Partnership for Equity: Engaging with Faculty to Cultivate Inclusive Professional Identities for Engineers and Computer Scientists

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Ronald R. DeLyser is currently an Associate Professor Emeritus in the Department of Electrical and Computer Engineering the University of Denver where he was on the faculty from 1986 - 2019. He has received all of his degrees in Electrical Engineering: the B.S. degree from the University of Florida, Gainesville, in 1974; the M.S. degree from the University of New Mexico, in 1978; and the Ph.D. degree from the University of Colorado, Boulder in 1991. Dr. DeLyser, a member of the U.S. Air Force between 1965 and 1986, held a teaching position at the United States Air Force Academy, served as a development engineer at the Air Force Weapons Laboratory at Kirtland AFB in New Mexico and was the Requirements Officer for the Nellis AFB Ranges in Nevada. Prior to 2000, his research areas included pedagogy, outcomes based assessment, the study of periodic gratings used as antennas and in antenna systems, high power microwave interactions with large complex cavities, anechoic chambers, and anechoic chamber absorbing materials. Since 2000, he has been concentrating on engineering education pedagogy, engineering program accreditation, and outcomes based assessment for both engineering programs and general education. His research continues in the area of inclusive excellence in engineering and computer science programs.

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Introduction

The Partnership for Equity (P4E) is a collaborative project funded through the NSF IUSE (Improving Undergraduate STEM Education) program. Project partners include four university campuses, each with unique combinations of engineering and computer science programs and local academic cultures. The P4E project is novel in that the ultimate goal of the project is to cultivate inclusive professional identities in *all* undergraduate engineering and computer science students. The project team defines inclusive professional identities in terms of four key features graduates of the programs should possess: (a) the necessary technical knowledge, skills, and abilities to work in their chosen field; (b) an appreciation for how all kinds of diversity strengthen engineering and computer science as disciplines; (c) knowledge of how to act in inclusive ways and create inclusive environments within their fields; and (d) preparation to consider the impact on a diverse array of people using or otherwise influenced by engineering and computer science endeavors. The project defines diversity in a broad sense including different life experiences, demographic characteristics, problem-solving approaches and personalities, while also placing some emphasis on the experience of populations historically underrepresented in engineering and computer science and those who have been traditionally under-served by engineering and/or computing products.

The project has a set of activities operating, with local variations, in most of the first-year engineering courses at partner campuses [1], [2], [3]. During this year of the grant, emphasis has been placed on maintaining and expanding activities implemented in sophomore, junior, and senior level courses as well as crafting activities for computer science courses. Two key issues that have arisen for project personnel are (1) meaningful engagement, motivation, and professional development of faculty and other instructors; and (2) differences between disciplines (particularly between engineering and computer science, but also between engineering disciplines). The poster will share findings and some successful practices with regard to instructor development and disciplinary diversity that ASEE attendees might be able to use at their own campuses.

Engaging Faculty in the Project

When this project was conceptualized, the researchers were most interested in how undergraduate students would change (or not) over time as they were exposed to their engineering or computer science curriculum and the new project activities. As a result, the research design emphasized collecting data from students in undergraduate courses. As the project has progressed the research team has come to recognize that effective involvement of faculty could have been the topic of a separate research study. While not the primary target of data collection, the past several years (up to five years on one campus) of trying to invite faculty

participation has led the project team to a more refined understanding of what critical faculty engagement looks like. Our project had hoped to target particular faculty teaching particular courses and use financial incentives to motivate faculty. This strategy has had limited success, in some cases due to basic structural issues and in other cases due to the attitudes and motivations of particular faculty. For example, in some cases teaching assignments regularly change, which means that activities meant for a particular course would only be sustained if we could successfully recruit new faculty for the course, who may or may not be interested. Broad-scale research on faculty incorporation of diversity-oriented activities into the curriculum has found that even when faculty believe that diversity in a classroom leads to better learning outcomes, belief doesn't necessarily translate into teaching practices that include diversity-oriented materials [4]. However, departmental support is important in integrating diversity into the curriculum, as faculty who believed their departments emphasized the importance of diversity in their field and supported the integration of diversity-related content into their courses were more likely to do so [4], and were more likely to be advocates for diversity [5]. Interestingly, engineering faculty in Mahew and Grunwald's [4] study of faculty practices at one R1 university were more likely to include diversity-related content in their courses than faculty in arts and sciences, business and administration, and fine arts. Therefore, the high integration of diversity-related content into engineering courses in Mahew and Grunwald's [4] study may have been related to a departmental culture, particularly since in a nation-wide survey Park and Denson [5] found that engineering faculty were likely to have low levels of diversity advocacy. Therefore, supportive departmental culture may be a key component in engaging faculty.

Based on the experiences of the research team, the following list describes characteristics of faculty who have been effectively engaged in the project. This list includes suggestions on both what to look for in a potential faculty partner and desirable types of faculty involvement.

Characteristics of Engaged Faculty

1. The faculty member had some intrinsic motivation to incorporate diversity and inclusion in their course. The intrinsic motivation may come from the faculty member's experience with her/his/their own identity, or interactions with students, friends, and family members who have experienced discrimination and microaggressions. This motivation might encourage the faculty member to keep learning about DEI issues and continue to enhance activities in the future. (Also, participation in organized activities (e.g. professional development) around diversity issues was a strong predictor of integrating diversity-related content into their courses, across disciplinary affiliations [4].)
2. The faculty member is active in developing or at least modifying/refining activities. If the instructor takes more ownership for the assignments the assignments are more likely to be continued in future offerings of the course.
3. The faculty member does not depend too much on outside support. In an effort to help promote faculty adoption, we have had project members handle coordination tasks such as scheduling panel members or inputting assignments into course management tools. Some faculty have taken ownership and moved past that support, others have remained

dependent, which reduces the number of new faculty with whom the team can work and raises the question about what will happen when the project wraps up.
4. The faculty member will share what they are doing with others and conduct informal public outreach as they share what they have learned.

As noted above, a supportive department culture might be a key motivator for engineering or computer science faculty to adopt diversity and inclusion related changes in their course(s). Cultural change is a long-term process and may run on a timeline that is not compatible with a fixed length grant-funded project. The following list includes strategies used by the P4E research team to find engaged faculty partners. Not all of these strategies work with all faculty, and often a combination of strategies is needed.

What things seem to work to engage faculty?

1. Individual invitations to faculty and reaching out to the same faculty member more than once. Some faculty might not be ready in a certain semester, but as diversity efforts gain attention on campuses the climate around faculty can change and they may be ready in the future.
2. Time and continued support and engagement. We have several faculty who once reluctantly tried a few activities, who over time have become enthusiastic participants and have started to help recruit other faculty. We must remember that most engineering and computer science faculty have no training in discussing topics such as diversity and inclusion that our society has deemed sensitive. Faculty will need time to become more comfortable in speaking and engaging their class on these topics. We have also seen faculty, who originally didn't see much room in their course for non-technical content, find more time as they become more comfortable with the topic. To support faculty in their development, one campus is piloting faculty learning communities for professors to come to a shared space and problem solve together, as professional-development opportunities are recommended by [5] for increasing diversity advocacy in faculty.
3. Provide faculty with example activities – but make sure they are clearly just examples. Faculty may have trouble envisioning how a DEI activity can fit in their purely technical course. Providing concrete examples from other courses or from the same type of class on another campus can be very helpful. At the same time, it is also important that faculty have the ability to modify assignments to better fit their course or context.
4. Work with faculty who have primarily a teaching role. While we certainly want to gain as many faculty participants as possible, our project has had particular success with faculty who have a larger teaching role. While these faculty are just as busy as any faculty member, time spent developing new activities is less likely to be seen as "taking away" from other pursuits (such as research). The other advantages of working with teaching-oriented faculty is that often these faculty work with large numbers of students, potentially expanding project reach, and these faculty have likely spent more time in teaching professional development activities and may be more comfortable with alternative teaching strategies.

5. Time may be a bigger incentive than money. In our experience stipends in amounts small enough to be viable for a research project are likely not large enough to be particularly motivating for many faculty. An alternative approach that seems to have promise is to use the funding that might have gone to stipends to pay a student (undergraduate or graduate) to help the faculty member develop course activities. The benefits can be twofold in that not only are students providing time on the project, they can also share their perspective on which activities or resources would be appropriate for the target audience.

Most importantly for campus change agents is patience. It can be frustrating to move slowly on issues that continue to impact students every day – but a change that can be sustained is worth the time it took to create.

Disciplinary Diversity and Data Collection

Engineering and computer science courses may be taught out of the same academic unit (two of the four partner institutions house computer science and engineering in the same college) and may be considered similar by some. This project has exposed significant differences in how engineering and computer science majors think about their career trajectories. These differences have led to modifications in data collection and the need to carefully consider the applicability of classroom activities. Our poster will highlight how we have adapted our data collection methods to be relevant to both engineering and computer science classes. For example, the primary purpose of the grant is to develop inclusive professional identities. While those pursuing an engineering degree generally have a clear objective of becoming a "practicing engineer," there is no single collective term applicable to the professional careers pursued by those with a computer science degree. In addition, the goals for a student in a computer science major are often non-specific and may include multiple career options. Therefore, assessing inclusive professional identities necessarily looks different for engineering majors and computer science majors.

In the following table, we provide some examples for engineering survey items and their computer science adapted counterparts. As illustrated, the engineering interest items did not translate with perfect alignment to the computer science item. We tried to capture more breadth of what computer science could entail.

Comparison of Survey Items for Engineering and Computer Science Majors

Construct	Prompt	Engineering item	Computer Science item
Interest	How much interest do you have in…	working on a project involving engineering principles?	creating things on computers?
		working on a project involving engineering principles?	using the computer to answer questions about the world?
		solving complicated technical problems?	modifying things on computers?
		working on a project involving scientific concepts?	exploring how computers work?
			learning new ways to get computers to do what you want?
Identity	Please select the best answer on a scale from 1 to 7 (anchors in the responses)	In general, being an engineer is an important part of my self-image.	In general, being a computer science student is an important part of my self-image.
		Being an engineer is an important reflection of who I am.	Being a computer science student is an important reflection of who I am.
		I have come to think of myself as 'an engineer'.	I have come to think of myself as 'a computer science student'.
		I feel like I belong in the field of engineering.	I feel like I belong in a computing-related field.

Additionally, unlike engineering where students generally take engineering classes because they want to become engineers (and engineering courses are often restricted to only engineering majors), computer science was more likely to have students taking classes for a wide variety of purposes. To capture this diversity, we added some items to the computer science survey, such as the one below:

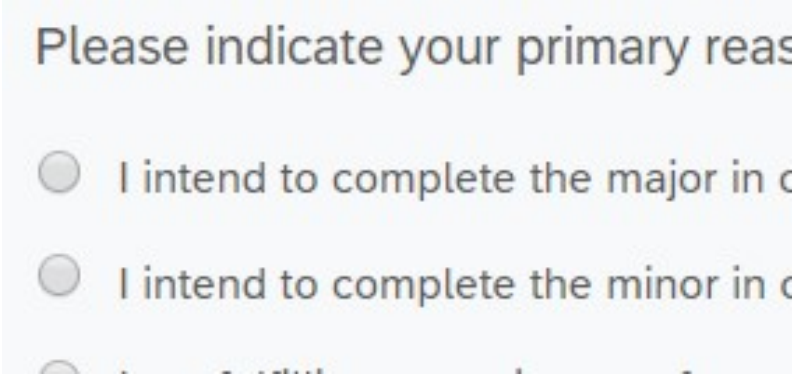

Figure 1. Item specific to computer science to determine the purpose of taking the course

While this may seem a simplistic question, had we not captured the various reasons for taking computer science courses and then tried to compare engineering to computer science students we would have been not just comparing apples to oranges- but apples to speedboats (if you will).

Another example of different questions is in the open-ended questions. We attempt to capture student changes in their conceptions of what makes a "good" engineer by asking the question:

- "What are some characteristics good engineers have?"

While not in the scope of this poster/paper, we analyze the student pre- and post-survey responses to this question to see how student understanding of engineering changes after participating in the grant supported activities in the courses. After discussing, as a team, the various conceptions of what students see as a "computer scientist" as well as the lack of consistency of what a computer science major/minor would do post-graduation, we reframed the item for the computer science survey into two questions:

- "What kinds of careers do you expect to pursue?"
- "What characteristics are shared by people who are most successful in the kinds of careers you expect to pursue?"

In this way, students will define for us what their career path is and what makes people successful in that path.

Conclusion

Providing equitable demographic representation has been an ongoing challenge in engineering and computer science classrooms and professions. In order to address this challenge, our project designs and implements several diversity-oriented activities to expose students to more inclusive engineering and computer science practices. These activities can foster engineering or computer science students who can appreciate contributions of peers with diverse backgrounds and also create synergy with diverse colleagues in their profession. This poster/paper discusses the

obstacles we faced as we expanded our activities to all levels of undergraduate courses and computer science courses and how we handle them. One major challenge we have faced is how to encourage and motivate faculty members to incorporate activities with their teaching in engineering classrooms. We found that not only their personal awareness or attitudes towards diversity issues in engineering but also overall support from the department was crucial for their engagement. The second issue was how to embrace substantial differences between engineering and computer science majors in terms of their career pursuits. We adjusted the measure for computer science majors to grasp students' various stances in computer science courses. The practical implications explored here can be useful guidelines to develop students' inclusive professional identities and to enhance instructors' teaching practices in engineering classrooms.

References

[1] Paguyo, C. H., Atadero, R.A., Rambo-Hernandez, K.E., and Francis, J. "Creating Inclusive Environments in First-Year Engineering Classes to Support Student Retention and Learning." ASEE Annual Conference 2015. Seattle, WA, USA. June 14-17, 2015.

[2] Rambo-Hernandez, K.E., Roy, A., Morris, M., Hensel, R., Schwartz, J., Hasemi, M., Atadero, R. & Paguyo, C. "Using Interactive Theater to Promote Inclusive Behaviors in Teams for First-Year Engineering Students: A Sustainable Approach" ASEE CoNECD Conference. Washington, D.C. April 29-May 2, 2018.

[3] Hedayati, A., Atadero, R.A., Baker, D. and Casper, A. "Analyzing the Effects of an Innovative Intervention to Infuse Diversity and Inclusion in a Statics Course." ASEE Annual Conference, Tampa, FL, USA. June 16-19, 2019.

[4] Mayhew, M.J. & Grunwald, H.E. (2006). Factors Contributing to Faculty Incorporation of Diversity-Related Course Content. *The Journal of Higher Education*, 77:1, 148-168, DOI: 10.1080/00221546.2006.11778922 .

[5] Park, J. J., & Denson, N. (2009). Attitudes and advocacy: Understanding faculty views on racial/ethnic diversity. *The Journal of Higher Education*, *80*(4), 415-438.