Promoting Equity and Academic Achievement for Traditionally Underrepresented First-Year Students in Engineering through a Peer Mentoring Program

Dr. Kelyn Rola, Southern Methodist University

Dr. Kelyn Rola is a Research Professor in the Caruth Institute for Engineering Education in the Lyle School of Engineering at Southern Methodist University. She is Director of the Thrive Scholars Program in the Lyle School, which supports historically underrepresented students in engineering and computer science during their transition to college. She received her Doctorate in Education Policy and Leadership at SMU with an emphasis on Higher Education. Dr. Rola's professional efforts focus on promoting equity, inclusion, and student success in higher education. Her research projects center on supporting traditionally underrepresented students in engineering, social justice education in predominantly White contexts, student well-being and thriving, gender inequities in STEM fields, and navigating the hidden curriculum as a first-generation student.

Dr. Caitlin M. Anderson, Southern Methodist University

Dr. Caitlin Anderson is a Senior Lecturer in the Department of Applied Physiology and Sport Management at Southern Methodist University. She is the Director of the Hilltop Scholars Program at SMU, an honors community for first-year college students with an emphasis on leadership and community engagement. She received her Doctorate in Education Policy and Leadership from SMU with an emphasis in Higher Education. Dr. Anderson's research interests include college student community engagement, college honors programming, and academic programs and their relationship to student retention and attrition. She is a frequent presenter of college student well-being and the effectiveness of first-year programming at professional conferences nationwide.

Dr. Kristen McAlexander, Schreiner University

As a kinesiologist, Dr. McAlexander educates individuals and communities about living well and serving others. Her research interests include obesity prevention and treatment in urban and rural settings. She holds a PhD in Kinesiology from the University of Houston, a Master of Arts in Kinesiology and Education from Sam Houston State University and a Bachelor of Science in Journalism from Texas A&M University. Dr. McAlexander is a member of the American College of Sports Medicine, the National Wellness Institute and the American Association of University Women. She currently serves as the Associate Provost at Schreiner University.

Promoting equity and academic achievement for traditionally underrepresented first-year students in engineering through a peer mentoring program

Introduction

Throughout the history of the United States, racial and ethnic minorities have faced socially constructed barriers to access, equity, and success. Though higher education policies are no longer explicitly exclusionary, the campus climates of many colleges and universities are far from inclusive. Further, the lack of racial and ethnic diversity at predominantly White institutions (PWIs) presents particularly unwelcoming environments for underrepresented minority (URM) students, including individuals who identify as Black, Hispanic/Latino, and American Indian or Alaska Native [1]. URM students attending PWIs frequently report feelings of prejudice, discrimination, and exclusion [2], and such experiences negatively impact their academic and social success [3], [4]. The challenges that URM students face are further exacerbated in engineering disciplines, where they are disproportionately underrepresented relative to non-STEM fields [1]. In order reduce race-based equity gaps that persist related to bachelor's degree obtainment and subsequent participation in the engineering workforce, targeted efforts must be made to support URM students during their postsecondary education. As such, the purpose of this study is to examine the efficacy of a peer mentoring program for traditionally underrepresented students in engineering as a strategy for increasing students' first-year retention and academic achievement. Specifically, we aim to address the following research questions:

1. Is there a relationship between participation in a peer mentoring program and the retention of traditionally underrepresented first-year students in engineering at a PWI?
2. Is there a relationship between participation in a peer mentoring program and the academic outcomes of traditionally underrepresented first-year students in engineering at a PWI?

Literature Review

Throughout the history of the United States, racial minorities, particularly those who identify as Black, Hispanic, and Native American or Alaska Native, have been excluded from widespread participation in both higher education and STEM professions [5]. National efforts have been made in recent decades to remediate this discrimination and to diversify STEM disciplines, yet policies and practices that advantage white men over other social groups continue to persist within both academia and engineering [5]. Antiquated ideologies about who belongs in engineering education often persist among faculty and students [6], particularly within PWI settings, which can result in students of color experiencing marginalization and isolation during their undergraduate careers [7], [8], [9]. Consequently, these students are often retained in the engineering pipeline at disproportionately lower rates than their white peers [1], [10]. The continued underrepresentation of Black and Brown individuals among engineering bachelor's degree recipients in the U.S. contributes to persistent equity gaps and racial homogenization within the profession [11].

Diversifying the engineering workforce is not only beneficial for improving the social and economic mobility of historically marginalized racial groups, but it is necessary for the innovation and technological advancements that are hallmarks of the U.S.'s global competitiveness [12]. Identifying practices that effectively support traditionally underrepresented students in engineering education is critical for improving their sense of belonging (both to the profession and the institution), which can result in improved academic persistence and degree completion [13]. Interventions that target students during their first-year of college represent a particularly salient strategy for broadening participation in engineering, as it is during this time that students are most likely to make decisions related to whether or not they will continue pursuing a given degree [14].

At the postsecondary level, numerous curricular and co-curricular factors contribute to the departure of traditionally underrepresented students from the engineering pipeline. Within academic contexts, students report experiencing bias and microaggressions from faculty [6], [15] and poor performance in introductory coursework [16]. Outside of the classroom, students often report a lack of community, social support, and generally unwelcoming environments [15], [17], [18], [19]. These are all negative retention indicators, whereas when students develop strong social connections, engage with role models, and have support navigating the engineering curriculum [20], they are more likely to persist. For students attending PWIs, developing these types of supportive relationships with similarly-situated peers may represent a challenge due to limited compositional diversity within the student body. Difficulties related to forming relationships with racially minoritized peers are likely to be further compounded for students pursuing engineering degrees due to the even further underrepresentation of Black and Brown students in STEM fields.

To foster social connections among underrepresented students in an effort to enhance their sense of belonging and associated academic persistence, one approach that postsecondary institutions have taken is to pair incoming students with a peer or near-peer mentor [21]. Peer mentors reduce barriers during students' transition to college by serving as an emotional support system, role model, someone with insider knowledge of the curriculum, and an accountability partner. Peer mentors also provide insights to students-in-transition based on their own experiences navigating the university environment. Providing incoming students with an insider source of knowledge related to the both academic coursework *and* the hidden curriculum (i.e., unwritten rules that are often unknowingly expected of first-generation students [22]) may be a particularly valuable asset for racial minorities studying in PWI contexts. Peer mentoring models have proven to be effective at reducing attrition among the broader population of first-year students within undergraduate engineering programs [23]; thus, this form of an intervention was utilized to support traditionally underrepresented first-year students enrolled in the school of engineering at a private, four-year PWI. This work contributes to the broader literature by filling a gap related to the efficacy of a peer mentoring program designed specifically for underrepresented students studying engineering within the PWI context.

Method

Program Development

The peer mentoring program (PMP) discussed in this study was recently established within a school of engineering at a mid-sized, private, PWI in the Southwest United States (referred to in this paper as *SW-PWI)* to improve the climate for traditionally underrepresented students and to reduce consistent achievement gaps that were observed among retention rates and degree completion. The first full year of the program's implementation was in 2022-23, and further details about the program's origin are presented in [24]. SW-PWI is a four-year institution that enrolled approximately 7,000 undergraduate students in Fall 2022. About 900 of those undergraduates were enrolled in the school of engineering.

Program Structure

All incoming first-year students who were eligible to participate in the PMP were invited to join the program. To be eligible to participate, a student must identify as an underrepresented racial minority (Black, Hispanic, Native American, and/or Alaska Native), a first-generation college student, and/or as coming from a low-socioeconomic background (indicated by Pell Grant-eligibility). Because the goal of the PMP is to reduce equity gaps for students who have historically not been well-represented in engineering, we refer to the collective population of undergraduates who identify in at least one of these categories as *traditionally underrepresented* (TU) students throughout this paper. Program leadership expanded eligibility requirements beyond race and ethnicity to include first-generation status and Pell Grant-eligibility since both populations encounter unique challenges that threaten their persistence and success within engineering [25], [26]. In addition to belonging to a TU group, only students who were enrolled full-time in the school of engineering were invited to join the program. At the beginning of the academic year, students signed an electronic agreement to remain active in the program throughout their first year on campus. There were no costs for students to participate in the program, and they were further incentivized to attend program-wide events where they received free food and affinity merchandise.

Throughout the initial development and ongoing implementation of the program, the PMP leadership team drew heavily upon research related to best practices in supporting traditionally underrepresented students in engineering, first-year students and the transition to college, and underrepresented racial minorities at PWIs. Intentional interventions that promoted social connections among students, such as game nights and design challenges, were woven throughout the PMP's programming to foster students' social support and associated sense of belonging [19]. To encourage faculty relationships, the program hosted mixers that featured opportunities for students to meet and engage with engineering faculty outside of the classroom [27]. The PMP offered at least one event or seminar each week throughout the academic year, all of which featured content designed to support students' transition to college. While widely-recognized practical skills, such as time management, degree planning, financial literacy, and professional development, were included in the programming schedule, the PMP also featured a strong emphasis on student thriving [28]. Specifically, a portion of the program's seminars incorporated less-conventional content for first-year programs in engineering, such navigating imposter

syndrome, identifying and managing to stressors, developing a growth mindset, and refining personal character strengths. The collective range of content addressed in the PMP's weekly seminars was designed to support students' holistic development and well-being, the latter of which is associated with positive retention outcomes for first-year students [29].

Participation in the weekly seminars was encouraged but not required, thus the primary method of engagement for most PMP participants was in the form of one-on-one meetings with their peer mentor. Prior to the beginning of the academic year, upper-class students (i.e., juniors and seniors) who identified as TU students were recruited, interviewed, and selected to serve as paid peer mentors. The PMP's leadership was intentional about creating paid student worker positions for peer mentors to support students who needed additional sources of income. Providing an on-campus employment opportunity is particularly important for students pursuing STEM degrees, as working off-campus is associated with decreased institutional belonging and persistence [30], [31].

At the beginning of the academic year, each peer mentor was assigned approximately five student mentees. The pairings were based on a variety of student-level characteristics, such as gender, race/ethnicity, academic interests, and hobbies. Peer mentors and mentees were required to meet every other week, in person, for approximately one hour. During the first meeting of each semester, peer mentors helped their mentees develop SMART goals related to their academic, social, and professional development; mentors were encouraged to follow-up with their students' progress throughout the academic year and revise goals as necessary. Additional areas of support that peer mentors were encouraged to address included resume writing, coursework selection, student organization membership, and on-campus resources. Outside of these recommendations, peer mentors were encouraged to foster genuine relationships with their mentees and offer support as needed. At the end of each mentee meeting, peer mentors were required to submit an online report that summarized the content of the meeting and gave mentors an opportunity to report any potential retention-related concerns (e.g., financial hardship or academic struggles). These reports were used by PMP leadership for student outreach, as well as to document and disseminate some of the unique barriers faced by PMP participants (e.g., food insecurity) to faculty and administrators within the school of engineering.

Sample

Two-hundred and twenty-nine first-year students enrolled in the school of engineering at SW-PWI in Fall 2022. During Summer 2022, PMP leadership reviewed institutional data and identified 86 students (approximately 37.55% of the first-year engineering class) as TU students who were eligible for program participation. All eligible students received an invitation to participate in the program, and of those, 35 students (40.70% of the eligible population) applied and actively engaged in the PMP throughout the academic year (2022-23). We refer to students who were eligible for the PMP, but who chose not to apply or to participate in the PMP, as *peer mentoring program-eligible* (PMP-E) and students who were not eligible for the program as *non-traditionally underrepresented* (non-TU) throughout this paper. Table 1 demonstrates the descriptive statistics for our sample population.

Table 1. First-Year Engineering Students at SW-PWI: 2022 Cohort (N=229)

	Non-TU (N=143)		PMP-E (N=51)		PMP Participants (N=35)	
Variable	N	Percent	N	Percent	N	Percent
Gender						
Female	41	28.67%	20	39.22%	17	48.57%
Male	102	71.33%	31	60.78%	18	51.43%
Race/Ethnicity						
Asian	14	9.79%	4	7.84%	2	5.71%
Black or African American	0	0.00%	8	15.69%	10	28.57%
Hispanic of any Race	0	0.00%	28	54.90%	18	51.43%
Native Hawaiian/ Other Pacific Islander	2	1.40%	0	0.00%	0	0.00%
International Student of any Race	5	3.50%	0	0.00%	0	0.00%
Race and Ethnicity Unknown	9	6.29%	0	0.00%	0	0.00%
Two or More Races	6	4.20%	2	3.92%	3	8.57%
White	107	74.83%	9	17.65%	2	5.71%
Pell-Eligible	0	0.00%	18	35.29%	25	71.43%
First-Generation College Student	0	0.00%	13	25.49%	15	42.86%

Data Source

We accessed two primary data sources for the purposes of this paper. First, we received Institutional Review Board approval to access an institutional dataset for our sample population. The dataset included student demographic information, declared or intended majors for each academic term, enrollment status for each academic term, term and cumulative credit hours, term and cumulative grade point averages (GPAs), and student participation in campus programs (including the PMP, Honors, and Athletics).

Second, we were granted access to a retention dashboard of de-identified data at SW-PWI. This dashboard allowed researchers and practitioners to track retention at the institution, as well as within individual schools. Further, the dashboard included several filters so that those using it could evaluate retention trends for specified student populations. With this dashboard, we were able to look at historical retention data within the school of engineering at SW-PWI. While we were limited on the available filters, we were able to use the dashboard to get a better understanding of retention-based outcomes for the current cohort, as well as key subpopulations of students, in comparison to previous cohorts.

Measures

We measured first-year student retention at SW-PWI by pulling students' institutional enrollment status *(enrolled, discontinued, leave of absence*, or *not enrolled*) as of the institutional census date (the 12th day of undergraduate classes) for each academic term across the span of one academic year (Fall 2022, Spring 2023, and Fall 2023). Students marked as enrolled on that date

in Spring 2023 were considered retained for the first semester, and students marked as enrolled on that date in Fall 2023 were considered retained for the first year. First-year retention is an important academic success measure within SW-PWI's strategic plan, so we selected it as a primary academic measure of interest. We also measured student retention within the school of engineering by evaluating students' declared or intended major as of the 12th day of undergraduate classes for each academic term. If the student had at least one declared or intended major within the school of engineering, they were considered retained within the school of engineering for that term.

We measured student academic success by examining student term and cumulative GPAs and term hours for Fall 2022 and Spring 2023. Term hours, as referred to in this paper, are the number of hours passed, and therefore completed, for a student and do not include the number of hours a student may have dropped or failed. SW-PWI uses student term hour-completion and GPA as predictors of student retention, persistence, and timely graduation, so we included them as key variables of interest in this study.

Analytic Method

We performed univariate and bivariate analyses to address our research questions. Research Question 1 (RQ1) explored the potential relationship between participation in a peer mentoring program and the retention of traditionally underrepresented first-year students in engineering at a PWI. Since the PMP is a new initiative and there is only one full year of data for program participants, we have limited historical retention data for comparison purposes. As a result, we compared the retention rate of the TU population in the school of engineering (which includes both PMP and PMP-E students) to the retention rate of non-TU students for the 2021 cohort. For the 2022 cohort, we examined the retention rate of the TU population in comparison to the non-TU population, then further examined the retention rates of both PMP and PMP-E students. We limited our study to the 2021 and 2022 cohorts due to changes in admissions policies that were implemented at SW-PWI in Fall 2021. To determine if there were statistical differences for retention across student groups (PMP, PMP-E, or non-TU*)*, we performed a series of chi-square tests.

Research Question 2 (RQ2) explored the relationship between participation in a peer mentoring program and the academic outcomes of traditionally underrepresented first-year students in engineering at a PWI. In order to address this research question, we focused on completed term hours and cumulative GPA for students in the 2022 cohort. We performed a variety of independent samples t-tests between non-TU and TU students, non-TU and PMP-E students, and non-TU and PMP students in order to evaluate various populations of traditionally underrepresented students and their performance as compared to their non-TU peers. We then evaluated differences between the performance of PMP and PMP-E students to better understand achievement gaps between those who participated in the program and their eligible peers. We utilized independent samples t-tests to test for statistical significance between mean values for GPA and completed term hours across the groups.

Results

To address RQ1, we performed a series of chi-square analyses to assess first-year retention data for the 2021 and 2022 cohorts of engineering students at SW-PWI (see Figure 1). For the 2021 cohort, we found that SW-PWI retained non-TU students at a significantly higher rate than TU students ($\chi^2(1, N=207) = 4.019$, $p=0.045$), which aligns with broader trends related to academic persistence gaps for traditionally underrepresented students in engineering [1]. After the implementation of the PMP at SW-PWI, we found no significant difference between the first-year retention of non-TU and TU students ($\chi^2(1, N=229) = 0.044$, $p=0.834$), indicating that traditionally underrepresented populations persisted in engineering at similar rates to their non-TU peers. Further, we found that those who participated in the PMP were retained in engineering at a significantly higher rate than those who were eligible for the program, but did not participate ($\chi^2(1, N=85) = 5.639$, $p=0.018$), indicating a positive relationship between program participation and retention (see Figure 2).

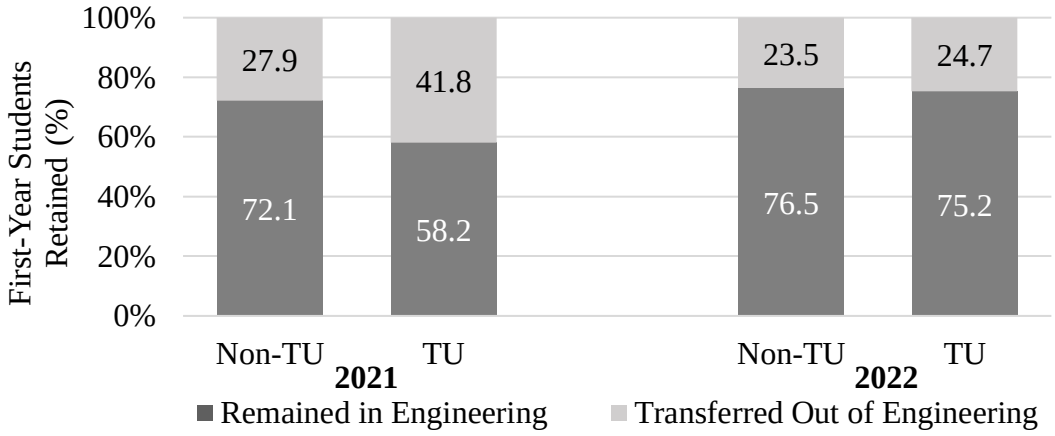

Figure 1. First-Year Student Retention Rates in the School of Engineering: Percentages of TU students and non-TU students who remained in engineering following their first year at SW-PWI.

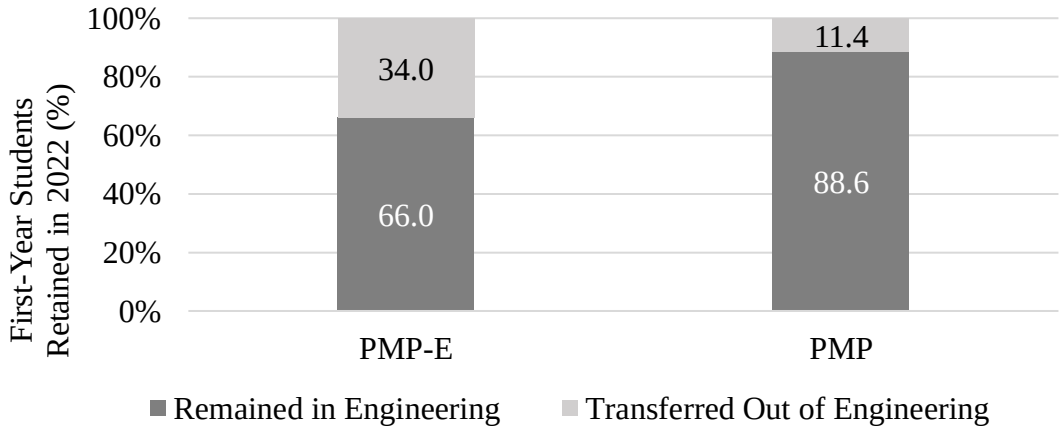

Figure 2. First-Year Student Retention Rates in the School of Engineering in 2022: Percentages of PMP-E students and PMP students who remained in engineering following their first year at SW-PWI.

To address RQ2, we analyzed first-year GPA and completed term hours for the 2022 cohort of first-year engineering students at SW-PWI. First, we compared the first-year cumulative GPA of all TU students to non-TU students. We found that the non-TU population had significantly higher first-year GPAs than their TU peers (t=3.209, p=0.002; see Table 2). This finding aligns with the literature related to equity gaps for traditionally underrepresented students in engineering [10], [32].

Table 2. Academic Performance Metrics: Mean (SD) GPA and completed term hours for Fall 2022 first-year students in school of engineering at SW-PWI

	GPA		Completed Term Hours	
	Mean	St. Dev	Mean	St. Dev
Non-Traditionally Underrepresented Students	3.510	0.426	29.30	3.797
Traditionally Underrepresented Students	3.236**	0.717	28.20	5.448
PMP-Eligible Students	3.161**	0.813	28.02	5.255
PMP Participants	3.343	0.546	28.46	5.782

Significance reflects results of an independent samples t-test between non-TU students and TU student subpopulations. * $p \leq 0.05$, ** $p < .01$, *** $p < .005$.

Since RQ2 seeks to understand the relationship between participation in the PMP and student academic performance, we then evaluated the outcomes for the TU subpopulations (PMP and PMP-E) against their non-marginalized peers. Like the larger TU population, PMP-E students had a significantly lower cumulative first-year GPA than non-TU students (t=2.898, p=0.005). When comparing program participants to their non-TU peers, however, we found no statistical differences between the mean GPAs of the two groups (t=1.693, p=0.097). This finding is meaningful as it demonstrates a positive relationship between program participation and cumulative first-year GPA and demonstrates a narrowing of the equity gap traditionally observed in engineering schools.

We did not find a significant difference between the mean GPAs of those who participated in the PMP (M=3.343) and those who were eligible but chose not to participate (M=3.161). While this difference was not statistically significant, it does have practical implications for the students at SW-PWI. SW-PWI often uses GPA cut-offs as one of many metrics when making financial aid decisions, determining scholarship eligibility, selecting students for study abroad programs, or admitting students into particular majors or minors. GPA thresholds for scholarships and competitive academic programs are typically set between 3.0 and 3.3 at SW-PWI, which puts the PMP-E students at-risk of being filtered out of available opportunities to enrich or enhance their academic experience, or even select their major of choice, due to their cumulative first-year GPA.

We observed no significant differences related to first-years students' completed term hours among the populations (see Table 2). While no statistical differences existed, the results still highlight practical implications for PMP participants at SW-PWI, who completed 0.44 credit hours more, on average, during their first year than their PMP-E peers. According to trends in institutional data, students who do not complete at least 30 term hours by the end of their first

year are less likely to graduate in four years than those who do. For TU students, especially those who are Pell Grant-eligible, the financial implications of having to complete extra semesters of coursework could be detrimental to students' ability to persist and graduate.

Discussion and Conclusion

Prior to the implementation of the PMP, SW-PWI saw large retention-related gaps present between non-TU and TU students. After PMP implementation, those gaps closed significantly, indicating that participation in the PMP had a positive relationship with student retention in the school of engineering. The professional and financial gains associated with a career in engineering offer social and economic mobility in a way that can create generational change [1], therefore, evaluating ways to retain students equitably within engineering majors deserves further attention. While research supports PMPs as an effective tool for encouraging student belonging and academic success [21], [22], [23], the present study points to the particular salience of PMPs as tools to close achievement gaps in engineering at PWIs for TU students. Future research should examine the mechanisms behind the narrowing of the achievement gaps observed following implementation of the PMP.

Future research should also examine which elements of the PMP are most effective for improving student outcomes. For example, the PMP includes both weekly seminars and a peer mentoring element. While research supports both seminars [19], [27], [29] and peer mentoring [21], [22], [23] as effective interventions for first-year student belonging and academic success, the present study examined PMP participation on a whole and not the efficacy of the individual elements of the PMP. By evaluating individual elements of the PMP in addition to overall program participation, program leadership could strengthen those elements most closely aligned with improving student outcomes, as well as potentially develop an intervention model that can be adopted by other institutions who are interested in supporting underrepresented first-year students within their schools of engineering.

Given the relationship between positive academic outcomes and participation in the PMP, the PMP showcases opportunities for future research related to ways institutions can invest in and support traditionally underrepresented engineering students. While the results of this paper indicate strong retention and academic outcomes at the end of students' first year, future research can explore second-, third-, and fourth-year retention, as well as four- and six-year graduation rates. By doing so, researchers will have a better understanding of the institutional pay-off related to investing in first-year students' transition and academic success.

There are several limitations associated with this paper. First, this research is limited by data collection and maintenance practices at SW-PWI. For example, we used declared or intended major as a proxy for retention within the school of engineering. It is possible that students decide they no longer want to pursue a degree in a particular major but choose to wait to formally declare a new one until they have explored alternative options. Conversely, it is possible that a student must declare a dual major in another school but wait to declare their engineering major until later in their academic career (giving the impression that they were not retained in engineering based on institutional data, even if they intended to do so). While we anticipate some

inaccuracies in the data, we expect, based on the current enrollments in engineering coursework at SW-PWI, that any inaccuracies are minimal.

Second, while bivariate analyses are helpful in determining if differences across populations are related to something other than chance, they are limited in that they do not allow for the consideration of multiple independent variables. Future research should employ logistic and multiple regression analyses in order to evaluate primary variables of interest (in this case, student involvement in the PMP) with other key student-level variables (race/ethnicity, Pell Grant eligibility, first generation status, etc.) and other student-related factors, such as engineering identity, sense of belonging, and student thriving.

Despite these limitations, the PMP at SW-PWI appears to be a positive intervention for closing equity gaps related to retention and persistence. Achieving a retention rate of 100% in the school of engineering is not a feasible or realistic goal, and student attrition due to a lack of interest in the discipline should be expected. In an equitable environment, however, we would expect that both non-TU and TU students would leave the school of engineering at similar rates. By utilizing interventions like the PMP, institutions can strategically support TU students to improve equitable outcomes.

References

[1] NCSES, "Diversity and STEM: Women, minorities, and persons with disabilities," National Center for Science and Engineering Statistics, Alexandria, VA, NSF 23-315, 2023. [Online]. Available: https://ncses.nsf.gov/wmpd

[2] S. R. Harper and S. Hurtado, "Nine themes in campus racial climates and implications for institutional transformation," *New Dir. Stud. Serv.*, vol. 2007, no. 120, pp. 7–24, Dec. 2007, doi: 10.1002/ss.254.

[3] S. Hurtado, M. Mayhew, and M. Engberg, "Diversity courses and students' moral reasoning: A model of predispositions and change," *J. Moral Educ.*, vol. 41, no. 2, pp. 201–224, Jun. 2012, doi: 10.1080/03057240.2012.670931.

[4] L. I. Rendon, "Validating culturally diverse students," *Innov. High. Educ.*, vol. 19, no. 1, pp. 33–51, 1994.

[5] S. Secules, "Putting diversity in perspective: A critical cultural historical context for representation in engineering," Jun. 2017. doi: 10.18260/1-2--28776.

[6] M. J. Lee, J. D. Collins, S. A. Harwood, R. Mendenhall, and M. B. Huntt, "'If you aren't White, Asian or Indian, you aren't an engineer': racial microaggressions in STEM education," *Int. J. STEM Educ.*, vol. 7, no. 1, p. 48, Sep. 2020, doi: 10.1186/s40594-020-00241-4.

[7] M. Berger *et al.*, "A tale of two universities: An intersectional approach to examining microaggressions among undergraduate engineering students at an HBCU and a PWI," in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, ASEE Conferences, Jun. 2020, p. 34072. doi: 10.18260/1-2--34072.

[8] K. J. Mills, "'It's systemic': Environmental racial microaggressions experienced by Black undergraduates at a predominantly White institution," *J. Divers. High. Educ.*, vol. 13, no. 1, pp. 44–55, Mar. 2020, doi: 10.1037/dhe0000121.

[9] E. McPherson, "To commit or leave from STEM majors at a PWI: An exploration of African American women's experiences," 2013, pp. 83–102.

[10] K. M. Whitcomb and C. Singh, "Underrepresented minority students receive lower grades and have higher rates of attrition across STEM disciplines: A sign of inequity?," *Int. J. Sci. Educ.*, vol. 43, no. 7, pp. 1054–1089, May 2021, doi: 10.1080/09500693.2021.1900623.

[11] A. L. Pawley, J. A. Mejia, and R. A. Revelo, "Translating theory on color-blind racism to an engineering education context: Illustrations from the field of engineering education," *ASEE Annu. Conf. Expo. Proc.*, Jun. 2018, Accessed: Jan. 16, 2024. [Online]. Available: https://par.nsf.gov/biblio/10067982-translating-theory-color-blind-racism-engineering-education-context-illustrations-from-field-engineering-education

[12] D. E. Chubin, G. S. May, and E. L. Babco, "Diversifying the engineering workforce," *J. Eng. Educ.*, vol. 94, no. 1, pp. 73–86, 2005, doi: 10.1002/j.2168-9830.2005.tb00830.x.

[13] R. T. Palmer, D. C. Maramba, and T. E. Dancy, "A Qualitative Investigation of Factors Promoting the Retention and Persistence of Students of Color in STEM," *J. Negro Educ.*, vol. 80, no. 4, pp. 491–504, 2011.

[14] S. A. Elkins, J. M. Braxton, and G. W. James, "Tinto's separation stage and its influence on first-semester college student persistence," *Res. High. Educ.*, vol. 41, no. 2, pp. 251–68, 2000.

[15] K. C. Smith, C. Poleacovschi, S. Feinstein, and S. Luster-Teasley, "Ethnicity, race, and gender in engineering education: The nuanced experiences of male and female Latinx

engineering undergraduates targeted by microaggressions," *Psychol. Rep.*, p. 00332941221075766, Jan. 2022, doi: 10.1177/00332941221075766.
[16] S. L. Dika and M. M. D'Amico, "Early experiences and integration in the persistence of first-generation college students in STEM and non-STEM majors," *J. Res. Sci. Teach.*, vol. 53, no. 3, pp. 368–383, 2016, doi: 10.1002/tea.21301.
[17] J. Grant, S. Masta, D. Dickerson, A. L. Pawley, and M. W. Ohland, "'I don't like thinking about this stuff': Black and Brown student experiences in engineering education," *2022 ASEE Annu. Conf. Expo.*, Jul. 2022, Accessed: Jan. 16, 2024. [Online]. Available: https://par.nsf.gov/biblio/10382972-dont-like-thinking-about-stuff-black-brown-student-experiences-engineering-education
[18] J. A. Whittaker and B. L. Montgomery, "Cultivating diversity and competency in STEM: Challenges and remedies for removing virtual barriers to constructing diverse higher education communities of success," *J. Undergrad. Neurosci. Educ.*, vol. 11, no. 1, pp. A44–A51, Oct. 2012.
[19] D. R. Johnson, "Campus racial climate perceptions and overall sense of belonging among racially diverse women in STEM majors," *J. Coll. Stud. Dev.*, vol. 53, no. 2, pp. 336–346, 2012.
[20] R. Campbell-Montalvo *et al.*, "The influence of professional engineering organizations on women and underrepresented minority students' fit," *Front. Educ.*, vol. 6, 2022, Accessed: Feb. 06, 2023. [Online]. Available: https://www.frontiersin.org/articles/10.3389/feduc.2021.755471
[21] G. Flores and A. Estudillo, "Effects of a peer-to-peer mentoring program: Supporting first-year college students' academic and social integration on campus," *J. Hum. Serv. Train. Res. Pract.*, vol. 3, no. 2, Oct. 2018, [Online]. Available: https://scholarworks.sfasu.edu/jhstrp/vol3/iss2/3
[22] R. Gable, *The hidden curriculum: First generation students at legacy universities*. Princeton University Press, 2021.
[23] C. Gattis, B. Hill, and A. Lachowsky, "A successful engineering peer mentoring program," presented at the 2007 Annual Conference & Exposition, Jun. 2007, p. 12.133.1-12.133.17. Accessed: Feb. 06, 2023. [Online]. Available: https://peer.asee.org/a-successful-engineering-peer-mentoring-program
[24] K. Rola and C. Anderson, "Work in progress: Efficacy of a peer mentoring program for underrepresented first-year students at a predominantly white institution," presented at the 2023 ASEE Annual Conference & Exposition, Jun. 2023. Accessed: Feb. 08, 2024. [Online]. Available: https://peer.asee.org/work-in-progress-efficacy-of-a-peer-mentoring-program-for-underrepresented-first-year-students-at-a-predominantly-white-institution
[25] J. P. Martin, S. K. Stefl, L. W. Cain, and A. L. Pfirman, "Understanding first-generation undergraduate engineering students' entry and persistence through social capital theory," *Int. J. STEM Educ.*, vol. 7, no. 1, p. 37, Aug. 2020, doi: 10.1186/s40594-020-00237-0.
[26] R. Stevens, K. O'Connor, L. Garrison, A. Jocuns, and D. M. Amos, "Becoming an engineer: Toward a three dimensional view of engineering learning," *J. Eng. Educ.*, vol. 97, no. 3, pp. 355–368, 2008, doi: 10.1002/j.2168-9830.2008.tb00984.x.
[27] C. Newman, "Engineering success: The role of faculty relationships with African American undergraduates," *J. Women Minor. Sci. Eng.*, vol. 17, pp. 193–207, Jan. 2011, doi: 10.1615/JWomenMinorScienEng.2011001737.
[28] L. A. Schreiner, "Thriving in college," *New Dir. Stud. Serv.*, vol. 143, pp. 41–52, 2013.

[29] J. Bean and S. B. Eaton, “The psychology underlying successful retention practices,” *J. Coll. Stud. Retent. Res. Theory Pract.*, vol. 3, no. 1, pp. 73–89, May 2001, doi: 10.2190/6R55-4B30-28XG-L8U0.
[30] E. T. Pascarella and P. T. Terenzini, *How college affects students: Findings and insights from twenty years of research.* San Francisco: Jossey-Bass, 1991.
[31] L. W. Perna, M. Gasman, S. Gary, V. Lundy-Wagner, and N. D. Drezner, “Identifying strategies for increasing degree attainment in STEM: Lessons from minority-serving institutions,” *New Dir. Institutional Res.*, vol. 2010, no. 148, pp. 41–51, 2010, doi: 10.1002/ir.360.
[32] M. W. Ohland *et al.*, “Race, gender, and measures of success in engineering education,” *J. Eng. Educ.*, vol. 100, no. 2, pp. 225–252, 2011, doi: 10.1002/j.2168-9830.2011.tb00012.x.