Board 57: Identifying and Disseminating Transformative Professional Development of STEM Undergraduates Who Perform Outreach: Progress in Year 1

Mr. Michael Alley, Pennsylvania State University, University Park

Michael Alley is an associate professor of teaching in the College of Engineering at Pennsylvania State University. He is the author of The Craft of Scientific Writing (Springer, 2018) and The Craft of Scientific Presentations (Springer-Verlag, 2013). He is also founder of the popular websites Writing Guidelines for Engineering and Science (www.craftofscientificwriting.com) and the Assertion-Evidence Approach (www.assertion-evidence.com).

Dr. Joanna K. Garner, Old Dominion University

Dr. Garner is a Research Associate Professor and the Executive Director of The Center for Educational Partnerships at Old Dominion University, VA.

Identifying and Disseminating Transformative Professional Development of STEM Undergraduates Who Perform Outreach: Progress in Year 1

Summary and Introduction

To teach STEM content to K-12 students and to recruit talented and diverse K-12 students into STEM, many outreach programs at universities in the United States rely on STEM undergraduates. While the design of such outreach typically focuses on the K-12 students who are taught or recruited, an important but often overlooked consideration is the effect of the outreach on the professional development of the STEM undergraduates themselves. Our NSF EAGER project is determining which outreach programs in the United States provided the most transformative professional development of the participating STEM undergraduates. This project then is capturing the essence what practices in those programs provided transformative professional development. Next, the project is disseminating these practices to a network of institutions doing outreach. Supporting this project is the NSF EArly-concept Grant for Exploratory Research (EAGER) program.

In this first year of the project, we performed a review of literature and university websites with follow-up survey data to identify outreach programs that may be transformative for STEM undergraduates. This review yielded a matrix of about 100 college-based outreach programs. We then invited these programs to attend one of the following workshops: a March workshop held at Tufts University in Boston or an April workshop held at the University of Nebraska in Lincoln. Nine institutions sent representatives to the Boston workshop, and five institutions sent representatives to the Lincoln workshop. In addition, we held conference calls to gather information from an additional six institutions. The purpose of the workshops and conference calls was two-fold: (1) determine best practices for outreach that used STEM undergraduates, and (2) determine what in those programs provided the most transformative development of the participating STEM undergraduates. This paper presents the main tasks accomplished in these workshops and conference calls.

Tasks Accomplished in Year 1

Two main tasks were associated with the first year of this grant. The first was a systematic review of the literature to determine which schools would contribute, and the second was a series of information-gathering sessions. The following two subsections discuss these tasks.

Systematic Review of Literature. In this first year, we first performed a systematic review of literature with follow-up survey data to identify outreach programs that may be transformative for STEM undergraduates. Our review targeted ASEE PEER and ERIC and used inclusion terms “ambassador” and “engineering” and “outreach.” This search process initially yielded many potential articles and conference papers for review. For example, ASEE PEER returned 3,416 possible matches. However, this number was quickly reduced to less than 15

papers once peer review criteria were added in the ERIC search, duplicates were removed, and the focus of the papers was honed to include the description of practices and program structures and the exclusion of descriptions of outreach activities or the impact on the K-12 students to whom ambassadors were presenting. In the end, our search of relevant literature databases yielded surprisingly few formal resources describing the impact of university-based outreach programs on undergraduate STEM students. Proceedings of the American Society for Engineering Education (ASEE) yielded a small number of resources pertaining to engineering outreach programs that seek to provide professional development for undergraduate students. ERIC yielded several papers comparing ambassador programs or investigating particular aspects of ambassadorship and its impact on students [1-6]. From this process we concluded that very few research studies have examined the structure and practices of ambassador outreach by undergraduate engineering students.

Our highest yield strategy was to use the ABET list of accredited engineering programs to identify schools in which such outreach programs may be housed. The schools' websites were located, and a search was conducted to identify any webpages that were associated with formal engineering outreach programs such as an ambassador program. Not saved were references to other programs such as Project Lead the Way, and references to lab-based outreach conducted by individual faculty members that did not fall under a college-wide program or initiative.

A matrix of approximately 100 ambassador or college-based outreach programs was created. Key indicators included the presence of intentional professional development for undergraduate students, the presence of measured outcomes of the program, and information about the selection of ambassadors. Programs varied along these and other indicators. The designated advisor or group leader was noted and subsequently contacted via e-mail with a view to providing information about the program. We were able to gather responses from 31 schools. These individuals were then contacted to invite them to share best practices, including more detailed information about their programs, at in-person and virtual meetings. Written information was requested from these representatives ahead of time, concerning the topics of the features of the program that provide a vehicle for undergraduate students' professional development, areas in which students manifest change, and methods used to measure the impact of the program on the undergraduate student ambassadors. A subset (approximately 20) programs was represented in this smaller data set.

Concurrent with these activities has been a review of literature regarding undergraduate students' motivation to participate in STEM ambassador-related activity, and the effect of doing so during the students' undergraduate career. This review has yielded less than two dozen published papers on this topic, and, along with a synthesis of the responses from the program leaders' survey mentioned above, has revealed the need for additional research in this area.

Workshops for Gathering Information. In this first year, we held two workshops—one in the east and one is the west—to gather information. The first workshop occurred in March 2018 in Boston to serve programs on the eastern half of the United States. Attending were representatives of the following programs:

a. Boston University (independent)
b. MIT (independent)

c. Old Dominion (independent, but joining the EAN)
d. Rensselaer Polytechnic Institute (EAN)
e. University of Connecticut (EAN)
f. University of Texas at Austin (independent, but affiliated with the EAN)
g. University of Wisconsin-Platteville (independent, but affiliated with the EAN)
h. Worcester Polytechnic Institute

The second workshop was held in April 2018 in Lincoln, Nebraska, to serve programs on the western half of the United States. Attending were representatives of the following programs:

a. Central Florida University (independent)
b. Pennsylvania State University (EAN)
c. Tennessee Tech University (EAN)
d. University of Nebraska (EAN)
e. University of Nevada Las Vegas (EAN)

In actuality, this workshop served additional schools from the eastern part of the United States.

Because of conflicts in schedules, a number of schools could not send representatives to either workshop. To accommodate these schools, we held conference calls in May 2018 to gather information. The following schools participated in the calls:

a. Cleveland State University (independent)
b. Michigan Tech University (EAN)
c. North Carolina State University (independent)
d. Oregon State University
e. University of Illinois (EAN)
f. University of Oslo (affiliated with the EAN)

Preliminary Results. The workshops and conference calls identified the following features by programs that used undergraduate engineers in the outreach:

1. *Enriching the outreach visit by leveraging research at the institution*: Boston University, Rensselaer Polytechnic University (RPI), University of Texas at Austin
2. *Incorporating large numbers of undergraduate ambassadors*: University Connecticut (UConn), NC State University, Penn State, Rensselaer Polytechnic University (RPI), University of Texas at Austin
3. *Vetting the technical content of the outreach*. Boston University, RPI, Worcester Polytechnic Institute (WPI).
4. *Using online activities to deepen outreach*: MIT
5. *Reaching significant numbers of K-12 students who are underrepresented in STEM*: Cleveland State University, MIT, NC State, Tufts University, University of Connecticut
6. *Being effective even when resources (or time) are thin*: University of Texas at Austin, University of Wisconsin-Platteville
7. *Formally training the undergraduate ambassadors*: Penn State, RPI, Tufts University, UConn, WPI

8. *Reaching large numbers in the outreach*: Boston University, Central Florida University, Cleveland State University, Engineering Ambassadors Network, MIT, ODU, University of Texas

Conclusion: Outlook for Year 2

In Year 2, our goals are to synthesize the data gathered in Year 1, assess the features shown in the preliminary results, and begin disseminating our results. To that end, we are submitting a Work-in-Progress paper to the 2019 ASEE Conference that summarizes the similarities and differences in the foci of college of engineering outreach programs [7]. This paper also discusses how such programs train their undergraduate ambassadors. Finally, this paper discusses how these programs assess the development of their undergraduate ambassadors.

As far as dissemination is concerned, a major goal will be to create a website that summarizes best practices in the training and development of undergraduate ambassadors. These best practices were gathered at the workshops that occurred during the first year of the grant. A second goal is to prepare a manuscript for publication that describes the systematic review of literature, synthesizes the feedback obtained through the best practices workshops, and lays out an agenda for further research on the topic.

Acknowledgments

We wish to thank the National Science Foundation EArly-concept Grant for Exploratory Research (EAGER) program for their support of this work. In particular, the onsite workshops and activities were supported by EAGER Grant 1752096 from the National Science Foundation.

References

1. J.K. Garner, C. Haas, M. Alley, and A. Kaplan, "The Emergence of Outreach Ambassador Role Identities in Undergraduate Engineering Students," *Journal of STEM Outreach,* vol. 1 no. 2, pp. 1-18, Dec. 2018. [Online]. Available: https://www.jstemoutreach.org/article/6515-the-emergence-of-outreach-ambassador-role-identities-in-undergraduate-engineering-students [Accessed: 30-Jan-2019].

2. T. Anagnos, A. Lyman-Hold, C. Marin-Artieda, and E. Momsen, "Impact of engineering ambassador programs on student development." *Journal of STEM Education: Innovations and Research 15* (3), 14-20. 2014.

3. C.R. Smaill, "The implementation and evaluation of a university-based outreach laboratory program in electrical engineering." *IEEE Transactions on Education 53* (1), 12-17, 2010.

4. L. Nadelson and J. Callaghan, "A comparison of two engineering outreach programs for adolescents," *Journal of STEM Education 12* (1), 43-54, 2011.

5. J.R. Amos and M-C. Brunet, Pre-post assessment in a speaking communications course and the importance of reflection in student development of speaking skills, *ASEE Conference and Exposition, June 25-28, Columbus, Ohio, 2017.*

6. M. Moseleh, and C. Marin-Artieda, "Impact of Engineering Ambassador Program on academic attainment of minority students in engineering." *ASEE Conference and Exposition, June 25-28, Columbus, Ohio, 2017.*

7. J. K. Garner, Melissa Kuhn, and Michael Alley, "Work in Progress: Common Practices in Undergraduate Engineering Outreach," *2019 ASEE Annual Conference and Exposition* (Tampa, FL: ASEE, June 2019).