Board 389: Strengthening Student Motivation and Resilience through Research and Advising

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Dr. Wong is an Assistant Professor in the School of Engineering at San Francisco State University (SFSU). Her research interests focus on traditional and sustainable structural resilience and engineering education. Her doctorate research at UC Berkeley investigated the applicability of seismic isolation and supplemental viscous damping to nuclear power plants with focus on seismic resilience and safety. After receiving her PhD, Dr. Wong began a post-doctoral fellowship at Lawrence National Laboratory focusing on computational analysis for nonlinear seismic analysis of Department of Energy nuclear facilities and systems. She has established an active research lab at SFSU with a diverse group of undergraduate and Master's level students. For her engineering education research, she is interested in exploring how to use technology such as virtual reality and 3D printing to enhance student engagement. She is an active member of ASCE, ASEE, and SEAONC.

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Strengthening Student Motivation and Resilience through Research and Advising

Abstract

At San Francisco State University, a Hispanic Serving Institute and a Primarily Undergraduate Institution, 67% of engineering students are from ethnic minority groups, with only 27% of Hispanic students retained and graduated in their senior year. Additionally, only 14% of students reported full-time employment secured at the time of graduation. Of these secured jobs, only 54% were full-time positions (40+ hours a week). To improve the situation, San Francisco State University, in collaboration with two local community colleges, Skyline and Cañada Colleges, was recently funded by the National Science Foundation through a Hispanic Serving Institute Improving Undergraduate STEM Education Strengthening Student Motivation and Resilience through Research and Advising program to enhance undergraduate engineering education and build capacity for student success. This project will use a data-driven and evidence-based approach to identify the barriers to the success of underrepresented minority students and to generate new knowledge on the best practices for increasing students' retention and graduation rates, self-efficacy, professional development, and workforce preparedness. Three objectives underpin this overall goal. The first is to develop and implement a Summer Research Internship Program together with community college partners. The second is to establish an HSI Engineering Success Center to provide students with academic resources, networking opportunities with industry, and career development tools. The third is to develop resources for the professional development of faculty members, including Summer Faculty Teaching Workshops, an Inclusive Teaching and Mentoring Seminar Series, and an Engineering Faculty Learning Community. Qualitative and quantitative approaches are used to assess the project outcomes using a survey instrument and interview protocols developed by an external evaluator.

This paper discusses an overview of the project and its first-year implementation. The focus is placed on the introduction and implementation of the several main project components, namely the Engineering Success Center, Summer Research Internship Program, and Faculty Summer Teaching Workshop. The preliminary evaluation results, demonstrating the great success of these strategies, are also discussed.

The Need

San Francisco State University (SFSU) is classified as a Hispanic Serving Institute (HSI) with a deep-rooted and long-standing history and commitment to recruiting, retaining, and graduating a highly diverse student body, particularly from underrepresented minority (URM) groups. In 2019, SFSU was named one of the nation's most ethnically and culturally diverse campuses by *Diverse Issues in Higher Education*, which rated SFSU as a top producer of minority baccalaureates nationally in 22 disciplines[1]. In Fall 2020, 42.8% of the total 27,075 enrolled students were among

the federally designated URM groups, while 52% were first-generation college students. During the same period, 31% of students were financially disadvantaged, and 65% received financial aid from different sources (e.g., 57% Pell Grants and 46% Federal loans). In addition to that, 75% of all students had to work part- or full-time to cover their educational expenses. The School of Engineering (SoE) is currently the second-largest major in terms of student enrollment (5.3% of the total campus student population; 1394 total in 2020[2]). Over the past ten years, engineering enrollment has steadily increased with a recent drop starting in Fall 2019. However, the demographics of the first-time freshman (noted as 1st Freshman in the following tables) and new undergraduate transfer students present concerning trends. Although there is a consistent increase in enrollment of first-time Hispanic freshmen (see Tables 1 and 2), there is a significantly lower percentage of Hispanic transfer students. It also can be seen from Table 1 that the percentage of the female engineering student population is much lower than that of the university. Besides, there is a low graduation rate for Hispanic students (Table 3) with the fourth-year retention rate for first-time freshman Hispanic students falling below the overall retention rate (Table 4). These 1st Freshman rates contrast against a much higher second-year retention rate for Hispanic transfer students (Table 5). Additionally, only 14% of students reported full-time employment secured at the time of graduation. Of these secured jobs, only 54% were full-time positions (40+ hours a week). As a result, there is an urgent need to improve the graduation rate of all Hispanic students and better prepare them for their future careers.

Table 1. Entry enrollment Student Type

	1st Freshman-Engineering				1st Freshman (SFSU)			
Yr.	All Engr	Hispanic	African American	Female	All Univ	Hispanic	African American	Female
17	281	130 (46%)	14 (5%)	45 (16%)	4323	1946 (45%)	249 (6%)	2662 (62%)
18	308	125 (41%)	13 (4%)	54 (18%)	4287	1920 (45%)	256 (6%)	2561 (60%)
19	237	118 (50%)	9 (4%)	37 (16%)	3688	1681 (46%)	237 (6%)	2161 (59%)
20	178	84 (47%)	8 (4%)	29 (16%)	2779	1280 (46%)	197 (7%)	1666 (60%)

Table 2. Entry enrollment Student Type

	New UG Transfer Engineering				New UG Transfer (SFSU)			
Yr.	All Engr	Hispanic	African American	Female	All Univ	Hispanic	African American	Female
17	167	44 (26%)	12 (7%)	26 (16%)	3710	1203 (32%)	254 (7%)	1918 (52%)
18	154	44 (29%)	9 (6%)	23 (15%)	3390	1117 (33%)	190 (6%)	1745 (52%)
19	175	62 (35%)	11 (6%)	23 (13%)	3554	1201 (34%)	211 (6%)	1830 (52%)
20	112	34 (30%)	9 (8%)	16 (14%)	3016	1092 (36%)	197 (7%)	1578 (52%)

Table 3. Degree Granted

	Engineering				SFSU			
Yr.	All Engr	Hispanic	African American	Female	All Univ	Hispanic	African American	Female
16	187	37 (20%)	7 (4%)	26 (14%)	6094	1562 (26%)	247 (4%)	3423 (56%)
17	205	53 (26%)	11 (5%)	29 (14%)	6288	1812 (29%)	276 (4%)	3532 (56%)

18	232	62 (27%)	8 (3%)	44 (19%)	6356	1960 (31%)	319 (5%)	3590 (57%)
19	240	65 (27%)	12 (5%)	32 (13%)	6283	1995 (32%)	318 (5%)	3539 (56%)

Table 4. Fourth-Year Retention Rate for 1st Freshman

	Engineering (%)				SFSU (%)			
Yr.	All Engr	Hispanic	African American	Female	All Univ	Hispanic	African American	Female
13	48.3	44.4	33.3	57.1	62.5	61.7	67.1	64.0
14	59.4	45.2	66.7	71.4	60.4	57.1	60.0	63.3
15	47.3	34.5	100	51.3	58.7	54.0	54.5	60.8
16	46.3	39.2	33.3	68.4	58.5	55.0	55.5	60.0

Table 5. Second-Year Retention Rate for Community College Transfer Students

	Engineering (%)				SFSU (%)			
Yr.	All Engr	Hispanic	African American	Female	All Univ	Hispanic	African American	Female
15	71.3	82.1	87.5	61.1	79.4	79.8	74.7	80.1
16	75.4	67.6	100	75.0	79.5	77.4	72.1	80.3
17	81.8	85.7	100	94.7	81.4	81.2	77.7	83.8
18	80.3	79.3	75.0	86.7	80.2	79.5	73.2	81.7

NSF HSI Program

Responding to this need, SFSU is funded by the National Science Foundation (NSF) HSI Improving Undergraduate STEM Education (IUSE) Strengthening Student Motivation and Resilience through Research and Advising (S-SMART) program on a collaborative effort with two local community colleges, Cañada College and Skyline College, to enhance the quality of engineering education and increase the recruitment, retention, and graduation of URM engineering students. The goal of this project is to enhance undergraduate engineering education and build capacity in the School of Engineering at SFSU, by: (1) increasing retention and graduation rates of URM students, particularly, Hispanic students by 30%; (2) shortening time to graduation; (3) enhancing career development opportunities and resources for students; (4) improving teaching effectiveness through faculty development, and (5) strengthening our collaborative relationship with our local community colleges. This will be achieved by pursuing the following objectives: (1) Developing and implementing a Summer Research Internship Program in collaboration with our community college partners, a Transfer Evaluation Days event to advise new transfer students; (2) Establishing an HSI Engineering Success Center (ESC) to foster and centralize career development resources; and (3) Collaborating and offering faculty development workshops and seminars creating an environment of open discussion on effective teaching methods, particularly for the URM student population. The logic model in Figure 1 serves as an overview of the NSF HSI program.

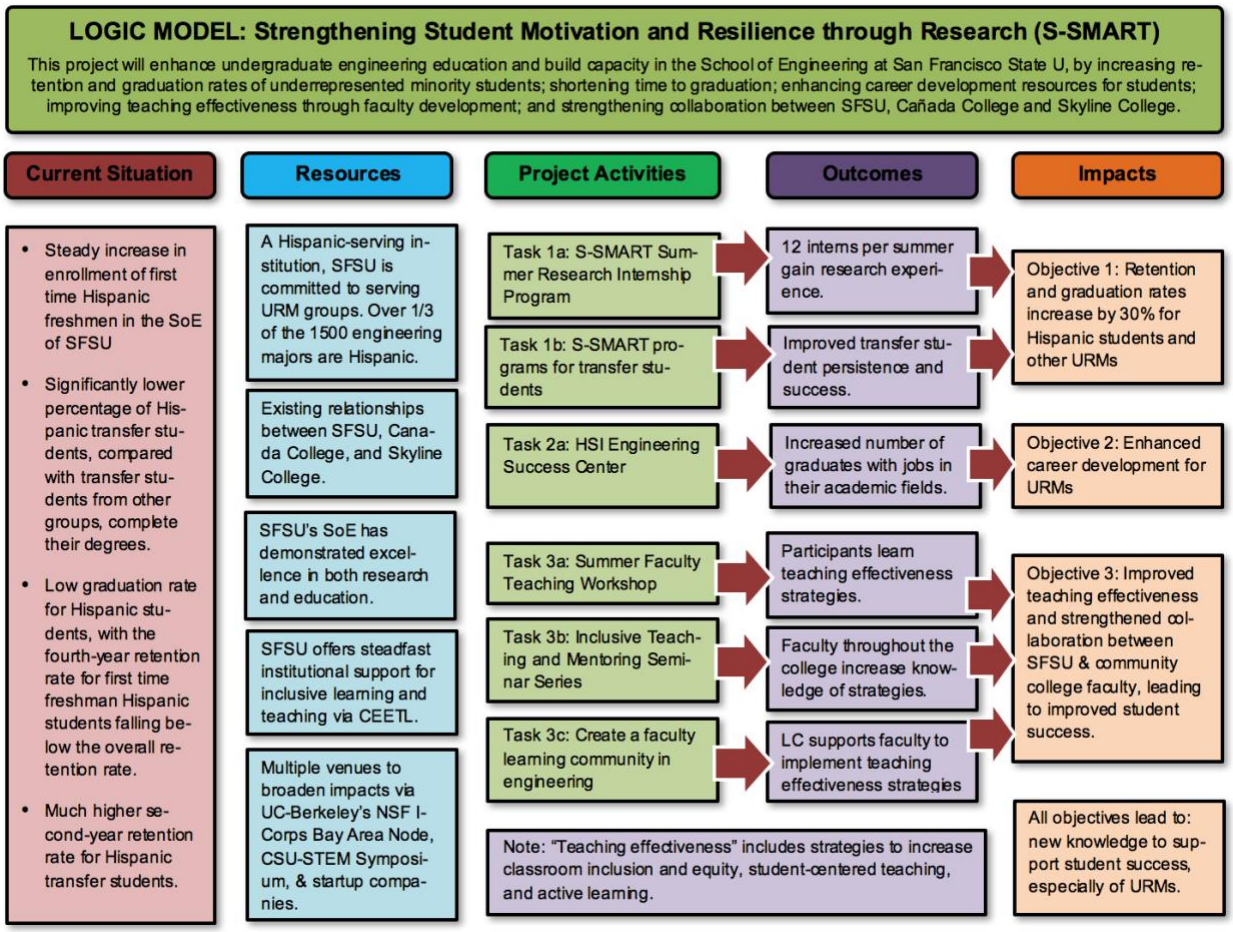

Figure 1. Logic Model of the NSF HSI Program

First Year Implementation

The project started on Oct. 1, 2021. During over one year of implementation, we put the focus on establishing three main components of the program, namely the Engineering Success Center, the Summer Research Internship Program, and the Summer Faculty Teaching Workshop. In the following, a brief introduction to these components is provided, followed by a summary of the evaluation results.

Engineering Success Center (ESC): Despite the COVID-19 pandemic, an ESC was established to provide academic support and career development services to students. The center is aimed at increasing student retention, graduation rates, and career development. At SFSU, there was still a significant percentage of courses being taught through remote modality up to Spring 2022. Students were geographically spread out which made engagement and communication more challenging than ever. The ESC initiated several services, including tutoring, academic excellence workshops, and strategies for success seminars. Tutoring was offered as a hybrid option to broaden the range of students who could participate and engage with the service. With the students back to in-person instruction, the ESC is expected to offer more services such as academic and career

counseling, assistance in securing scholarships, and conducting workshops on interview tips and resume preparation. In addition, the ESC intends to serve as a community center for the Society for Hispanic Professional Engineers (SHPE), National Society of Black Engineers (NSBE), and Society of Women Engineers (SWE) to reach out to URM students in engineering through peer mentoring, tutoring, and networking. Also, the ESC will promote engagement and a sense of belonging by connecting URMs with successful alumni and industry experts through panel discussions, workshops, networking, seminars, career fairs, and other forums. The ESC director will establish partnerships with local Bay Area companies to seek internship opportunities for our diverse student body, sponsor our Capstone Design Projects, and organize semiannual career fairs and interviews on campus. Industry partnership in senior design projects will provide a year-long culminating hands-on experience on real-world engineering problems for students. The professional services offered by the ESC are expected to strengthen URM students' persistence, resilience, and retention through advocacy and any necessary interventions. By lowering the achievement gaps for URM students through the targeted and informed activities organized by ESC, we will educate well-prepared and diverse engineers for the workforce in the near future.

Summer Research Internship Program: This is an eight-week program for Cañada College and Skyline College students with limited or no previous hands-on research experience. Many studies have documented the benefits of research opportunities for undergraduate students[4-10]. It has been shown that sincere engagement and close mentorship in undergraduate research are positively correlated with improving academic performance, retention rates, persistence to graduation, and motivation to pursue graduate studies[11-20] in URM students. A collaborative learning environment positively impacts URMs and reduces students' sense of isolation[13] and improves cognitive development[21]. The summer internship program intends to recruit twelve students each summer across four engineering majors – Civil Engineering, Mechanical Engineering, Electrical Engineering, and Computer Engineering. The interns are assigned to designated graduate student mentors and faculty members who have active ongoing research projects as part of their first research internship experience. All interns are encouraged to present and showcase their research achievements at the end of the summer undergraduate research program as well as at local/regional professional conferences. The summer research program is expected to increase retention rates by relating classroom experiences to real-world applications and instilling essential technical skills required for engineering careers or for pursuing graduate studies in their respective disciplines[3-10]. In the first-year implementation, nine community college students were successfully recruited into the program and divided into four project teams (Civil, Mechanical, Electrical, and Computer Engineering teams). Each student was compensated with $4,000 for the eight-week period. Each project team was supervised by at least a faculty advisor and a student peer mentor enrolled in the four-year university.

Summer Faculty Teaching Workshop: In collaboration with SFSU's Center for Equity and Excellence in Teaching and Learning (CEETL), the project is designed to offer a set of teaching

workshops for the engineering faculty at SFSU and our partner community colleges (e.g., Cañada College and Skyline College). The workshops intend to engage engineering faculty from SFSU and the community colleges in a vibrant and vigorous environment to promote inclusive teaching practices and redesign their pedagogy by applying evidence-based and inclusive learning strategies for a diverse community of students. The hands-on workshop activities assist the faculty in reevaluating their engineering courses' learning outcomes and modernizing their course materials to enhance student learning experiences and close their achievement gaps. In the summer of 2022, a three-day summer faculty development workshop was offered to ten engineering faculty members (seven from SFSU and three from community colleges). The workshop covers different themes, including culturally-relevant teaching strategies in an HSI, strategies for designing more inclusive formative and summative assessments, practicing evidence-based and student-centered active learning approaches, and state-of-the-art educational technology.

Preliminary Evaluation Results

An independent external evaluator, Dr. Robert Petrulis from EPRE Consulting LLC, leads the project evaluation. To measure the success of the project in achieving its objectives and outcomes, both quantitative and qualitative data were collected. Some preliminary results were summarized in the following.

Student use and perceptions of ESC services: To gauge the amount of student awareness and use of the services provided by the ESC, survey invitations were sent to all undergraduate engineering majors registered for classes in the spring of 2022. The invitation offered a chance to win a gift card as an incentive for participation. The invitations were sent to 1,047 students and 218 responses were received, a response rate of 20.8%. Additional strategies, such as following up with reminders or having students complete the survey during courses, are being explored to increase the response rate.

Of the 218 who responded, 103 (47.2%) said they had participated in one or more of the Engineering Success Center's services, as shown in the chart below. Overall, the services received 89% positive ratings. A summary of the results is shown in Figure 2. More details on the specific services and student comments are provided in another article submitted to the 2023 annual ASEE conference and exposition[22].

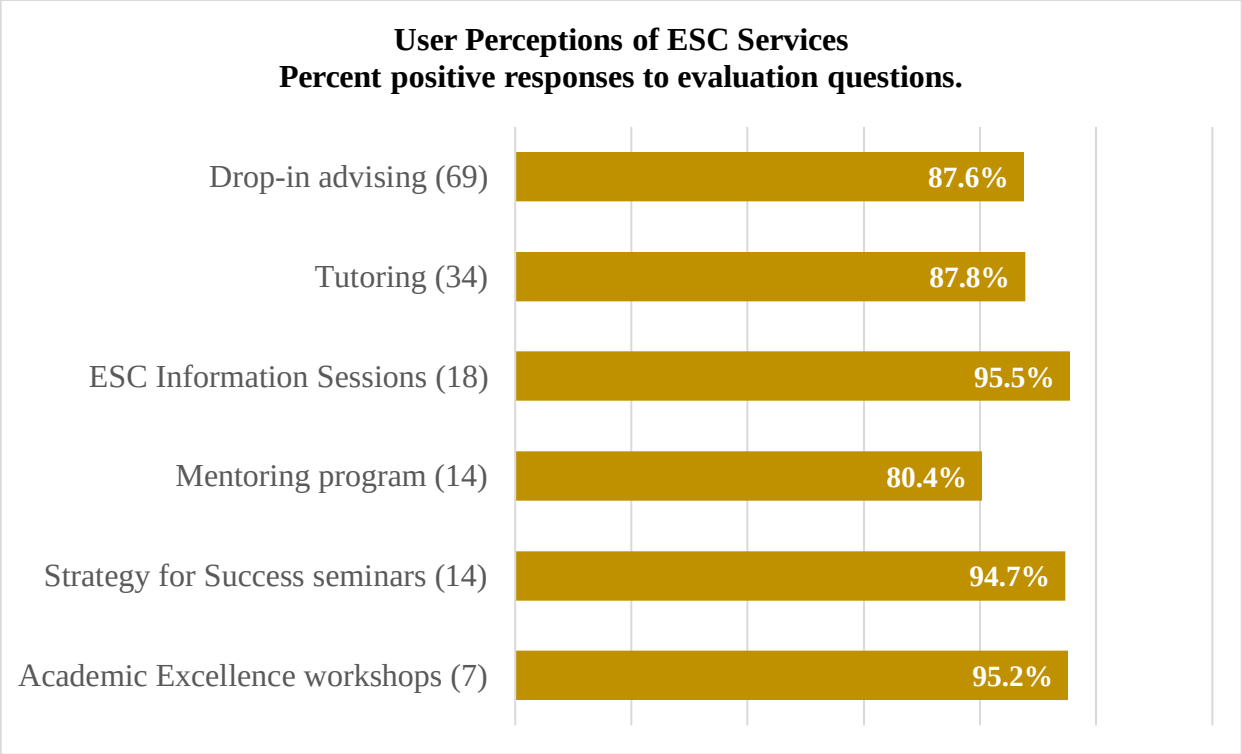

Figure 2. User Perceptions of ESC Services

Summer internships: In its first-year offering, the summer research internship program provided summer internships to nine students from partner community colleges. The internships offered participants the opportunity to engage in research projects with mentor faculty members and SFSU students. Participants were asked to complete surveys at the beginning and end of their experiences. Most of the items were rated on a six-point scale, from "Strongly Disagree" (1) to "Strongly Agree" (6). The changes in the pre- and post-surveys are shown in Figure 3.

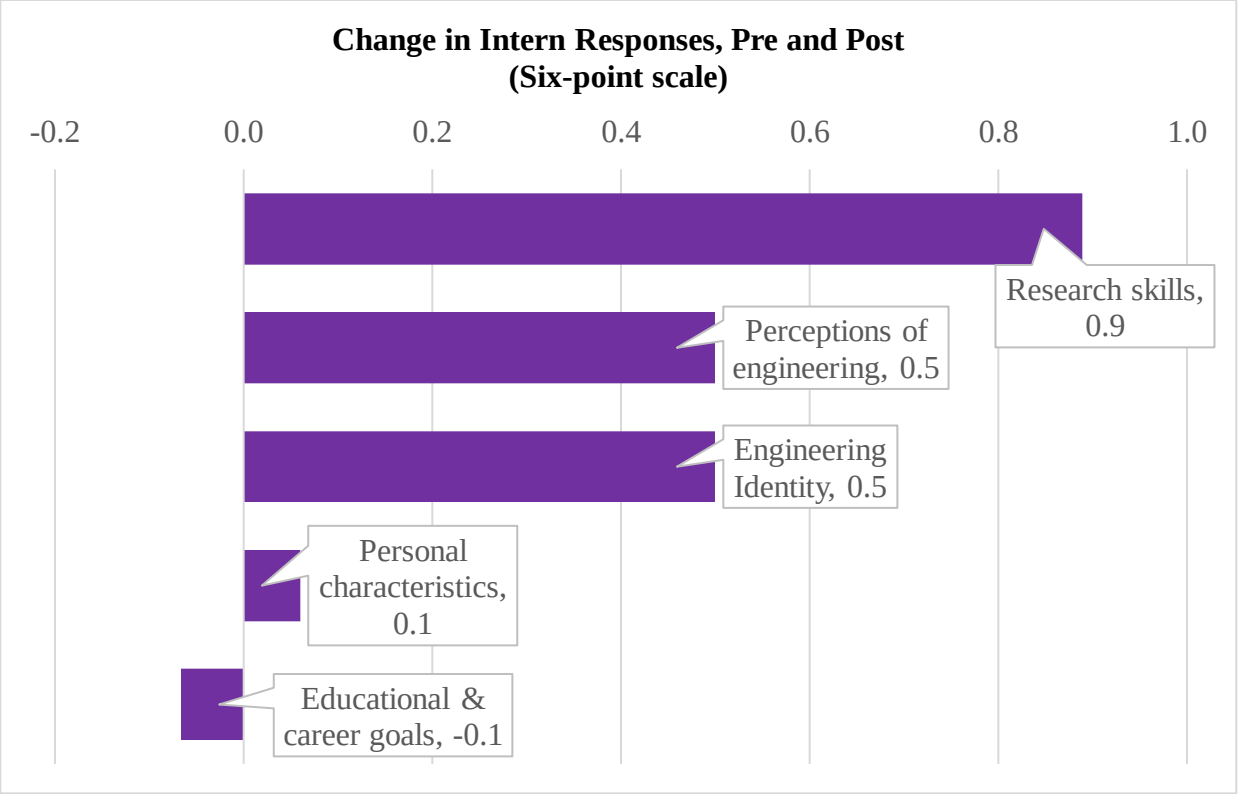

Figure 3. Change in Intern Responses in Pre/Post-Survey

The participants' self-assessments of their lab- and research-related skills (familiarity with laboratory techniques, interpreting experimental results, communicating effectively about their research) increased by just under 1 point on the six-point scale, from an average response of "Slightly Agree" (about 4) to "Agree" (about 5). Responses also showed increases regarding general perceptions of engineering, such as "I understand how engineers work on real problems" and "I understand engineering." We also found similar increases in the participants' engineering identity, such as "I enjoy laboratory research and would like to make it my career." On average, personal characteristics and educational goals did not change significantly, although these tended to be high already (around 5.5).

Faculty summer teaching workshop: A survey instrument was sent to faculty participants to collect their thoughts on the teaching workshop. All ten faculty members participated and returned evaluation surveys. The results are summarized in Figure 4. The survey asked participants to rate their skills and knowledge in the four workshop content areas before and after the workshop on a scale of 0 (None) to 4 (A great deal). The mean increase was almost a full position, from 2.93 to 3.75, or 0.83 positions. All participants said they expected to integrate what they had learned into practice.

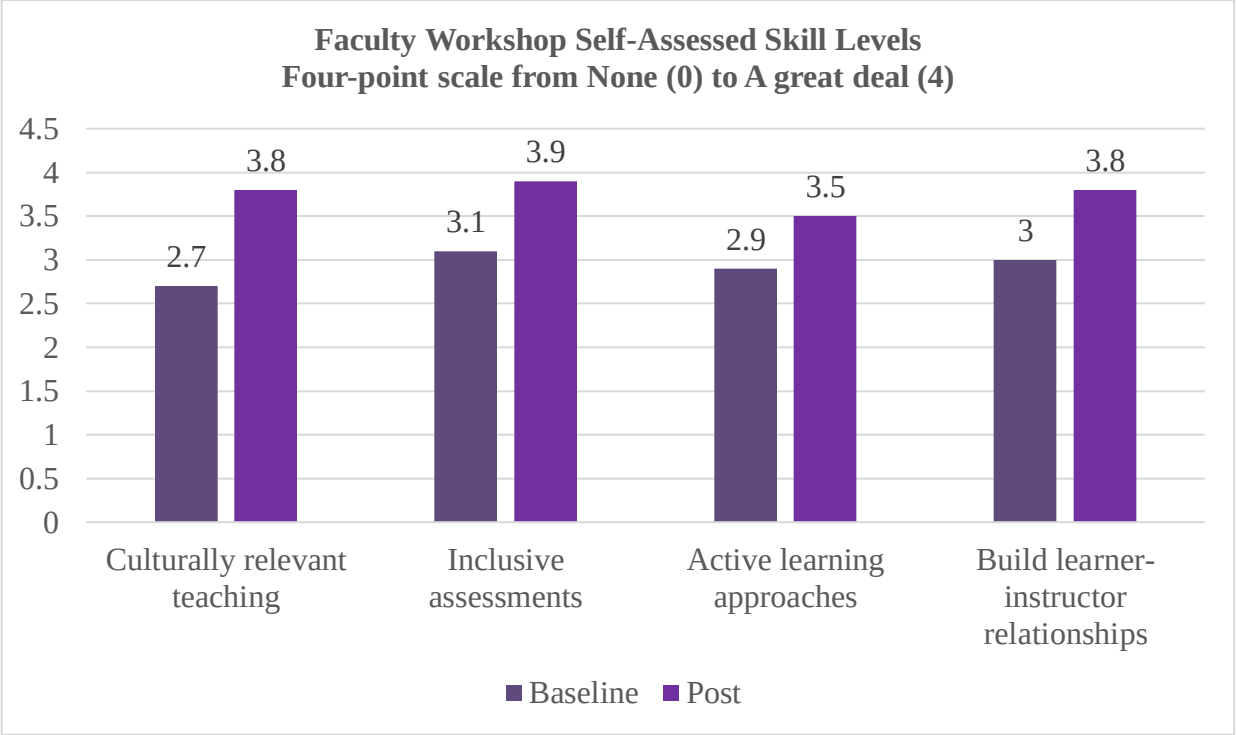

Figure 4. Faculty Workshop Self-Assessed Skill Levels

Conclusion

To better serve the students in the URM groups, an S-SMART project was funded by the NSF HSI IUSE program to enhance undergraduate engineering education and build capacity for student success at SFSU. This paper intends to provide an overview of the program. Detailed information and evaluations on the various project components are documented in a few separate papers for the 2023 ASEE annual conference and the 2023 ASEE PSW conference[22-25].

Despite some of the imposed restrictions by the COVID-19 pandemic, the project successfully established several main components, namely the ESC, Summer Research Internship Program, and Faculty Summer Teaching Workshop, as planned. The evaluation results from the external evaluator demonstrated the great success of these strategies during the first year of implementation. The authors are taking a more strategic approach to increase the response rate during evaluations for the upcoming years. Additionally, they plan to analyze whether there is a relationship between student characteristics and the project findings as the project unfolds in the next few years and more information becomes available through future assessments.

The support from the NSF HSI IUSE program has provided the opportunity to tap into some untapped issues in our institution and intends to better support and develop underrepresented minority students in engineering. Additionally, the work presented in this manuscript can be used to identify some best practices for increasing student retention and graduation rates, self-efficacy, professional development, and workforce preparedness.

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