes: Hands-on activities are conceptualized as serving a clear instructional and motivational purpose for students; ambassadors understood that activities reinforce presentation concepts and inspire students to be interested in engineering; ambassadors engaged in iterative design processes while creating activities, and sought the assistance of a supportive facilitator when necessary. The hands-on activities are, for ambassadors, a key component of outreach visits and that the local training environment supports the development of these activities. Activities are generally aligned with ambassadors' interests and prior knowledge, as well as the presentations that they are also developing in the training context. Additional theoretical and practical implications are discussed.

Work in Progress: Developing and Inter-Relating the Role Identities of Engineering Ambassadors through Hands-On Outreach Activities

Introduction

In response to the need for a diverse and highly skilled STEM workforce, colleges of engineering have developed diversity-focused recruitment, retention, and outreach efforts that target middle-school and high-school students. Simultaneously, many programs have also begun to emphasize technical communication in their engineering curriculum in order to promote engineering students' client-orientation, collaborative abilities, and effective communication skills. The Engineering Ambassadors Network (EAN)[1] is a national organization that integrates these priorities. The EAN trains engineering undergraduates in effective presentation techniques that raise awareness among their audience about what engineers do and how they contribute to society. Typical EAN activities include the delivery of a presentation and a hands-on activity to middle or high school students. Currently, there are an estimated 634 Engineering Ambassadors (EAs) participating in on- and off-campus outreach visits through 20 colleges of engineering in the United States.

For many, the ambassador role begins during a large, multi-institution workshop. Post-event surveys at training workshops have indicated that participants report increased levels of ability, confidence, and preparedness to create and deliver outreach presentations. [2] Post-workshop interviews have also suggested that the training offers participants a platform for personal and professional role identity development. [2] Specifically, the ambassador role seems to align career-related motivations and pre-existing personal values with the action possibility of communicating messages contained in the National Academy of Engineering's *Changing the Conversation* report. [3] Identity development was also hinted at through the exploration of personal beliefs about and identification with the mission of the EAN, and individuals' plans for using the ambassador role to fulfill the Network's mission. [4] After the initial two-and-a-half-day training in outreach presentation development, undergraduate students' role identities seem to show an integration of an undergraduate engineering student role with a new role of ambassador, and an intermediary or bridging role of effective presenter.

More broadly, EAN training continues beyond the workshop to include learning to create and facilitate the delivery of a hands-on activity that demonstrates or simulates the work of engineers. Since our previous research has focused on the contribution of the presentation training to the professional identity development of EAs, the current study sought to examine the effects of learning to administer the hands-on activity on role identity development. Our central question was, What role does learning to design and administer an exciting engineering-related hands-on activity to middle- and high-school students play in EAs' professional identity development as engineers?

Literature Review: Students' Involvement in Outreach Programs

Engineering students' desire to be involved in outreach. A sense of purpose is a motivating factor that describes an individual's goal(s) for their actions [5]. Students may be

attracted to organizations that convey values aligned with their personal and professional goals [6-9]. For some students the messages that engineering outreach programs convey, such as the application of engineering to solving the world's problems [10], the need for diversity among engineers [11] and the fact that engineering involves problem solving, [12] are congruent with their own goals for a professional career in which they engage in work that ameliorates societal problems.

Prior research has shown that engineering students with goals that include social engagement are more likely to be diverse in cultural and racial background [13-14]. These students are also more likely to become involved in service activities at the university level. For example, a qualitative study of undergraduate members of the ambassadorial group Engineers Without Borders (EWB) revealed that members' professional goals tended to align engineering with social justice, humanitarian work, community development, and sustainability. [14] In another, survey-based study of 51 undergraduate engineering ambassadors, [15] researchers found that three quarters of respondents indicated that ambassador participation was commensurate with their goal of making a difference in their communities, whereas just 20 percent indicated ambassadorship as a means of doing well in their studies, and only 6 percent expressed interest in the program as a way to explore options for a future career in engineering. However, variance does suggest that specific motivations for participating in outreach activities should not be assumed.

Outreach participation as a form of professional development. If students become ambassadors, the structure and nature of the role may offer opportunities for honing technical communication and public speaking skills, learning to participate in or lead the activities of teams, receive mentoring from senior ambassadors, and even interact with industry sponsors and future employers. [16] A recently published retrospective interview study of the perceptions of 19 engineering students explored the benefits of outreach participation. [17] Students in the study attributed great meaning to interactions with other professionals and peers throughout the program. Interactions were interpreted as opportunities to observe others as role models and gatekeepers of professional actions, skills and behaviors. Students reported specific gains in their ability to connect engineering concepts with real world topics, and their confidence to communicate with non-expert audiences. They also reported gains in self-perceptions as engineers and purveyors of engineering content, personal value of an anticipated career in engineering, and satisfaction in raising others' interests in engineering careers.

Hands-on activities in engineering outreach. Many outreach programs are activity-oriented, and provide opportunities for middle and high school students to work collaboratively to solve problems, participate in design challenges, and increase their awareness of the types of activities that engineers engage in [13]. Research on the effectiveness of hands-on activities has tended to take a pedagogical perspective, or highlight instructional design and learning and attitudinal outcomes. Less attention has been paid to the role that designing these activities might play in the professional development of the undergraduate students who then facilitate them. It is plausible, however, that ambassadors must consider the instructional goals of the activities, along with any constraints or design parameters that the activity must conform with such as its appeal to a middle or high school audience. In this way, it may be that undergraduate students engage in a hybrid design process that integrates technical content with an acute need for audience awareness,

but in a different way than would be required during the development of a whole-group presentation.

Theoretical Framework: The Dynamic Systems Model of Role Identity

Theoretical framework. The theoretical framework used to interpret findings relating to the impact of developing hands-on activities is the Dynamic Systems Model of Role Identity (DSMRI) [18]. This model proposes role as the primary unit of analysis and offers theoretical and practical means of understanding motivated action. The DSMRI proposes that the social role of ambassador is one of many roles that an individual can possess, and that it is comprised of four distinct components: purpose and goals for action; self-perceptions in the role; epistemological and ontological beliefs and assumptions about the world and the domain in which the role exists; and action possibilities that may or may not be performed in that role. The formation of and interaction among these components occurs in a dynamic fashion such that one can promote or constrain the other(s) depending on the individual and the context. The four components are involved in originating motivated action by the person in that role within a particular sociocultural context.

Previously, research using the DSMRI has investigated the nature and development of role identity in samples of individuals in formal educational settings such as courses for graduate student teaching assistants (ref) and professional development institutes for teachers (ref). It has not investigated role identity formation for individuals who have sought extra-curricular professional activities. The previous studies have shown that professional training settings offer a context for existing role identities to inform the development of new ones, and that successful outcomes tend to emerge when individual show a willingness to integrate rather than isolate their existing with their new roles. They have also shown that even a relatively short intervention of days rather than weeks can be influential in role identity development (ref). Given this framework we felt that the DSMRI had the potential to offer insights into the ways in which undergraduate engineering students apply themselves to creating an ambassadorial role that requires the temporary suspension (but not removal) of their role as an undergraduate engineering student and an emphasis on two action possibilities—giving a talk and facilitating a hands-on activity. Whereas previous ambassador research using the DSMRI [2] has focused on the former action possibility, this study focuses on the latter. Of particular interest are potential connections between students' self-perceptions as beginning engineers or educators and the action possibility of the activity, and relations between their purpose and goals for designing the activity and the processes and outcomes that they report. A better understanding of how students' role identities incorporate the action possibility of the hands-on activity may yield insights into how to approach training and outreach planning.

The present study. The present study was conducted to facilitate a broader picture of the impact of the training that students receive as Engineering Ambassadors. Previous work [2] has examined the impact of the national Network training, which focuses on students' communication proficiency and the development of an outreach presentation that can be given in K-12 settings. However, local trainings and chapter meetings are the settings in which the ambassadors prepare hands-on activities to accompany the whole-group presentation. Surprisingly, relatively little is known about whether learning to create and facilitate a classroom

activity impacts what outreach and ambassadorship means to students, or how these perceptions are integrated into existing ambassadorial or professional future role components of self-perceptions, goals, beliefs and action possibilities. In the present study we asked two research questions that are germane to the first issue identified above[1]. Specific research questions for the present study were:

1. For students in an ambassador role during an outreach visit, what is the purpose of the hands-on activity?
2. How do ambassadors approach the development of a hands-on activity?

Methods

The context for this case study with embedded units [5] was a five-day intensive training at a small, northern university with a substantial engineering program. Training involved 30 students, and was led by a team of three facilitators. At the local training, students engaged in team building exercises, developed a presentation, and developed a hands-on activity that could be done with middle or high school students. All students had recently completed the national-level workshop, which focused solely on communication skills and did not require them to develop a hands-on activity.

From the larger group of ambassadors, the lead researcher selected a purposefully diverse (gender, ethnicity) sample of 8 students. Students were contacted via e-mail to request their participation in a post-training phone interview. Informed consent was obtained prior to conducting the interview. Interviews were conducted with 4 junior and 4 senior ambassadors. Three participants were male and five were female. Six ambassadors were Caucasian and two were Hispanic/Latino.

Interviews lasted 20-30 minutes in length and were conducted as part of an ongoing series of interactions between the researchers and the ambassadors. The protocol requested a narrative summary of the events that took place at the national and local workshops. Follow up questions then focused specifically on the ambassador's role at the local training workshop, the perceived purpose and role of the hands-on activity and the process by which the activity was developed. Ambassadors were also asked about particular highlights or challenges that they had faced during the workshop.

Interview recordings were transcribed by an independent transcriptionist. The first author took the lead role in coding the text with one additional author acting in the role of auditor, and another author acting as a subject matter expert who was knowledgeable about the nature of the training event. [17-19] Coding was conducted in an iterative manner. First, portions of the interview that related to the development of the hands-on activity were highlighted. Next, close reading and paraphrasing was used to begin to identify the main ideas in the ambassadors' responses. A third step then involved cross-case comparisons to establish themes and the presence of theme saturation. This involve two strategies: establishing the degree to which the thematic ideas presented in one, some or all cases, and second, establishing the degree to which

[1] Additional data collection is underway at this time to examine the ambassadors' perceptions about the activity development and delivery process in relation to their future professional roles.

the entirety of the individual's activity-related statements were captured by the coding scheme. For the purpose of this paper, findings are presented thematically in accordance with the research questions.

Findings

RQ1. For students in an ambassador role during an outreach visit, what is the purpose of a hands-on activity?

Theme 1. Activities serve a learning purpose. When asked about the purpose of the hands-on activity, all eight of the ambassadors we spoke with explicitly referenced a purpose of K-12 student participants' learning. Ambassadors commented that the activity "reinforces the scientific principles," and "makes it stick a little bit more." One ambassador commented that it can help students to "internalize the information," while others spoke about the role of the activity being to help students to "relate the things they just learned" to everyday life.

Sub-theme: Hands-on activities augment the presentation. Seven out of eight ambassadors also conveyed that the purpose of an outreach activity is to augment the presentation in a meaningful way. They indicated that the activity can relay, supplement, or showcase applications of the science and engineering concepts. One stated that the "purpose of the activity…is to reinforce whatever we taught in that outreach presentation." Another ambassador remarked that the activity can deepen students' appreciation for the scientific information in the presentation, calling to students' attention "'Hey, this is an actual thing, not just some information.'" A third ambassador commented that the hands-on portion of the visit is meaningful because "that hands on aspect really helps with the ideas." A fourth ambassador commented on how questions at the end of the activity would be tied to the presentation, such that students might "guess [the answers] based on the presentation they just saw."

Sub-theme: Activities reach the students in a different way. Four of the eight ambassadors we interviewed expressed that hands-on activities can reach students who otherwise may not understand or be engaged by the presentation. One said, "Some kids may learn it through the PowerPoint, but others really need to see it." Another ambassador commented that "for a lot of kids, they are not going to learn very well just being lectured at even…as good as our presentations are." Another ambassador implied that some students may learn the targeted concepts through the activity rather than through the presentation, saying "Not all kids know, but because they do the activity they have an understanding of it and [are] able to talk about it and share it."

Theme 2. Activities engage students in what it means to "be" an engineer. All eight of the ambassadors expressed a link between the professional activities of being an engineer and the hands-on activities, but they emphasized different aspects of this relationship. Many referred to problem solving, visualization, creativity, and the potential to engage in addressing real-world problems. One ambassador described how the best activities "really connect with students" so that they can see "how they can help develop technology to help other people and also help the world around them." Another ambassador provided an example of an activity about biomimicry and stated that it involved students engaging as engineers would by making "armor based off an

animal that they know." As engineers, the ambassador explained, students would be asked "what animal did you draw information from and why did you do that?"

Sub-theme: Hands-on work is part of being an engineer. Four of the ambassadors directly compared the outreach activities to the activities of a professional engineer, although they recognized that the activities were at a greatly simplified level. One commented that she felt the activities were helpful because the students "get to be imaginative and work together and pretend they are engineers for a little while." Another ambassador stated that a function of the activity is to "show that engineering, if you ask me, it is all about hands on. It is never really about just the concept [but about] about how to use it." A third ambassador commented on how the structure of the activity can parallel the feature of creativity within engineering, saying that the activity is "always a very open-ended creative activity because we don't want to give the students just set rules of follow this procedure. We want to leave it more open than that."

Sub-theme: Purposeful engagement and fun. Six of the eight ambassadors explicitly referred to the idea of the activity being fun, and linked this to learning or attitudinal outcomes. One ambassador remarked that if students were engaged, "curious and talking to us – that is the biggest success we can look for." Another acknowledged that while students may not "remember all the cool vocab and equations," the purpose of the activity was "to kind of excite them. It is one more tool that we have to get them interested in engineering." Two ambassadors explicitly linked the idea of fun with promoting students' recall of the content. One said that "associating the information along with a fun activity might have them associate the entire experience in a better light" and another said that "associating the presentation with something fun is also good." One ambassador linked this idea to the overall mission of the Engineering Ambassador organization. When talking about the activities, he relayed that they are relevant since "our mission is to make these kids as excited and interested in engineering and science as possible."

RQ2. How do ambassadors approach the development of a hands-on activity?

Theme 1. Which comes first, the presentation or the activity? The ambassadors we interviewed had just participated in a one-week intensive training at their institution, and a portion of the time had involved the development of a hands-on activity to be used in an outreach setting. Overall, ambassadors were very much aware of the link between the presentation and the hands-on activity. One remarked that the hands-on activities were "intended" to be paired with a presentation. We were curious to learn how students engaged in the process of developing the activity.

Sub-theme: Process. Although a back and forth process was reported, generally it seemed that the hands-on activity was developed in response to a presentation or at least to a topic. In addition, excitement and passion were mentioned by two ambassadors as the inspiration for the overall topic. When asked which comes first, the presentation or the activity, one ambassador said "I think it depends. I know a lot of people come up with ideas for presentations that they are super passionate about and then they can kind of figure out based on that, an activity that would go along well with that." This ambassador went on to say that although they developed the activity first, they brought their topic from a previous presentation that they had drafted at a previous ambassador training event. Similarly, another said, "It kind of goes one of

two ways. Either you find the topic you are extremely excited about and you come up with an activity to pair with that or you find an activity that you are really excited about and you develop a presentation towards that." Statements such as these reveal the salience of personal interest as a point of origin for the content of the ambassadors' outreach work.

Sub-theme: Consideration of pedagogical goals. In developing hands-on activities that would encourage middle and high school students to engage in an engineering design process, ambassadors themselves engaged in a design process that required a combination of considering scientific and engineering principles at a simple level and thinking about the audience that would be engaged in the activity. One ambassador described how "I came up with foam…we decided we would first do a demo of this toothpaste experiment where you mix paste, in warm water and hydrogen peroxide and then it makes this giant thing of foam that comes out of soda bottles. We thought that would be really cool to show the kids and they would really like it, but if we had all of them do it then that would be really, really messy. So for the experiments that they themselves would do, we would give them soap, water, vinegar and oil and see how mixing soap into each one of those medians would react. So in water it you get foamy suds, but in oil it just gets thicker. So we were going to illustrate why that happens between the hydrophobic molecules that absorb the soap and the water but don't absorb it in the oil and things like that…[it] worked really well and we just needed to find ways to have more design factors into the activity for the middle schoolers, so it wasn't just step by step."

The comments of another ambassador revealed how technical information was considered alongside the central problem or design challenge for the activity. He said, "the topic of my presentation was…what is paint and the components of it… there is actually some engineering to it that people do not realize, like if you are selecting certain additives that change some physical qualities/properties… for the bottom of ships or something." The perceived difficulty of the activity was also part of the process of designing the activity. For the paint activity, the ambassador team seemed to recognize the possibility that the activity was too challenging. The ambassador said "we realized that what we were thinking about was probably a lot to ask for and just a lot of stuff to do and maybe a little bit too much at times."

Sub-theme: Consideration of technical constraints. Whereas sometimes the activity choices seemed to be very open, one ambassador discussed the need to incorporate projects or technology that are peculiar to the institution. One ambassador explained that her group was "trying to expand on something that we had found but also tie it in with some of the projects that we do at [Institution] and some research in [Institution]. They were creating a small robot that moved around out of a toothbrush head. We also had them add stuff on to the toothbrush head and be able to try to complete tasks that they could. There is a robot that is developed I think at [Institution], called [identifier removed] and it is a disposal robot so we were going to transport ping pong balls out of a way from a certain distance."

Another ambassador discussed making changes to the activity in order to connect it more to the topic of the presentation. She said, "Ours changed a lot. We started out throwing balls. You know how what happens is that you fill water bottles and you create a pyramid and then you throw balls at it and depending on how full the water bottles is how depending on how filled the

water bottles are the center of mass changes… ended up being we made a catapult type thing because that ended up being more closely aligned with…our presentation."

Theme 2. Support from institution staff. Several students mentioned that working with the workshop facilitator was beneficial to the outcome of their activity development process. One said that the facilitator gave them general guidance by sending them to "a couple of websites that we could go on and find activities" and that the facilitator gave them practical feedback by telling them that "it should be a longer activity" that would be "more challenging." The role of the facilitator seemed to include helping the ambassadors become aware of the audience, for example by suggesting that they try "something that we had done personally in middle school or high school." However, other comments revealed that the facilitator was allowing ambassadors to engage in an open-ended process. One ambassador said that the facilitator "was really great about coming over and talking to us about potential things you could do when you were struggling and then [identifier removed] would go away and talk about it and then figure out what direction it should be." The facilitator "definitely waited for us to ask for help…[identifier removed] was letting us figure it out ourselves."

It was uncommon for students to describe the workshop as an event where the logistics of hands-on activities would be covered. More typical were comments about the workshop as an opportunity to develop the goal and format of the activity. However, one ambassador remarked that they learned something about how to facilitate the activity, saying that they covered "how [students] might react to a certain activity…let's say you give them all the material before the activity begins then they will probably get distracted…how you are going to progress through the activity in the given time period and how you are going to wrap it all up at the end." A senior ambassador relayed that junior ambassadors were supposed to develop the details of the activity, including "what supplies they would need for the activity" and practicing so that they "make sure they know exactly what they would do if they took this to a middle school."

Discussion

The majority of research on the topic of what makes for an effective engineering outreach program has focused on the impact on the K-12 students and not on the undergraduate engineering students who are often called upon to volunteer their time and knowledge. Previous work in this area [2] investigated the role of training to create persuasive and informative engineering related messages on ambassadors' beginning professional role identity, and found that students' personal and professional goals and interests were often very much aligned with the mission and content behind the Engineering Ambassadors Network. In addition, many felt an affiliation with under-represented groups of middle and high school students and relayed that an individual in their life had been influential in helping them pursue a degree in engineering.

The Engineering Ambassadors Network has become associated with high quality technical communication, often in the form of presentations that draw on messages contained in *Changing the Conversation.* However, interviews with the ambassadors in the present study revealed another facet of their role, which is to act as an instructional designer and facilitator of hands-on learning experiences for middle and high school students. The findings of this small scale study showed that all of the ambassadors we interviewed designed the hands-on activity

with clear pedagogical goals in mind. One goal is to provide an opportunity for students to deepen their learning of science and engineering concepts. Another goal is to experience activities that mimic those of an engineer. In both cases, ambassadors seem to be refining their capacity to convey technical content in ways that appeal to specific (non-technical) audiences, which is very much aligned with the overall goals of the ambassador program.

The activity design process demonstrated the potential for this aspect of ambassador training to further undergraduates' thinking as subject matter experts and communicators to non-technical audiences. Most of the ambassadors gave specific examples of how the content of their presentation was manifest in the hands-on activity. A less-expected outcome, however, was the finding that the design process itself seemed to parallel the engineering design activities that the K-12 students would be engaging in. Several ambassadors referred to the notion of design factors both for students and for themselves. Ambassadors had to prepare a task that would meet a set of pedagogical, developmental and logistical parameters. For some students, the activity also presented a challenge to their communication and teamwork skills. This last finding is similar to the outcomes of other studies that have examined the way in which undergraduates might benefit from participation in educational outreach programs [20].

Implications

Although this was a small-scale, descriptive qualitative study, it has theoretical and practical implications. From a theoretical perspective, a provisional, thematic analysis of the interview data suggests that the development of hands-on activities relates to the components of the ambassadorial role identity. For example, several ambassadors expressed personal interest in their activity and presentation topic area. This reinforces previous findings that ambassadors tend to choose to talk about topics of interest to them. Similarly, one ambassador recalled that it was challenging to generate a topic when parameters were pre-determined for them. This also supports previous findings that when ambassadors find it more challenging and less personally satisfying to generate a presentation on a pre-determined or unfamiliar topic. In addition, several ambassadors described the personal relevance or importance to them of conducting meaningful outreach to middle and high school students. This suggests that the activity is another vehicle for ambassadors to interact with K-12 students in ways that are aligned with pre-existing goals.

Other implications of the findings are that they revealed the centrality of the activity to a successful visit, from the ambassadors' perspective. This is an important finding that should not be overlooked during the initial stages of ambassador training, when the focus is also on technical communication skills and the formation of strong interpersonal affiliations among the undergraduate students. Outreach activities are tasks that the ambassadors find time-consuming and challenging, and more than half of the interviewees described instances where they sought or received assistance from the facilitator. Therefore, it seems important to recognize that ambassador professional development should include specific opportunities to work on hands-on activities and to receive support from more experienced ambassadors or outreach staff. In this particular case study, the results suggest that the small setting of the institution-specific training was a successful one because it offered a context in which ambassadors could work on both their presentation *and* their activity with the support of other ambassadors and a facilitator. A next step for this line of investigation may therefore be to study more deeply the ways in which

students come to think of themselves as educators, and exactly how they engage in problem solving in order to satisfy the overlapping parameters of both the presentation and the activity.

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