Stimulation of Scientific Interest and Higher Confidence through the Engineering Ambassador Programs Experience

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Abstract

The primary goal of the Engineering Ambassador Program (EAP) at the inception was to engage undergraduate engineering students in K-12 outreach activities for promoting careers in engineering. The ambassadors run hands-on earthquake and coastal engineering challenges at large-scale public outreach events and schools throughout the Washington DC area. This paper, however, focuses on the stimulation of both scientific and engineering interests as an attribute by which the ambassadors themselves significantly benefit from. As the ambassadors engage on carrying out the critical mission of serving the EAP, they also have to develop the necessary skills and competencies that further stimulate their interest and confidence in STEM education, especially during the early years of undergraduate education through the exposure to engineering challenges that show the real-world relevance of science and engineering. Also, by mentoring in outreach programs and platforms, ambassadors both exude and experience an inculcation of enthusiasm which is known to be a key element of fueling the interest in STEM education.

Keywords

K-12 outreach, Engineering Ambassador, confidence, engineering interests, STEM education.

Introduction

The main goal of the Engineering Ambassador Program (EAP) at Howard University is to engage undergraduate engineering students in K-12 outreach activities for promoting careers in engineering. The EAP runs hands-on earthquake and coastal engineering challenges at large- and small-scale public outreach events and schools throughout the Washington DC area. The EAP started in 2011 and was supported by NFS grants (CMMI-1150462 and CMMI-0927178). EAP provides a vibrant connection between the engineering students from Howard University with the K-12 community, the NSF personnel, and general public through outreach events.

T. Anagnos, et al.[1] performed a study to identify the impact of engineering ambassador programs on student development. This study included the EAP at Howard University and a relatively similar EAP at Oregon State University. This study highlighted the positive impact of participation in an EAP on students of both universities. The participation in these programs had a positive impact on student goals, attitudes, leadership skills, and self-efficacy. The data collected on previous studies (T. Anagnos, et al.[2]) also revealed that 89% of activity leaders and project coordinators at the EAP at Howard University, a historically black college and university (HBCU), have strongly agreed in obtaining confidence in their ability to succeed in engineering thought the EAP. In contrast, only 55% of activity leaders and project coordinators at Oregon State University, a predominately white institution, expressed increased confidence in their ability to succeed in engineering. Considering that the attrition rate of 65% for African-Americans in STEM

disciplines is significantly higher than that of all STEM students nationwide, i.e. 48%, the significance of the EAP in a HBCU setting on retention is highlighted.

This paper focuses on the stimulation of engineering interests as an attribute by which the ambassadors themselves significantly benefit from participating at EAP. As the ambassadors engage on carrying out the critical mission of serving the EAP, they also have to develop the necessary skills and competencies that further stimulate their interest and confidence in STEM education, especially during the early years of undergraduate education through the exposure to engineering challenges that show the real-world relevance of science and engineering. Also, by mentoring in outreach programs and platforms, ambassadors both exude and experience an inculcation of enthusiasm which is known to be a key element of fueling the interest in STEM education.

Overview of EAP at Howard University

The EAP at Howard University started in 2011 in collaboration with NEEScomm and NEES-Oregon State University (NEES, The George E. Brown, Jr. Network for Earthquake Engineering Simulation, an NSF program). When NEES-NSF expired in 2014, the EAP has been continually supported through the NSF Career Award (CMMI-1150462) of the lead author of this paper.

The EAP engages undergraduate engineering students in outreach to K-12 and general public in the promotion of careers in engineering. The program allows hands on experiences in the Washington DC area to educate children and families about tsunamis, earthquakes, costal and earthquake-structural engineering. The original objective of establishing this ambassador program was to lead an outreach activity at National Engineering Week family day in Washington DC, which usually hosts over 9,000 children. The program successfully expanded its original scope and the engineering ambassadors have participated in numerous large- and small-scale outreach events in the last six years. The current objectives of the EAP include (1) leading outreach activities at National Engineering Week family day in Washington DC., (b) coordinating and running; large- and small-scale educational and outreach engineering activities at K12 level in the DC area, (c) providing training to volunteers, involving government agencies personnel to run similar activities, and (d) coordination of new outreach activities including earthquake-structural engineering concepts.

EAP currently runs two main hands-on outreach activities; a mini wave flume structure challenge and a mini-shake table structure challenge. These two activities are composed of three stations: demonstration/introduction, building/construction, and testing. In the mini-wave flume structure challenge the ambassadors provide children and families a basic introduction to forces on a structure, engineering as socially relevant, and a quick problem solving activity. This activity utilizes a 16-foot long mini-wave flume. In this activity, the ambassadors inform children and families about tsunamis and their effects on structures and about the relevant role that engineers play in the preparedness for extreme events such as a tsunami. This activity provides children and families the opportunity to build a structure to try to keep safe a LEGO person and later to test the structure using the mini-wave flume. The ambassadors are in charge of logistics, transporting and setting up the flume and materials, interact with the activity's participants, introducing the general role of coastal engineers and how engineers design structures to protect people life. The ambassadors guide the participants during the different stations of the activity, building the

structure and later testing it in the flume. Similarly, the shake table challenge is an interactive activity informing youth participants and families about earthquakes, their impact on structures, and the role of earthquake engineers. This activity utilizes a small scale earthquake simulator for demonstration, and a hand-held shake table for testing. Fig.1 presents some pictures of the ambassador running the two outreach challenges.

Demonstration/Introduction, Building/Construction Testing

Fig.1 Ambassador running the two outreach challenges.

A faculty mentor from the Department of Civil and Environmental Engineering administers the EAP at Howard University. The faculty mentor provides general guidance, communicates with the NSF, manages resources, defines general objectives, and serves as an advisor. However, the ambassador program functions as a self-managed team with characteristics of a student organization under the lead of a student coordinator. The selection of ambassadors is based on dedication to the team and ability to commit necessary time. The ambassadors are students from the different engineering departments at Howard University; however, the majority of ambassadors are students from the Department of Civil and Environmental Engineering. The student coordinator responsibilities include planning and scheduling of activities. The ambassadors' responsibilities include: recruiting team members, organizing training sessions, and training new ambassadors, defining program purposes and helping to generate ideas, committing to decision making and being fully in charge of activity logistics and organization, identifying skills and responsibilities of ambassadors for each activity, and participating in assessments after events to identify potential improvements.

From the faculty perspective, this program provides the opportunity to: interact with the students outside of the classroom and in different environments, identify students' skills, use out-of-classroom activities to develop students' communication and teamwork skills, provide experience in public relations (meeting people, public speaking, representing the university, etc.), which enables ambassadors to feel more "connected" to their role in society as engineers, and identify potential students for undergraduate research activities.

Training is an essential component of the EAP. The training focuses on the preparation to run the two challenges and getting prepared for training sections of volunteers (non-students). The ambassadors attend several training sessions where they work on specifics about the activities and their roles as ambassadors. Fig. 2. Shows ambassadors during training sections. Prior to training sessions, the ambassadors must read specified background materials about tsunamis, earthquakes, and structural engineering. They also practice the introductory talks and how to answer potential questions. The ambassadors do "run-throughs" of the activity so they can anticipate issues they might encounter on the actual day of the activity. The more experienced ambassadors take leadership roles in the training sessions.

Fig. 2 Ambassadors during training sessions

Skills and attitudes changed on ambassadors

Data collected on survey developed by T. Anagnos, et al.[2] identified the positive impact of Engineering Ambassador Programs on student development. The participation in this program had a positive impact on student goals, attitudes, leadership skills, and self-efficacy. Fig. 3 presents the summary of the data collected on previous studies on the percentage of ambassadors at Howard University that strongly agree or agree that the participation on the EAP have changed their attitudes and skills.

Overall, participating in the EAP at Howard University had a positive impact on students' perception of their abilities and confidence. More than 80% of students indicating they feel they improved their (1) confidence of speaking in front of audience, (2) confidence in ability to succeed in engineering, (3) abilities to explain technical concepts to multiple audiences, and (4) confidence in ability to make positive change through your leadership. These results indicate that the participation on the EAP at Howard University affect the ambassadors view of themselves as successful engineers.

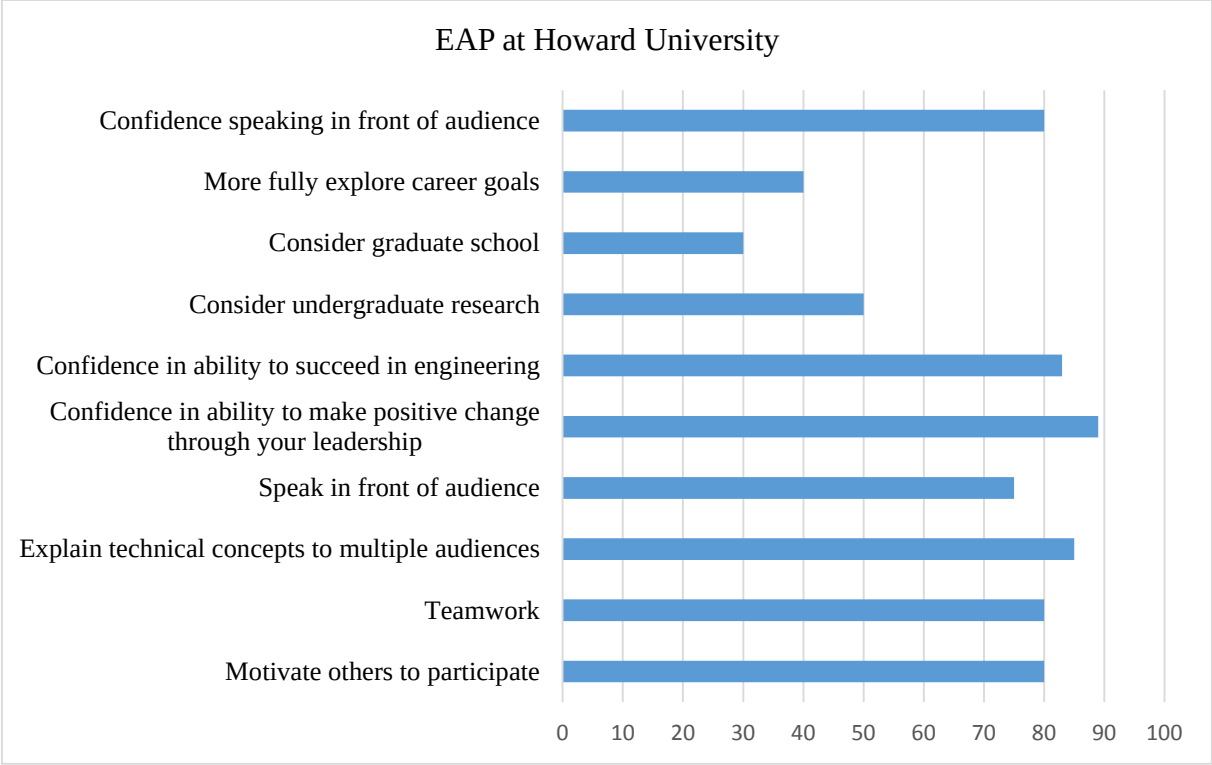

Fig. 3 Attributes that EAP participants were surveyed about versus the percentages of respondents that strongly agree or agree

Table 1 summarizes the demographics and evolution of the EAP participants per year. This data indicates linear growth per year in the ambassador's participation. During the sixth years of the EAP there is a total of 158 ambassadors' participants. 18 ambassadors are or were involved in undergraduate research projects as a direct result of their participation in the EAP. It is also noteworthy that all EAP participants in 2011 (12 out of 12) and 2012 (20 out of 20) have graduated with a Bachelor's degree. This graduation data corresponds to 100% graduation rate for the EAP participants which is a significant achievement. The graduation rate of the EAP participants for 2013 and the following years will be monitored for measuring the consistency.

Table 1 – EAP at Howard University

	2011	2012	2013	2014	2015	2016
Total number of participants	12	20	24	30	35	37
Black/African American	11	17	24	30	34	25
Latina/Latino/Hispanic American	0	2	0	0	1	2
Asian	1	1	0	0		0
Have earned BS and graduated	12	20	20	24	8	9
Participants in undergraduate research as a consequence of the ambassador program	3	2	6	3	1	3

On the impact of EAP on stimulation of engineering interest and confidence

The participation on the EAP can bring challenges to the ambassadors during the training of volunteers, when running activities, and when they are answering different questions of the participants of the activities. During these interactions, the ambassadors not only need to recall their background/knowledge, but also to talk with authority about new subjects "tsunamis, earthquakes, and structural engineering." The faculty advisor perceives the ambassadors' enthusiasm to get prepared to properly handle the different interactions and to be perceived as good role models to different audiences. Further, the ambassadors perceive themselves understanding that new subjects much better than their peers that are not part of EAP.

EAP provides exposure to the ambassadors to engineering challenges that show the real-world relevance of science and engineering; consequently, their involvement in EAP also remind them on the reasons why they decided for engineering and the important role of engineer is the society.

The following is the summary of collected ideas from a set of 13 interviews that were prepared by the ambassadors to gather data on the impact of EAP on stimulation of engineering interest and confidence.

- EAP has helped students solidify concepts they are learning in the classroom through a distinct form of community outreach. Throughout EAP, ambassadors must first learn the basic theories of coastal, seismic, and structural engineering, and how to effectively run an organized activity with the participants (children, parents/teachers, NSF volunteers, etc.).
- All of the civil engineering students interviewed perceived that the participation on the program has contributed to their academic success because it introduces a hands-on learning component that is missing from several civil engineering courses.
- Both, past and current volunteers have credited EAP for exposing them to advance technical engineering concepts, and more importantly, how to effectively communicate engineering knowledge.
- All the interviewed ambassadors perceived that their technical presentation skills with different audiences have improved because as an ambassador, they must find the way to explain effectively engineering concepts to a younger audience.
- The use of the mini-shake table has been cited to benefit students who were taking statics, structures or mechanics of materials while serving at EAP.

Overall, the interviewed students perceived that EAP has helped ease the pressure of learning in a classroom and has translated into academic success.

Discussion

As the survey indicated the perceived confidence in the ability to succeed in engineering among the EAP participants at Howard University was significantly increased. The participants from the Department of Civil and Environmental Engineering also affirmed that the introduction of hands-on learning components in during their EAP involvement contributed to their academic success. This is consistent with the findings in the literature that the "learning by doing" approach through hands-on experience projects is a key factor in better learning and improved academic performance [3]. The literature also underlines the positive impacts of hands-on educational and research

activities on higher graduation rate in STEM disciplines [4]. It is noteworthy that the positive effects of such activities have been reported to be strongest among minorities such as Affrication American students [5, 6]. Also, the results presented in this paper point to the fact that participants during the EAP activities in 2011 and 2012 have all successfully completed their bachelor's degree at Howard University. As such, the graduation rate of the participants in the EAP was 100%. Since the data on the number of years before graduation was not gathered, this graduation rate could not be compared with the typical 6 year or less data which is available for the Collee of Engineering and Architecture (CEA) and that of the Howard University. Also, the fact that the EAP participants were top academic performers might explain the 100% graduation rate. Nevertheless, the perfect graduation rate can be an indicator of the significant positive impact that the EAP participation plays on the academic success of the undergraduate students in engineering.

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