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Work in Progress: Efficacy of a Peer Mentoring Program for Underrepresented First-Year Students at a Predominantly White Institution

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Introduction

The structure of higher education in the United States often favors the norms and values of majority populations, as well as those with family members who have previously navigated the postsecondary system [1]. Moreover, the field of engineering represents a discipline in which policies and practices that privilege White men are particularly entrenched [2]. For this and other socially-constructed reasons, engineering programs tend to retain and graduate Black, Hispanic, and Native American students at disproportionately lower rates than their White peers [3]. This phenomenon ultimately leads to reduced professional opportunities and social mobility for these populations. Identifying interventions that lead to improved academic outcomes for historically underrepresented students in engineering is a critical step to broadening participation and diversifying the discipline. Programs that target students during their first year of college represent a particularly salient context in which to examine impacts, as the first year of college is when students are most likely to decide whether or not to persist within a degree [4]. The purpose of this work in progress paper is to examine outcomes associated with participation in a novel peer mentoring program designed for traditionally underrepresented first-year students in engineering at a predominantly White institution (PWI). 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?

When examining the persistence rates of various student subgroups, it becomes clear that certain populations experience larger barriers to academic success than others. Specifically, underrepresented racial minorities, first-generation students, and students from low-socioeconomic backgrounds leave the engineering pipeline at higher rates than their majority peers [5]. Reasons that these students report leaving engineering often include poor performance in introductory coursework [6], negative experiences with faculty [7], a poor sense of fit [8], and generally unwelcoming environments in their schools of engineering [9]. Conversely, when underrepresented students experience social support, encounter role models [10], and receive assistance navigating the engineering curriculum [11], they experience positive engineering-related outcomes. One way to provide these beneficial layers of support for students who are early in their academic careers is through the implementation of formalized peer mentoring. Peer mentors facilitate incoming students' transition to college by connecting them to campus resources, providing emotional support, fostering social connections, serving as an accountability partner, and being a role model. Peer mentors also provide insights and guidance to mentees based on their own experiences navigating the university environment. Peer mentoring programs have proven to be effective intervention tools at improving academic performance and retention in other schools of engineering [12]; thus, this intervention model was adopted to support traditionally underrepresented first-year students at a PWI.

Method

Program Development

The peer mentoring program described in this paper is housed in the school of engineering at a private, four-year PWI in the Southwest United States (hereafter referred to as *SW-PWI*). In Fall 2022, total undergraduate enrollment at SW-PWI was approximately 7,000 students, and roughly 900 undergraduate students were enrolled in the school of engineering. Much like the broader literature suggests, data from SW-PWI demonstrate that underrepresented racial minorities consistently experience disproportionately low retention and graduation rates in the school of engineering. To improve these trends, in 2020, the school of engineering at SW-PWI began taking steps to actively support racial minorities within the school. Faculty, staff, and student input led to the recommendation to adopt an institutionalized peer mentoring program (PMP). Engineering education faculty and underrepresented engineering students designed the PMP in Fall 2021 and piloted the program in Spring 2022. The program's leadership team incorporated additional structural elements into the program in Fall 2022, and the first full year of implementation (2022-2023) is currently underway. Data from the Spring 2022 semester of the PMP are excluded from this analysis since the pilot semester of the program lacked many of the structural components that are currently in place.

While the goal of the PMP is to support traditionally underrepresented students in pursuit of an engineering degree, we anticipate that some students leave the school of engineering due to an initial misconception of the field or lack of interest in the discipline. The PMP leadership acknowledges that, because of this reason, achieving 100% first-year retention is an unlikely goal. However, in an equitable world, attrition due to lack of interest in engineering should occur among traditionally underrepresented and majority student populations at similar rates. When traditionally underrepresented students exit the engineering pipeline at disproportionately high rates, it is indicative of a systemic issue. Reducing achievement gaps between traditionally underrepresented students and their majority peers is an intended outcome of the PMP.

Program Structure

To be eligible to participate in the PMP, a student must be enrolled full-time in the school of engineering at SW-PWI and be an incoming college student. Further, students must identify as an underrepresented racial minority (Black, Hispanic, or Native American), a first-generation college student, and/or as coming from a low-socioeconomic background (indicated by Pell Grant-eligibility). The collective population of students who identify in at least one of these categories is referred to 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 are underrepresented in STEM and experience unique challenges that threaten their persistence [1], [13]. To encourage participation in the PMP, there is no cost associated with program involvement for students. Students commit to participate in the program for one academic year.

The PMP leadership team grounded the design and implementation of the PMP in empirical evidence related to the first year of college, undergraduate retention, underrepresented racial

minorities and first-generation students in engineering, and college student thriving. While the goal of improving academic outcomes for underrepresented first-year engineering students is substantial on its own, the PMP's leadership is committed to investing in the holistic student so that they flourish across all dimensions of their being. Schreiner (2010) defines college student thriving as "students who are fully engaged intellectually, socially, and emotionally" (p.4). Thriving is integral to both students' well-being and their college retention [14]. To promote student thriving, the program features two main components: weekly seminars and peer mentoring. Each program component engages participants in complementary ways to provide a multidimensional approach to supporting students during their first year of college.

Weekly Seminars

PMP leadership and various student support offices at SW-PWI lead weekly seminars to expose students to skills and resources that facilitate their transition to college and the progression of their academic careers. The program's leadership encourages students to attend these seminars, but attendance is not required. The seminars provide student support in four key areas: 1) social engagement, 2) academic success, 3) professional development, and 4) personal well-being. The first seminar area, social engagement, is important for first-year students, as belonging to a community is critical for developing a sense of belonging and institutional fit [15]. Intentionally building community is particularly important for the persistence of first-generation and underrepresented racial minorities in the PWI context where they have limited opportunities to engage with diverse peers [6], [16]. The second seminar theme, academic success, supports students' transition to college and the navigation of the engineering curriculum. These seminars expose students to time management skills, course enrollment and degree planning resources, and opportunities to engage with engineering faculty in informal settings. The third seminar area, professional development, encompasses topics such as career planning, obtaining internships, and networking with professional engineers. Developing an engineering identity is critical to minority students' persistence [17], [18]; thus, the program's leadership designed the aforementioned content in an effort to provide the foundation of students' self-concepts as engineers. Students' personal well-being is likewise important for persistence [19], [20]; thus, a portion of weekly seminars address topics like identifying and managing stressors, developing a positive mindset, reframing cognitive distortions, and navigating imposter syndrome.

Peer Mentoring

Peer mentoring, which is required for all PMP participants, represents the majority of first-year students' engagement with the program. Peer mentors meet with their mentees every other week for approximately one hour. To track mentor-mentee engagement, peer mentors maintain a spreadsheet of scheduled and completed meetings in a shared, online drive. At the beginning of the academic year, peer mentors assist their mentees in the development of a personalized mentoring plan related to the achievement of academic, professional, and social goals. This mentoring plan serves as a road map for students' first semester on campus by providing within-semester target dates for completing smaller tasks. Students revisit and revise their goals at the beginning of the second term based on changes in their interests and prior goal attainment. Because first-generation and low-income students are often reluctant to seek help and utilize campus resources [21], peer mentors are highly encouraged to take their mentees to multiple

student support offices and to facilitate faculty introductions during office hours. Mentors are also responsible for supporting their mentees in the development of a professional resume, LinkedIn profile, and informal four-year degree plan. Outside of these expectations, each peer mentor has autonomy in their approach to conducting meetings, including the topics of conversation and the format (i.e., one-on-one meetings or meeting as an entire mentee group). Following all mentee meetings, peer mentors complete an online report that summarizes the meeting and provides an opportunity for mentors to identify and describe any areas of concern related to their mentees' campus adjustment. The program's leadership uses information from these reports to provide additional layers of individualized support for PMP participants, such as connecting students to tutors, scholarship resources, and counseling services.

Working off-campus while pursuing a STEM degree can lessen students' institutional belonging and persistence [22], [23]; thus, the PMP pays peer mentors in an effort to provide on-campus employment that aligns with their academic and professional goals. The program's leadership team thoughtfully recruits and selects peer mentors during the spring semester before employment begins. To be eligible for the position, a student must be an upper-class student who is enrolled full-time in the school of engineering, and preference is given to those who possess at least one traditionally underrepresented identity. At the beginning of the academic year, PMP leadership trains peer mentors on student support services within the school of engineering, broader institutional resources, and strategies to engage with mentees. The leadership then strategically pairs mentors with incoming students based on academic interests and racial and/or gender identity. In Fall 2022, the PMP employed nine peer mentors and assigned each peer mentor either four or five first-year mentees.

Sample

In Fall 2022, 229 first-year students entered the school of engineering at SW-PWI. Program leadership used institutional data during the summer preceding the first term on campus to identify eligible program participants, and approximately 37.55% (N=86) of the first-year class identified as a TU student. PMP leadership sent invitations to participate in the program to all eligible first-year students, and of those, 44.19% (N=38) applied and 40.70% (N=35) actively engaged in the PMP in Fall 2022. For the purposes of this study, we refer to the eligible students who chose not to apply to or participate in PMP as *peer mentoring program-eligible* (PMP-E). We refer to students not eligible for the program as *non-traditionally underrepresented* (non-TU) students. The focal point of this work in progress paper is the impact of the PMP on first-year student retention and academic outcomes, thus we excluded the transfer students who participated in the PMP (N=3) from our analysis. Table 1 includes descriptive statistics for our sample.

Data Source

To address the research questions, we utilized three main data sources. First, with approval from the Institutional Review Board, we collaborated with pre-major advisors in the school of engineering at SW-PWI to obtain Fall 2022 and Spring 2023 enrollment rosters for the school of engineering. These rosters included demographic information for all current majors or pre-majors in the school of engineering.

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%

We compared the two rosters to determine student transfer status, both out of the school of engineering and out of SW-PWI. The rosters also included students' term grade point average (GPA) and term hours completed for Fall 2022, which were used as measures of academic outcomes. Term hours completed refer to the credit hours that students passed and completed in a semester, and do not reflect students' initial credit hour enrollment. We selected both GPA and term hours completed as measurement metrics because SW-PWI uses these variables to measure student persistence and to predict students' retention and graduation.

Second, we requested and received access to a retention dashboard at SW-PWI. This dashboard contains historical retention data both within the school of engineering and at the institution. The dashboard contains filters that allows users to sort data based on race and Pell-eligibility. Unfortunately, there are limitations to the dashboard as it does not include a filter for first-generation student status. Despite the limitation, the dashboard gave us the ability to compare current first-year student retention rates to historical student retention rates across multiple entry cohorts and different subpopulations of students. Finally, PMP leadership provided us with data on the students participating in the program. We were able to use this information to compare PMP participants to PMP-E and non-TU students.

Our research goal is to evaluate the entire first year of the program's implementation, which includes first and second-term retention rates and academic outcomes. Since we are only partially through the first year of implementation, this work in progress paper presents preliminary findings related to first-term retention and academic outcomes only. In future papers, we will evaluate how participation in the PMP relates to ongoing student persistence and four-year graduation rates at SW-PWI.

Analytic Method

We employed univariate and bivariate analyses to address the research questions outlined in this study. Research Question 1 (RQ1) explores the extent to which participation in the PMP relates to the retention of TU first-year students in engineering at a PWI. Because the program is in its first full year of implementation, there is limited historical data from which to draw retention-related comparisons. Our approach was to compare the retention rate of the entire TU population in the school of engineering (underrepresented racial minorities, first-generation, and Pell-eligible students) to the retention rate of all other students (non-TU) for the 2021 and 2022 first-year cohorts. We focused on these cohorts as SW-PWI implemented new admissions policies in 2021 to address student testing implications related to COVID-19. Complete first-year retention data for the 2022 cohort will not be available until Fall 2023, thus the present analysis is limited to first-term retention data for the 2022 cohort and first-year retention data for the 2021 cohort. While descriptive statistics indicate if differences in retention status exist across different populations, they do not provide information on a statistically significant relationship. In order to examine statistical significance for any differences between retention status for the two groups, we performed a series of chi-square tests [24].

Research Question 2 (RQ2) explores the extent to which participation in a peer mentoring program relates to the academic outcomes of TU first-year students in engineering at a PWI. To address this research question, we compared the GPAs and term hours completed for the 2022 first-year cohort. One goal of the PMP is to reduce achievement gaps between TU populations and their majority peers, so we compared the first-term GPAs and completed term hours of PMP participants to non-TU students. We then repeated our analysis for PMP-E students to evaluate any achievement gaps between those who participated in the program and their similarly-situated peers. We performed a series of independent samples t-tests to examine statistical significance for any differences between mean values for these groups [24].

Once data for the entire first year of implementation of the PMP is available, we plan to utilize logistic regression and multiple regression analyses to determine the student-level variables (i.e., race, first-generation status, Pell-eligibility, and PMP participation) that influence retention and academic outcomes [24].

Results and Discussion

The PMP described in this paper appears to represent a successful intervention related to increasing the participation of historically underrepresented students in engineering. Findings from this preliminary analysis indicate that the PMP relates positively to students' first-semester retention in the school of engineering, as well as their academic performance. To address RQ1, we analyzed first-year retention data for the 2021 and 2022 first-year cohorts in the engineering school at SW-PWI. As previously mentioned, complete first-year retention data for the 2022 cohort will not be available until Fall 2023, thus the present analysis is limited to first-term retention for the 2022 cohort and first-year retention for the 2021 cohort (see Figure 1).

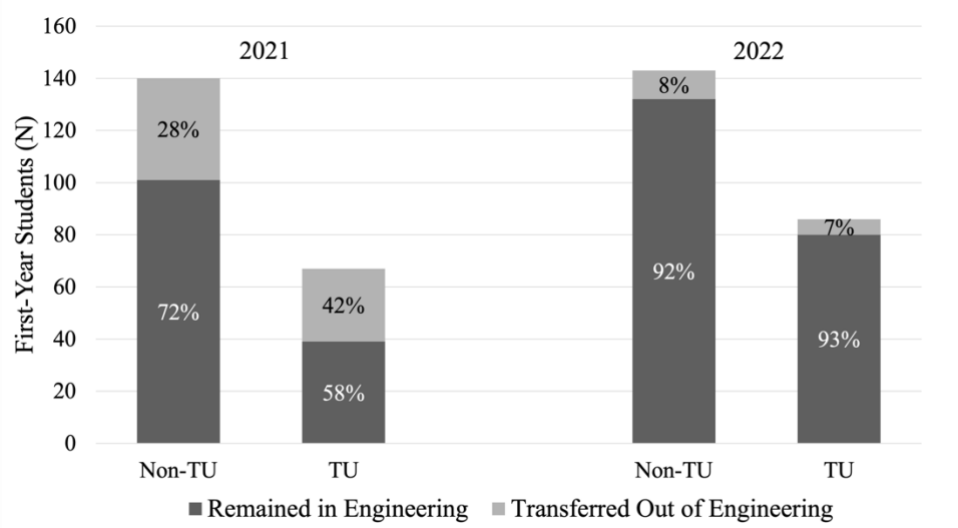

Figure 1. First-Year Student Retention Rates in the School of Engineering: Frequencies of TU students and non-TU students who remained in engineering following their first year (2021) or first term (2022) at SW-PWI.

For the 2021 cohort, we found that non-TU students persisted in the school of engineering at a significantly higher rate than TU students ($\chi^2(1, N=207) = 4.019$, $p=0.045$). The relationship between first-term retention and subpopulation was not significant for the 2022 cohort ($\chi^2(1, N=229) = 0.040$, $p=0.841$), indicating that, at least after the first term, TU students persisted at similar rates to their majority peers. Further, while the relationship was not significant ($\chi^2(1, N=229) = 1.543$, $p=0.214$), we found that students who participated in the PMP returned to the school of engineering in the Spring 2023 semester at a higher rate than their eligible peers who did not participate in the program (97% and 90%, respectively). We plan to further assess these relationships by analyzing first-year retention data with a logistic regression model in Fall 2023.

To address RQ2, we analyzed first-term academic outcomes for first-year engineering students. We compared the academic performance of all TU students to all non-TU students and found that the TU population had significantly lower GPAs than their peers ($t=2.779$, $p=0.006$; see Table 2).

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	3.478	0.580	14.874	2.258
Traditionally Underrepresented Students	3.209**	0.779	13.814***	2.957
PMP-Eligible Students	3.175*	0.859	13.608**	3.047
PMP Participants	3.257*	0.655	14.114	2.836

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

We next compared the academic performance of TU student subpopulations to non-TU students. Eligible students who did not participate in the PMP had significantly lower first-term GPAs than their non-TU peers ($t=-2.335$, $p=0.022$). The mean first-term GPA for PMP participants was significantly lower than that of their majority peers ($t=-1.971$, $p=0.050$). There was also no significant difference between the GPAs of PMP-E students and PMP participants ($p=0.640$). While statistically insignificant, the 0.203-point difference in GPA between PMP participants and non-TU students reflects a narrowing of the achievement gap that was observed (0.303 points) between non-PMP participants and majority students. The observed mean GPA difference (0.82 points) between underrepresented student groups likely reflects important practical implications for these students, as students' GPA is considered for financial aid, scholarship eligibility, major acceptance, and other thresholds that impact their ability to persist.

To further address RQ2, we analyzed the number of term hours completed for first-year engineering students. This is considered an important metric for students' likelihood of graduating in four years. On average, non-TU students completed significantly more hours than TU students ($t=2.861$, $p=0.005$; see Table 2). When assessed by subpopulation, PMP-E students completed significantly fewer term hours than non-TU students ($t=-2.714$, $p=0.008$). However, PMP participants completed academic credit hours at similar rates to their majority peers ($t=-1.693$, $p=0.092$). These data suggest that PMP participation positively relates to academic outcomes for underrepresented first-year students in engineering at SW-PWI. Further, they reflect practical implications for student persistence and graduation, as degree plans in the school of engineering at SW-PWI require students to complete more credit hours than degree plans in other disciplines. The 0.506-hour difference between PMP participants and PMP-E students represents the loss of roughly one term hour per academic year for eligible non-PMP participants. Every additional credit hour completed by PMP participants helps ensure that they complete their degrees in four years, which can impact tuition expenses, professional opportunities, and lifelong earning potential.

The findings of this work in progress paper are limited by both data availability and the small sample size of the student populations under consideration. Despite this, the PMP represents an outlet for abundant future research related to best practices in supporting underrepresented engineering students. The program's structure allows for a snapshot of student engagement during their first-year as a program participant, while also providing an opportunity for longitudinal analysis as students progress through their academic careers. There are likewise abundant opportunities to explore outcomes associated with being a peer mentor. To pursue qualitative analyses, we would like to conduct focus groups with members of the 2022-23 mentee cohort to better understand how the program impacted their first year on campus. Eventually, we would also like to utilize quantitative instruments to assess the relationship between PMP participation and individual-level persistence predictors, such as engineering identity, sense of belonging, and student thriving. Future longitudinal analyses that track students' enrollment in the school of engineering and time-to-degree completion will also reveal if supporting first-year students during their transition to college yields ongoing benefits as they progress through their academic careers.

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