RESULTS OF CROSS-SECTIONAL SURVEY OF UNDERGRADUATE STUDENTS WITH FOCUS ON DIFFERENTIAL EXPERIENCES BY STUDENT DEMOGRAPHICS

Jenni M. Buckley, PhD[2,1], Amy E. Trauth, PhD[1]
Sarah Rooney, PhD[2], Joshua Enszer, PhD[2], Tia N. Barnes, PhD[1], Rachel Davidson, PhD[2]
[1]University of Delaware, College of Education and Human Development
[2]University of Delaware, College of Engineering

Introduction

The underrepresentation of women and underrepresented minorities (URM, def. non-White, non-Asian) in engineering undergraduate programs can be attributed to a multitude of factors, including, but not limited to, insufficient access to high-quality curriculum and instruction and barriers in recruiting into engineering programs at the K-12 level, low self-efficacy, lack of peer support, inadequate academic advising or faculty support, harmful stereotypes of particular groups that influence interactions in classrooms or in peer groups, and a chilly or unappealing climate [1-9]. Given potential granularity of the problem within and across institutions, it is important for faculty and administrators to assess issues of diversity and inclusion as proximal as possible to their own academic units. With this in mind, the goal of this study was to assess internal (self-concept) and external (climate) issues in our own undergraduate student population (UD College of Engineering). In particular, we were interested in whether internal and external issues differentially impacted underrepresented students, specifically, women and students of color (designated URM in this report).

Methods

We administered a voluntary survey to the entire engineering undergraduate student body (Table 1). The survey included items from validated instruments specific to engineering undergraduates for self-efficacy with math and science skills, engineering application, and hands-on prototyping [15-17]. Custom items were also included that built upon the five aforementioned themes from the focus group study [11]. The survey was administered electronically (Qualtrics, Provo, UT) to all engineering disciplines and grade bands over the course of two weeks in Spring 2018. Survey responses were compared by gender (male, female) and race (URM or majority) using one-way ANOVA with post-hoc adjustment (JMP Pro, SAS Institute).

Results

The survey response rate was 10% of the student body population (n=246). Survey respondents were demographically representative of the at-large population by race (13.5% survey respondents vs. 10.5% population), and women were slightly over-represented (40.8% survey respondents vs. 24.1% population). Survey results indicated differential experiences by gender and race across several thematic areas (see Table 1). In terms of professional identity, women, but not URMs, rated themselves lower in science, engineering, and problem solving self-efficacy as compared to their majority peers. Women were more hesitant than majority peers to approach a faculty member for help, to ask questions in class, and to participate in class discussions. Women also experienced significantly higher self-reported stress levels related to workload and modestly more stress related to financial concerns. URMs were less likely to cite sufficient

financial aid opportunities and reasonable workload as positive influencers, but their self-reported stress levels related to workload and financial concerns were no different than majority students. Both women and URMs did report higher incidents of both experiencing and observing others experiencing peer-to-peer micro-aggressions; however, micro-aggressions were uniformly rare for peer-to-peer interactions as well as faculty-to-student interactions.

Conclusions

While student scores for self-concept and climate were overall fairly high, there were some concerning differences for minority populations. The survey results highlighted deficiencies in self-efficacy for women students that are highly consistent with the literature [5,6]. Women students were less comfortable contributing to group discussions and asking faculty for assistance, neither of which were reported concerns for URMs who were actually more comfortable approaching faculty. While incidences of micro-aggressions against women and URM students were reported in a prior focus group study with this same student body, our survey results showed that reported incidence of micro-aggressions was relatively rare and countered by fairly strong statements from both majority and minority students about inclusive course atmosphere. This is not to suggest that even rare instances of micro-aggressions are to be tolerated in our classrooms, and stronger evidence of their persistence and detrimental effects are presented in the literature [5,6].

References

[1] S. Cheryan, S. A. Ziegler, A. K. Montoya, and L. Jiang, "Why are some STEM fields more gender balanced than others?" Psychol Bull, vol.143, no.1, pp.1-135, Jan. 2017.
[2] C. E. Foor, S. E. Walden. and D. A. Trytten, "I wish that I belonged more in this whole engineering group: Achieving individual diversity," Journal of Engineering Education, vol. 96, no. 2, pp. 103–115, Apr. 2007.
[3] R.T. Palmer, D.C. Maramba, & T. E. Dancy, "A qualitative investigation of factors promoting the retention and persistence of students of color in STEM," The Journal of Negro Education, vol. 80, no. 4, pp. 491-504, Fall. 2011.
[4] K.D. Kendricks, K.V. Nedunuri, and A.R. Arment, "Minority student perceptions of the impact of mentoring to enhance academic performance in STEM discipline," Journal of STEM Education: Innovations and Research, vol.14, no.2, pp. 38-46, Apr-Jun. 2013.
[5] R. M. Marra, K. A. Rodgers, D. Shen, and B. Bogue, "Leaving engineering: A multi-year single institution study," J Eng Educ, vol. 101, no.1, pp. 6-27, Jan. 2012.
[6] M. Meyer and S. Marx, "Engineering dropouts: A qualitative examination of why undergraduates leave engineering," J Eng Educ, vol. 103, no. 4, pp. 525-548, Oct. 2014.
[7] S.D. Museus, R.T. Palmer, R.J. Davis, and D. Maramba (Eds.), "Factors that influence success among racial and ethnic minority college students in the STEM circuit," in "Racial and Ethnic Minority Student Success in STEM Education: ASHE Higher Education Report," John Wiley & Sons, San Francisco, CA, USA, 2011, vol. 36.
[8] A. S. Bix. Girls Coming to Tech! A History of American Engineering Education for Women. Cambridge, MA: MIT Press, 2014.
[9] M.W. Ohland, C. E. Brawner, M. M. Camacho, R. A. Layton, R. A. Long, S. M. Lord, and "Race, gender, and measures of success in engineering education," J Eng Educ, vol. 100, no. 2, pp. 225-252, Apr. 2011.
[10] M. H. Wasburn, "Race, gender, and measures of success in engineering education," J Eng

Educ, vol. 100, no. 2, pp. 225-252, Apr. 2011.

[11] Barnes TN, Zhang X, Trauth AE, Enszer J, Rooney S, Davidson R, Buckley JM. How granular is the problem? A discipline-specific focus group study of factors affecting underrepresentation in engineering undergraduate programs. 2018 Proceedings of the American Society for Engineering Education.

[12] C. E. Foor and S. E. Walden, "Imaginary engineering' or 're-imagined engineering': Negotiating gendered identities in the borderland of a college of engineering." *NWSA Journal*, vol. 21, no. 2, pp 41-64, Summer 2009.

[13] Creswell, J. W., & Plano Clark, V. (2011). Designing and conducting mixed methods research. Thousand Oaks, CA: Sage Publications, Inc.

[14] Merriam, S. B. (1998). Qualitative research and case study applications in education. San Francisco, CA: Jossey-Bass.

[15] D. Chachra and D. Kilgore, "Exploring gender and self-confidence in engineering students: A multi-method approach," Cent. Adv. Eng. Educ., Washington, USA, Tech Rep. Apr. 2009.

[16] H. Chen, K. Donaldson, O. Eriş, D. Chachra, G. Lichtenstein, S. D. Sheppard, and G. Toye, "From PIE to APPLES: The evolution of a survey instrument to explore engineering student pathways," in 2008 ASEE Proceedings.

[17] D. Baker, S. Krause, and S. Y. Purzer, "Developing an instrument to measure tinkering and technical self-efficacy in engineering," presented at the 2008 ASEE Annual Conference and Exposition, 2008

[18] Reams, P., & Twale, D. (2008). The promise of mixed methods: Discovering conflicting realities in the data. *International Journal of Research & Method in Education*, *31*(2), 133-142.

[19] Wagner, K. D., Davidson, P. J., Pollini, R. A., Strathdee, S. A., Washburn, R., & Palinkas, L. A. (2012). Reconciling incongruous qualitative and quantitative findings in mixed methods research: Exemplars from research with drug using populations. *International Journal of Drug Policy*, *23*(1), 54-61.

[20] Hart, C. H., Lawrence, F., & Thomasson, R. (1990). Article Metrics Related Articles Cite Share Request Permissions Explore More Download PDF Measuring Socioeconomic Status in Child Development Research.

Table 1: Results from cross-sectional survey of undergraduate engineering student body. Differential experiences by race and gender are presented only when statistically significant (p<0.05, one-way ANOVA). Table continued, overleaf.

	Population Mean (St.Dev)	Gender Male Mean (St.Dev)	Female Mean (St.Dev)	Effect Size (p value)	Race Non-URM Mean (St.Dev)	URM Mean (St.Dev)	Effect Size (p value)
High School Preparation							
Do you feel your high school coursework adequately prepared you to be successful in an engineering curriculum? *[3] Yes, [2] Somewhat, [1] No*	2.27 (0.75)						
Number of High School Engineering Co or Extra-Curricular Programs Participated	1.57 (1.34)						
Peer Interactions							
To what extent do you agree with the following statements about your engineering courses? *[5] Strongly agree, [4] Agree, [3] Neither agree nor disagree, [2] Disagree, [1] Strongly disagree*							
- I can relate to the people around me in my class	2.88 (1.28)						
- I have a lot in common with other students in my class.	2.81 (1.24)	2.96 (1.29)	2.60 (1.11)	0.35 (0.03)			
- The other students in my class share my personal interests.	2.68 (1.08)						
- I can relate to the people around me in my extracurricular activities.	2.85 (1.29)						
Please indicate the degree to which each factor has positively influenced your decision to stay in your major. *[4] Significant Influence, [3] Moderate Influence, [2] Small Influence, [1] No Influence*							
- Positive interactions with other engineering or computer science students	1.91 (0.92)						
- Positive experiences in design teams or other collaborative learning experiences in engineering or computer science	2.37 (0.97)						
- Friendly climate in engineering or computer science class	2.08 (0.95)						
How often did the following occur in your experience as a student in [computer science or engineering] courses? *[4] Almost Always, [3] Often, [2] Occasionally, [1] Almost Never*							
- I observed other students being ignored or excluded because of their backgrounds or identities.	1.34 (0.69)	1.25 (0.62)	1.45 (0.78)	0.20 (0.03)	1.29 (0.67)	1.64 (0.82)	0.35 (0.008)
- I was harassed or discriminated against by others in my major because of my background or identity.	1.19 (0.55)				1.16 (0.50)	1.39 (0.75)	0.24 (0.03)
Faculty Interactions							
Please indicate the degree to which each factor has positively influenced your decision to stay in your major. *[4] Significant Influence, [3] Moderate Influence, [2] Small Influence, [1] No Influence*							
- Engineering or computer science faculty/department personnel show an interest in me	2.39 (1.06)						
- Reasonable workload of engineering classes	2.52 (1.03)				2.58 (1.04)	2.15 (0.94)	0.44 (0.03)
- Faculty help me understand what practicing engineers or computer scientists do	2.25 (0.94)						
- Good teaching by engineering and computer science faculty, instructors, or graduate assistants	1.95 (0.94)						
- Effective academic advising by engineering or computer science faculty or advisors	2.37 (1.05)						
How often did the following occur in your experience as a student in [computer science or engineering] courses? *[4] Almost Always, [3] Often, [2] Occasionally, [1] Almost Never*							
- My instructors and I discussed diversity issues.	1.71 (0.83)						
- My instructors emphasized the importance of diversity in the workplace.	2.01 (0.95)						
- I observed the use of offensive words, behaviors, or gestures directed at students because of their backgrounds or identities.	1.32 (0.68)						
- I felt intimidated by some of my engineering and/or computer science instructors.	2.15 (0.96)	1.97 (0.92)	2.43 (0.97)	0.46 (0.002)			
- Open channels of communication exist between faculty and students.	2.87 (0.85)						
- Students are treated equitably and fairly by faculty in my major.	3.20 (0.83)						
- Course content reflects contributions of all engineers or computer scientists, including women and people of color, etc.	2.98 (0.89)	3.16 (0.81)	2.73 (0.95)	0.43 (0.002)			
- Students of all backgrounds/identities participate in class (in discussion, in-class assignments, team projects, etc.).	3.08 (0.88)	3.22 (0.86)	2.89 (0.90)	0.33 (0.004)			
- I received positive feedback from instructors that I can do well in engineering and/or computer science courses.	2.69 (0.99)						
- My engineering and/or computer science courses had an open and positive atmosphere.	2.98 (0.86)	3.11 (0.80)	2.82 (0.94)	0.29 (0.01)			

Table 1, continued:

	Population Mean (St.Dev)	Gender			Race		
		Male Mean (St.Dev)	Female Mean (St.Dev)	Effect Size (p value)	Non-URM Mean (St.Dev)	URM Mean (St.Dev)	Effect Size (p value)

Faculty Interactions, continued

For the following items please indicate your level of agreement: *[7] Strongly agree, [6] Agree, [5] Somewhat agree, [4] Neither agree nor disagree, [3] Somewhat disagree, [2] Disagree, [1] Strongly disagree*

	Population Mean (St.Dev)	Male Mean (St.Dev)	Female Mean (St.Dev)	Effect Size (p value)	Non-URM Mean (St.Dev)	URM Mean (St.Dev)	Effect Size (p value)
I feel comfortable asking questions in my engineering and/or computer science class	5.43 (1.5)	5.73 (1.31)	5.03 (1.61)	0.70 (0.003)			
I feel comfortable contributing to class discussions in my engineering and/or computer science class	5.45 (1.52)	5.78 (1.30)	4.98 (1.69)	0.80 (0.001)			
The professors in my engineering and/or computer science classes respect me	5.79 (1.22)						
I would feel comfortable asking a professor in my engineering and/or computer science classes for help if I did not understand course-related material	5.75 (1.33)	5.95 (1.17)	5.51 (1.47)	0.45 (0.01)			
When I interact with professors at this college, I feel they care about how I'm doing	5.43 (1.51)						
Professors at this college make me question whether I should be here	2.86 (1.8)						

Professional Identity

Please indicate the degree to which each factor has positively influenced your decision to stay in your major. *[4] Significant Influence, [3] Moderate Influence, [2] Small Influence, [1] No Influence*

	Population Mean (St.Dev)	Male Mean (St.Dev)	Female Mean (St.Dev)	Effect Size (p value)	Non-URM Mean (St.Dev)	URM Mean (St.Dev)	Effect Size (p value)
- Ability to find satisfactory co-ops and/or internships	2.39 (1.09)						
- My personal abilities/talents are a good "fit" for the requirements in my major	1.6 (0.79)						
- Confident of succeeding in engineering or computer science future classes	1.84 (0.91)						
- Sufficient opportunities for financial aid or scholarships	2.39 (1.12)				2.48 (1.11)	1.97 (1.01)	0.51 (0.02)
- Satisfactory performance on my grades in engineering or computer science	1.83 (0.93)						

How often did the following occur in your experience as a student in [computer science or engineering] courses? *[4] Almost Always, [3] Often, [2] Occasionally, [1] Almost Never*

	Population Mean (St.Dev)	Male Mean (St.Dev)	Female Mean (St.Dev)	Effect Size (p value)	Non-URM	URM	Effect Size
- I felt like a valued member of the engineering and/or computer science community at my university.	2.66 (0.97)	2.80 (0.95)	2.47 (0.98)	0.33 (0.008)			
- My courses emphasized acceptance of and respect for differences (of opinion, background, etc.).	2.68 (0.96)						

	Population Mean (St.Dev)	Male Mean (St.Dev)	Female Mean (St.Dev)	Effect Size (p value)			
How much stress do you feel in completing your coursework right now? *[5] Extreme stress, [4] Significant stress, [3] Reasonable stress, [2] Some stress, [1] No stress*	3.51 (0.98)	3.33 (0.98)	3.79 (0.90)	0.46 (0.003)			
How well are you meeting the workload demands of your coursework? *[5] Easily Meet All, [4] Meet All With Difficulty, [3] Cannot Meet Some, [2] Cannot Meet Most, [1] Cannot Meet Any*	3.89 (0.62)						
At the present time, how confident are you that you will earn a bachelor's degree in engineering or computer science? *[5] Very confident, [4] Somewhat confident, [3] Neither confident/unconfident, [2] Not very confident; [1] Not at all confident*	4.73 (0.62)						

Rate yourself on each of the following traits as compared to your classmates. *[5] Highest 10%, [4] Above Average, [3] Average, [2] Below Average, [1] Lowest 10%*

	Population Mean (St.Dev)	Male Mean (St.Dev)	Female Mean (St.Dev)	Effect Size (p value)			
- Math ability	3.90 (0.85)						
- Science ability	3.79 (0.79)	3.94 (0.78)	3.59 (0.77)	0.35 (0.007)			
- Engineering ability	3.73 (0.87)	3.97 (0.81)	3.39 (0.85)	0.59 (0.001)			
- Overall academic abilities	3.88 (0.75)						
- A bility to apply math and science principles in solving real world problems	3.82 (0.85)	4.00 (0.83)	3.57 (0.83)	0.44 (0.001)			

Family Supports

	Population Mean (St.Dev)	Male Mean (St.Dev)	Female Mean (St.Dev)	Effect Size (p value)			
How often in your day-to-day life at [college] do you think about your financial circumstances? *[5] Very often, [4] Often, [3] Sometimes, [2] Rarely, [1] Never*	3.22 (1.32)	3.06 (1.27)	3.43 (1.39)	0.36 (0.04)			
Do you have any concern about your ability to finance your college education? *[3] Major concerns, [2] Some concerns, [1] None*	2.53 (0.50)						