ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Paper ID #36498

A climate case study for understanding inclusion, equity, access, and diversity for broadening participation and reducing systemic barriers

Dr. Gregory E Triplett Jr., Virginia Commonwealth University

Experience involves strategic planning, resource management, consensus building, program development with a focus on continuous improvement.

Research activities include biophotonics, semiconductor device modeling and fabrication, sensor networks, and

Mrs. Rachel Levena Wasilewski

A climate case study for understanding inclusion, equity, access, and diversity for broadening participation and reducing systemic barriers

[a]Gregory E. Triplett and [a]Rachel L. Wasilewski
[a]Virginia Commonwealth University, Richmond, VA

The lack of equality in the traditional American educational system [1] poses an imminent threat to American innovation and global competitiveness. As the United States experiences changing demographics [2] and a greater shift towards a technology-driven society [3], it is not tapping into the entire talent pool, as the rest of the world is moving to more inclusive pedagogical models [4]. Given the quality of the future engineering workforce is at stake, it is critically important to comprehensively assess undergraduate engineering student experiences to better understand what is happening on engineering campuses [5] for maintaining a sustainable engagement continuum [6].

Over that past several decades, there have been numerous studies on persistence in engineering attempting to better understand why students leave [7-10]. Usually, the factors that influence student persistence in engineering fall into several categories: race and gender, unwelcoming academic climate, conceptual understanding in core courses, self-efficacy, interest and career goals, and access to social capital. While the impact of both academic and non-academic factors has been known to contribute to students leaving engineering, especially those from traditionally marginalized communities, we were motivated to assess the costs associated with failing to implement effective retention strategies [10]. This case study was initiated with an interest in understanding at a deeper level why engineering students were either unsatisfied with their major or the culture that existed within the school. At a midsize (~2,000 students) urban, diverse and predominantly white institution, a deep examination of historical climate issues faced by populations traditionally underrepresented in engineering was conducted over a three-year period. This is effort is similar to prior efforts except that studies conducted here were systematically performed to explore academic and non-academic factors.

With particular focus on the student experience, this research was conducted to (1) identify and ultimately reduce systemic barriers caused by subjective policies and practices, (2) improve an institutional climate that disproportionately impacts students from disenfranchised communities, and (3) collect more actionable data to improve the overall student experience. Using a phase approach that was developed organically, researchers explored the college of engineering's operations to identify biases in its systems and structures. The data collected and analyzed encompassed academic programs, enrollment, scholarships, advising, first-year experiences, and a host of other student support mechanisms. When collecting data from students, researchers developed and distributed topical electronic surveys, conducted focus groups in person and by video conference, and studied institutional data. Where data was not available, researchers

worked collaboratively with institutional research to develop engineering-centric data analytics tools for identifying opportunities and developing long term strategies.

The process for studying climate involved a closer look at every aspect of the student experience. In this report, admissions practices, reasons students leave/stay in engineering, and experiences within the college are the focal point. These topics were pursued to better understand the interconnectedness of student experiences and the impact on student decisions.

Phase 1: Admissions Practices

A review of the admissions practices was conducted and involved analysis of historical outreach activities, application data, admission/rejection practices processes, and the awarding of scholarships. For the college of engineering, efforts to attract students into degree programs followed a conventional framework. The college of engineering's enrollment management office provided a spectrum of outreach and recruitment activities to introduce undergraduate engineering opportunities to college-ready students and their families. These activities were regularly located at high schools, regional/national college fairs, and through campus visits. A student ambassador program (composed of student volunteers) was developed to more effectively increase student enrollment, particularly from traditionally underrepresented populations. Modest scholarship supplements were offered to incoming engineering students with high grade point averages and SAT scores in order to attract top talent. Historical data shows that scholarships were not only disproportionately awarded to white students, but also not dependent on financial need. Scholarship offers for transfer community college students were also less in value compared to scholarships for incoming engineering freshmen, despite the higher graduation rates demonstrated from transfer students. Scholarship offers were also tied to academic performance, which led many students to withdraw from classes with high rigor to preserve their grade point average, resulting in increased time to graduation.

In terms of enrollment demographics, the percentage of students from traditionally underrepresented populations remained flat, even as engineering enrollment grew by >50% during the 2007-2016 period. Over time and generally speaking, engineering faculty put more effort towards research, teaching, and service and played less of a role in enrollment management activities (such as call centers and visits to high schools). Eventually, engineering faculty were not involved in admission decisions, and the college's enrollment management office oversaw the entire admissions cycle. There was growing interest to broaden participation in engineering, but historical admissions data demonstrated that, despite efforts to diversify, admissions rejections disproportionately impacted traditionally underrepresented populations.

Phase 2: Student Retention

To better understand why students stay/leave engineering, a change of major study was conducted over a three-year period. A unique engineering student transitions report using

institutional research data was developed to identify students that changed majors (into/within/out of engineering). Each invited participant that changed majors was offered $10 to use at the university bookstore for completing the survey. During the three-year period of this study, more than ~230 students changed majors out of engineering, ~170 changed majors into engineering, ~300 changed majors within engineering, and ~500 left the university. Below is a snapshot from the survey instrument (more than 200 respondents).

- 90% talked with family before changing majors.
- 73% of respondents were satisfied or very satisfied with their decision to change majors.
- 68% had taken an ***Introduction to Engineering*** course and indicated it was helpful in deciding to change their major.
- 67% chose their major before they chose the institution.
- 56% changed their major because it no longer aligned with their interest and another major suited them better.
- 25% changed their major within two (2) semesters, with 30% changing their major after one semester. Very few students changed their major after 3 semesters.
- 16% had one bad experience with a faculty member, where 19% had multiple bad experiences with faculty.
- While 16% participated in engineering research, many indicated that it was helpful for their future career and in the decision to change their major.
- Many students commented that they were not receiving the help they needed.
- Several students commented wanting a better balance between theory and practicality.

The college of engineering has a list of academic policies and practices designed to usher students smoothly through the academic life cycle. Even with the focus on student enrollment, it seems the very academic and enrollment practices and policies designed to be fair were actually impacting specific student populations inequitably. For example, student support structures, intervention strategies, scholarships, and admission practices were not sufficiently resourced, thoroughly assessed for impact, and aligned with best practices. A culture of assessment was essentially absent. Moreover, approved changes to degree programs were constant and circular in nature and metrics for success did not take into consideration inclusive excellence. Most importantly, students were not part of the discussion for continuous improvement.

Phase 3: Climate and Culture

Based on student feedback obtained during focus groups and open forums, the impact of culture extended into student academic performance. Students have expressed associations between their feeling of belonging and effort put towards academic activities. When facing academic difficulty, many students also felt that policies seemed to encourage students to leave rather than stay in engineering. Some faculty felt that enrollment growth introduced unintended consequences, such as insufficient time to develop relationships with students. So, we analyzed course withdrawals from undergraduate engineering students during a ten-year period (2009-2018), when

engineering enrollment increased 44%. Interestingly, as enrollment increased, the number of course withdrawals stayed flat. On average, there were ~750 course withdrawals per year, where 28% of students had at least one course withdrawal. Whereas women were least likely to request course withdrawals (22% vs 30% for men), minority populations were more likely (30% vs 27% non-URM). So, we conducted a course withdrawal survey to better understand what can be done to improve student experiences, reduce educational costs, and improve time to graduation. Moreover, students who withdraw from courses are usually not afforded an opportunity to provide feedback. According to responses from the survey instrument, the general consensus was that the course workload was reasonable and manageable, but there was a growing need for academic support and more frequent feedback from course instructors and graduate teaching assistants. A significant percentage of students also enumerated a spectrum of culture/climate issues.

Because of the confluence of factors mentioned above and others related to student support, lack of assessment, and increased enrollment, a culture survey was launched in the college of engineering to understand the current state of climate from the student perspective. Since it is the first culture survey deployed in the college of engineering, this instrument will be used in the future to measure improvements [11]. Using REDCap, a 77-question voluntary climate survey was designed and distributed to all undergraduate students in the college of engineering. Students were not compensated for completing the survey, and responding to every statement was also optional. Nearly 21% (N=413) of invited students participated as anonymous survey respondents Women account for 29% of undergraduate membership, but represent 39% of survey respondents.

Survey participants were asked to think about their experience in the college of engineering and rate statements using a 5-point Likert scale (i.e. very often to never, strongly agree to strongly disagree) and sliding 10-point scales. Statements also included an additional option, “prefer not to respond”. Topics include fairness and equity; feeling valued and respected; safety; cooperation and collaboration; if they encountered prejudice, discrimination, sexism, racism; and inclusion. Survey statements were also separated into sub-categories, for example “feel respected by peers, …by graduate teaching assistants, and …by faculty”. Responses from the survey instrument were analyzed using diverging stacked bar charts to highlight the importance of a certain set of ranked responses. General themes are summarized below.

- There are significant disparities across gender, race, and majors in terms of services provided, opportunities presented, and academic support received.
- Regardless of demographic, culture in and out of the engineering classroom spaces are different.
- There is a perceived atmosphere of prejudice towards woman, Black/African Americans and other historically excluded racial/ethnic groups

- Not all students feel encouraged by faculty to challenge ideas.
- The environment for women is more toxic than it is for men. For example, women experience more bias, discrimination, and harassment.
- Women feel less valued (particularly by graduate assistants, peers) and treated less fairly and inequitably.
- Women were three times more likely to transfer out of engineering.

New Initiatives

An examination of admissions and scholarship award practices led to the launch of several piloted initiatives. The first initiative launched in Fall 2020 placed greater emphasis on grade point average during admissions decisions. Because the college of engineering has local control on admission decisions, test optional admissions practices were adopted. If an applicant's grade point average lay within the top 10% of their high school, it resulted in automatic admission. As a result, the freshman class size immediately increased 35% (n=130), where underrepresented minorities accounted for 72% (n=93) of this increase. This initiative also involved an overhaul of the scholarship framework. It was modified to enhance access to higher education, which accompanied increased fundraising. Scholarship offers were restructured to tie recruitment activities to retention strategies, thus scaling in financial value as the student matriculated through the engineering program. Scholarship offers for community college transfers were also significantly increased, placing them on par with four-year student offers. To recognize students who stayed the course, a special senior level scholarship was also piloted (requiring fundraising) to provide tuition relief for students needing funding. To be eligible, students must be in good standing, demonstrate need, and not have repeated any major courses. An average of 370 students are now funded each year.

As result of the retention study, several initiatives were piloted to improve acclimation and experiences during first and second year. These programs focused on increasing access to social capital including increased support for student-centered activities. A student success fund was also developed to support organizations including those that serve populations traditionally underrepresented. Among these included the National Society for Black Engineers, the Society of Hispanic Professor Engineers, and the Society for Women Engineers. The engineering and computer science curriculum were also reviewed for possible shifting of engineering course options to freshman and sophomore year. Each major now has at least two major classes in the first two semesters. In terms of intervention strategies, programs were developed that include mentoring from industry professionals across all demographics and more frequent check-ins. The inaugural industry mentoring network size was 180 and has since grown 140%. Academic policies were also re-examined that had a disproportionate impact on specific populations. One academic policy has since been suspended.

Accountability was a step towards improving climate. For example, measurable retention and graduation goals were incorporated into the college's strategic priorities. Teaching assistant training for all graduate teaching assistants was enhanced and required. Over 250 graduate students have since participated in training. To diversify the pool of graduate teaching assistants, new graduate scholarships were also resourced, targeting populations traditionally underrepresented. Academic departments were charged with filling unnecessary gaps in academic support, developing measurable student success and enrollment management goals, and addressing disparities in student performance. This included creating degree programs and certificates that tap into the intellectual curiosity from the diversity of students. Faculty were encouraged to use diverse examples in class lectures and incentivized to increase the frequency of feedback to students.

Conclusion

By probing deeper and collecting qualitative and quantitative data, valuable insights were gained for improving experiences for women and populations traditionally underrepresented. Studies were conducted to better understand the interconnectedness of student experiences and student decisions. In response to student feedback, engineering operations were re-examined for inclusivity, and programs were piloted to overcome systemic biases hampering student success and model more inclusive policies, practices and procedures.

[1] A. Gamoran, "American Schooling and Educational Inequality: A Forecast for the 21st Century," *Sociology of Education,* vol. 74, pp. 135-153, 2001.

[2] J. Vespa, D. M. Armstrong, and L. Medina, *Demographic turning points for the United States: Population projections for 2020 to 2060*: US Department of Commerce, Economics and Statistics Administration, US …, 2018.

[3] R. Montealegre and W. F. Cascio, "Technology-driven changes in work and employment," *Communications of the ACM,* vol. 60, pp. 60-67, 2017.

[4] K. Wall, *Engineering: issues, challenges and opportunities for development*: Unesco, 2010.

[5] E. Godfrey and L. Parker, "Mapping the Cultural Landscape in Engineering Education," *Journal of Engineering Education,* vol. 99, pp. 5-22, 2010/01/01 2010.

[6] G. Triplett, J. Stanley-Shanks, and L. Floyd-Miller, "Engagement in Practice: the Student Engagement Continuum (SEC) – Opportunities and Challenges for a Sustainable Pipeline Enhancement Model at an Urban Institution," presented at the 2018 ASEE Annual Conference & Exposition, Salt Lake City, Utah, 2018.

[7] C. C. Samuelson and E. Litzler, "Community Cultural Wealth: An Assets-Based Approach to Persistence of Engineering Students of Color," *Journal of Engineering Education,* vol. 105, pp. 93-117, 2016.

[8] B. R. Sandler, "The chilly classroom climate: A guide to improve the education of women," 1996.

[9] R. M. Marra, K. A. Rodgers, D. Shen, and B. Bogue, "Leaving Engineering: A Multi-Year Single Institution Study," *Journal of Engineering Education,* vol. 101, pp. 6-27, 2012.

[10] B. N. Geisinger and D. R. Raman, "Why they leave: Understanding student attrition from engineering majors," *International Journal of Engineering Education,* vol. 29, pp. 914-925, 2013.
[11] M. M. Camacho, S. M. Lord, C. E. Brawner, and M. W. Ohland, "Climate in undergraduate engineering education from 1995 to 2009," in *2010 IEEE Frontiers in Education Conference (FIE)*, 2010, pp. T2H-1-T2H-6.