Board 265: Enhancing the Transfer Experience through a Collaborative Cohort Program: the Culmination of a 5-year NSF S-STEM Program at a Community College

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Culmination of an NSF S-STEM: Enhancing the Transfer Experience through a Collaborative Cohort Program for Engineering Scholars

Abstract

This paper reports on the culmination of an NSF Scholarships in Science, Technology, Engineering and Mathematics (S-STEM) awarded to a two-year college located in a metro area with high rates of concentrated poverty and low levels of educational attainment. This two-year college is a minority-serving institution with curriculum to prepare students majoring in engineering to transfer and complete a baccalaureate degree at a four-year university. The Engineering Scholars Program (ESP) was established in fall 2019 to award students majoring in engineering annual scholarships of up to $6000, depending on financial need. In addition to supporting students through scholarships, the program engages scholars in professional development activities inclusive of academic seminars, extracurricular events, and undergraduate research opportunities in collaboration with the local four-year university. The program also established a mentorship structure with faculty mentors, student peer mentors, and academic advising. In addition to supporting scholars at the two-year college, the ESP provides support for a portion of cohorts that have transferred to the local four-year university and remained connected to the program. To date, the ESP has awarded a total of 131 semester long scholarships; 16 in year one (2019-2020), 28 in year two (2020-2021), 35 in year three (2021-2022), including six transfers, 38 in year four (2022-2023), including eight transfers, and 28 in year five (2023-2024), including 10 transfers. In year three, the ESP was awarded supplemental funding to support a larger portion of students and transfer cohorts; this helped reduce the financial burdens resulting from exacerbated financial needs due to the COVID-19 pandemic during years two and three of this project.

This paper details the progress made towards the achievement of the program goals of creating a welcoming STEM climate at the two-year college, increasing the participation and persistence in engineering among economically disadvantaged students, and establishing transfer support to the local four-year university. Program evaluation findings have identified several opportunities for sustaining scholar transfer support outside of the financial support provided in the form of scholarships. These opportunities fell into two major themes: (1) peer-led transfer support inclusive of connecting transferred students and students preparing for transfer with emphasis on navigating different university structures, and (2) collaboration across engineering disciplines to develop and offer interdisciplinary undergraduate research and/or collaborative work on other projects. Furthermore, research findings from interviews with scholars provided additional context for taking action on program outcomes while also enhancing the understanding of how participation in a collaborative cohort experience can contribute to students' membership within the STEM community and the construction of their own STEM identity. Although formal financial support sunsets during the final year of the ESP, program and research findings have identified programmatic elements that provide key support for students and can be sustained into the future. This paper reports on the program strategy for meeting the future needs of scholars at both the two-year college and the four-year transfer university.

Introduction

The Engineering Scholar Program (ESP), funded by a NSF Scholarships in Science, Technology, Engineering and Mathematics (S-STEM) award (*Enhancing the Transfer Experience through a Collaborative Cohort Program for Fresno City College Engineering Scholars,* Award #1833999), aimed to increase the graduation and persistence of engineering students whose collegiate career begins at Fresno City College (FCC) and continues at a transfer institution. This program accepted the first cohort of scholars in fall 2019. The COVID-19 pandemic in spring 2020 resulted in a number of significant impacts to the first cohort of students, including increase financial stress and mental health challenges, which put additional strain on student success. As a response to the unanticipated pandemic and additional student support needs, a supplemental funding request was submitted and awarded to enable the ESP to support additional students at FCC and enable them to take longer than the planned completion time of two years to finish their pre-transfer courses. The supplemental funding impact also extended to support scholars at the local four-year university, California State University-Fresno (CSU-F), where the majority of scholars transferred.

Demographics

FCC is two-year, Hispanic-Serving Institution (HSI) and an Asian American and Native American Pacific Islander-Serving Institution (AANAPISI) located in Fresno, California. The city of Fresno is one of the most racially and ethnically diverse areas in California. Of the more than 500,000 residents of Fresno, many face challenges of concentrated poverty [1], with 30.0% percent of the city's total population living poverty [2], [3]. This is compounded by low levels of educational attainment, where only 20.5% of adults over the age of 25 in Fresno have a bachelor's degree or higher. FCC serves a significant number of socioeconomically disadvantaged students. In fall 2023 there were 851 active engineering majors and 63.6% of them qualified as low income [4] with annual household incomes at or below 150% of the U.S. Department of Health and Human Services Poverty Guidelines. The ESP is open to students majoring in engineering with financial need.

Program Structure

The ESP supported students in each cohort with annual scholarships of up to $6,000, depending on financial need. The program has awarded a total of 131 semester long scholarships to-date; 16 in year one (2019-2020), 28 in year two (2020-2021), 35 in year three (2021-2022), including six transfers, 38 in year four (2022-2023), including eight transfers, and 28 in year five (2023-2024), including 10 transfers. In year three, the ESP was awarded supplemental funding to support a larger portion of students and transfer cohorts; this helped reduce the financial burdens resulting from exacerbated financial needs due to the COVID-19 pandemic during years two and three of this project. During years four and five, cohort composition consisted of multi-institution scholars, with scholars at FCC and CSU-F (Table 1). Eligibility requirements remained the same each year. Post-pandemic, scholars were allowed to be enrolled as either full-time or part-time students [5], [6].

Table 1. Awarded Scholarships by Program Year.

Year	Semester	Cohort A	Cohort B	Cohort C	Cohort D	Total
Year 5	Fall 2023	-	4[a]	4[a]	7	28
	Spring 2024	-	3[a]	4[a]	6[b]	
Year 4	Fall 2022	1	5[c]	6	7	38
	Spring 2023	1	6[c]	5[c]	7	
Year 3	Fall 2021	4[a]	6	8		35
	Spring 2022	4	5	8		
Year 2	Fall 2020	4	11			28
	Spring 2021	4	9			
Year 1	Fall 2019	8				16
	Spring 2020	8				

[a] including 3 that transferred to CSU-F
[b] including 4 that transferred to CSU-F
[c] including 2 that transferred to CSU-F

Student participation in the ESP was defined by engagement with five key components, including academic advising, professional development through academic seminars and events, undergraduate research, faculty mentoring, and peer mentoring, in additional to scholarships.

Academic Advising

Academic advising occurred on a semesterly basis for engineering scholars. At least once every semester, engineering scholars met with the FCC Transfer Center Director to discuss the transfer process and update their student education plan in alignment with transfer deadlines and their academic goals. The FCC Transfer Center Director was also available for follow up questions and engaged with the ESP leadership team to provide resources and information pertinent for transfer.

Professional Development

The ESP began each fall and spring semester with an orientation to the program. This orientation was attended by all scholars, faculty mentors, and the program's academic advisor. During orientation, scholars learned about program requirements for eligibility and expectations for engagement, had the opportunity to meet other scholars, and were introduced to the program faculty members. Throughout each semester, scholars also engaged in professional development seminars and events inclusive of conferences, presentations, and workshops, outreach activities, and tours of California High Speed Rail construction sites.

In fall 2023, eight seminars were held (Table 2). Scholars also had the opportunity to participate in two instructional field trips with the California Transportation Department (CalTrans) and to the Cedar Avenue Recycling & Transfer Station (CARTS). Both trips provided participants with opportunities to meet and connect with engineers in the field. The spring 2024 semester kicked off with the *CSU-F 63rd Annual Geomatics Engineering Conference* held at the CSU-F campus and ESP scholars presented their research posters.

Table 2. Fall 2023 Seminars and Events.

Subject
Program Orientation
Technical Communication Guidelines
Peer Mentoring – Best Practices
ArcGIS Remote Sensing I
ArcGIS Remote Sensing II
Panel Discussion with California High-Speed Rail staff and engineers
Geomatics Poster Preparation
End of Semester Celebration

Undergraduate Research

During their tenure with the ESP, scholars engaged in multi-semester undergraduate research projects that included scaffolded learning workshops and seminars with sociology and engineering faculty at FCC and CSU-F. Research activities were designed to foster: 1) understanding of how scientists and engineers perform their research, 2) exposure to engineering research, and 3) increased interest in STEM fields. Engineering scholars reached these research goals through the collaborative efforts of research faculty mentors at FCC and CSU-F who developed a program that included technical and socio-cultural aspects to engineering problem solving. CSU-F Assistant Professor of Geomatics Engineering and FCC Instructor of Sociology helped students connect the dots between engineering and its impact on people and society through semester projects.

The seminar schedule for Fall 2023 prominently featured undergraduate research opportunities in partnership with CSU-F. The sessions covered various topics, including Technical Communications, ArcGIS Remote Sensing I and II, Poster Discussion/Poster Preparation, and Applying Ethical Research. The overarching objective of these research activities was threefold: 1) to cultivate an understanding of how scientists and engineers conduct their research, 2) to expose participants to engineering research, and 3) to generate heightened interest in STEM fields. Engineering Scholars successfully achieved these research goals through collaborative efforts with research faculty mentors from both FCC and CSU-F.

Notably, workshops on remote sensing prompted students to contemplate local communities and the environment, preparing them to create posters on natural disasters. These posters were showcased at the 63rd Annual Geomatics Engineering Conference (Jan 24 - 25, 2024) at California

State University, Fresno. The featured poster topics include the LNU Lightning Complex Fires, the return of Tulare Lake, and utilizing Landsat Explorer to illustrate Urban Sprawl in the Fresno/Clovis Area.

Faculty Mentorship

Scholars also engaged with faculty mentors throughout their tenure in the ESP. Following program orientation, each scholar was assigned an ESP faculty mentor in physics or mathematics at FCC to meet with monthly, at minimum. Scholars who were on academic probation with a GPA below 2.75 were provided with an additional half-hour mentoring meetings with the project PI twice a month. Six faculty mentors from FCC, four physics faculty and two math faculty, have served the ESP scholars over the program duration.

The focus of faculty mentoring was to provide students with support as they navigated academic and personal challenges. The faculty mentors and student mentees met at least once a month and, in many cases, biweekly, as requested by student mentees. Mentor meetings included discussions on current courses, academic goals, study habits and internships, hobbies, and personal interests, among many other topics. Mentors also supported the personal well-being of scholars, providing referrals to additional campus services as needed.

Faculty mentors also worked to build community within the ESP in addition to monthly with their mentees. Faculty mentors sustained communication through the program's Canvas course, ensuring that there was interactivity among cohorts, internship and scholarships opportunities were promoted, and there was a space for scholars to share their volunteer and internship experiences with others.

Faculty mentors participated in a number of professional development trainings on mentorship throughout their engagement in the ESP. These included culturally relevant mentorship where mentors learned about their own beliefs and increased their awareness of the differences and similarities between themselves and their mentees; FCC Safe Space Ally Program where mentors learned the basics of sexual orientation and gender identity as well as strategies for increasing competency and addressing homophobia, transphobia, and biphobia; LGBTQ Cultural Competence Training workshop; a presentation on microaggressions in the classroom, including instances of micro assaults, microinsults, and microinvalidation; and a facilitated metacognitive reflection on mentorship during which faculty shared reflections on their mentoring experiences, discussed common challenges, and lessons learned, which was repeated each semester [7], [8]. Faculty mentors also supported one another with monthly 30-minute check-in meetings over Zoom.

Peer Mentorship

The ESP established peer mentoring during the second year of the program as a result of year one findings that scholars desired to build community with their peers in addition to faculty mentors [7]. Peer mentors were comprised of preceding cohort members that were assigned during orientation to the succeeding cohort members. Peer mentors and mentees met at least once a month through in-person and virtual modalities. Peer mentors that transferred were of particular benefit

to students preparing for transfer. These peers offered advice on things that are useful to know before transferring, questions that are helpful to ask before transferring, and resources to seek out after transferring. In the last two years of the program, a total of 13 scholars served as peer mentors, including transferred scholars attending CSU-F serving as mentors for FCC scholars. Peer mentors were provided with training during onboarding into their role as a peer mentor. The training focused on the benefits of mentorship, the concepts of belonging and identity within STEM, the roles a mentor plays, and the different structures that mentoring relationships can take on.

Scholars have expressed concerns with the peer mentoring component of the program, mainly related to meeting logistics. Accordingly, based on discussions during Fall 2023 end of semester celebration, it was agreed that monthly one-hour peer mentoring meetings will be hosted on Fresno City College campus. During those meetings, scholars will meet with their peer mentors in mentoring groups. At the beginning of each meeting, groups will agree on meeting goals. Additionally, the program lead will provide one topic of discussion each meeting; the topic will relate to relevant academic events that might be impacting scholars.

Program Goals

The goal of the ESP was to create a welcoming STEM climate at FCC, increase the participation and persistence in engineering among economically disadvantaged students, and establish transfer support to the local four-year university. As such, the ESP emphasized the development of a supportive community centered around student scholar cohorts. The activities within this program were developed to ESP's goals to: 1) create a diverse and welcoming STEM climate on the FCC campus through events and media that encourage broader participation, 2) increase participation in engineering among economically disadvantaged students through targeted outreach and recruitment, 3) increase persistence of engineering students along discipline specific pathways to transfer and graduation from four-year universities through a series of structured support interventions, and, 4) establish on-going collaborative transfer support processes between the FCC engineering program and CSU-F.

The success of the ESP was evaluated based on achieving the following objectives as they relate to the programmatic goals:

1. *Increase engineering degree and/or certificate completion rates at FCC to 5% over the project timeline.* A strikingly small percentage of students majoring in engineering at FCC have historically completed degrees and/or transferred within 2 years. The average engineering degree completion rate at FCC at the start of the ESP was less than 1%,
2. *Accelerate student progression through the engineering curriculum at FCC, reducing average time to degree or transfer by 25%.* The average time to degree for engineering at FCC was 10.4 semesters at the start of the FCC ESP. The objective is to reduce that average time to 8 semesters over the five-year project timeline, and
3. *Increase 2-year engineering transfer rates from FCC to four-year institutions from 7.7% to 10%.* Engineering curriculum roadmaps for degree or certificate completion are designed to see a student complete required courses within two years when beginning the curriculum at Math 5A (Calculus 1). When beginning in an earlier math, students are guided using a three-year plan to complete courses at FCC before transferring.

The FCC Institutional Research, Assessment, and Planning Office tracks institutional data for each objective. As the ESP was initiated in fall 2019, data reporting is ongoing and programmatic impact is not yet fully available, however each objective

Objective 1. Engineering degree and/or certificate completion rates at FCC

Data on completion rate impact lags behind cohorts and thus the full impact will not be determinable until after the project concludes. However, the project leadership teams expects to see an increase in both 2- and 3-year completion rates, indicative of student utilization of the engineering curriculum roadmaps to efficiently navigate their time at FCC. (Table 3).

Table 3. Fresno City College engineering degree and certificate 2- and 3-year completion rates.

Program Objective 1: Engineering degree and/or certificate completion rates at FCC

Student Group Year	# of First Time Students with Active Engineering Major	Graduated within 2 Years		Graduated within 3 Years	
		#	%	#	%
2012 Fall	171	0	0.0%	0	0.0%
2013 Fall	201	0	0.0%	0	0.0%
2014 Fall	149	1	0.7%	1	0.7%
2015 Fall	173	0	0.0%	0	0.0%
2016 Fall	225	0	0.0%	0	0.0%
2017 Fall	179	0	0.0%	1	0.6%
2018 Fall	147	0	0.0%	0	0.0%
2019 Fall	80	0	0.0%	1	1.3%
2020 Fall	117	0	0.0%	0	0.0%
2021 Fall	108	1	0.9%	N/A	N/A

Student groups include all students who claimed an engineering major by the end of the identifying fall term.

Objective 2. Time to degree and/or certificate for engineering

Since the ESP was implemented in 2019, FCC Institutional Research, Assessment, and Planning Office has reported significant increases in the number of earned degrees and certificates in engineering. Though program's goal of an eight-semester average has not yet been achieved, the average is trending downward and is expected to continue to do so as the impacts of the pandemic are felt less and the number of earned certificates and degrees continue to rise (Table 4).

Table 4. Average number of semesters taken for students to earn a Fresno City College engineering degree or certificate.

Program Objective 2: Time to degree and/or certificate for engineering			
Award Year	# of Awards	Average # of Semester (excluding summer)	
		Mean	Median
2012-13	1	12	12
2014-15	2	13	13
2015-16	2	4.5	4.5
2016-17	1	8	8
2018-19	1	10	10
2019-20	17	10.9	8
2020-21	15	11.7	14
2021-22	54	10.3	8
2022-23	56	8.1	8
Overall	149	9.6	8

Objective 3. 2-year engineering transfer rates from FCC to 4-year institutions

Data on transfer rates also lags and thus the full impact will not be determinable until after the project concludes. However, in alignment with degree and certification completion rates, it is anticipated that time to transfer will decrease and more students will be transferring within two and three years after starting at FCC in engineering will result in increased transfer rates (Table 5).

Table 5. Fresno City College engineering student 2- and 3-year transfer rates.

Program Objective 3: 2-year engineering transfer rates from FCC to 4-year institutions					
Student Group Year	# of First Time Students with Active Engineering Major	Transferred within 2 Years		Transferred within 3 Years	
		#	%	#	%
2012 Fall	171	10	5.8%	23	13.5%
2013 Fall	201	9	4.5%	21	10.4%
2014 Fall	149	10	6.7%	16	10.7%
2015 Fall	173	12	6.9%	20	11.6%
2016 Fall	225	14	6.2%	27	12.0%
2017 Fall	179	10	5.6%	20	11.2%
2018 Fall	147	10	6.8%	16	10.9%
2019 Fall	80	8	10.0%	9	11.3%
2020 Fall	117	11	9.4%	14	12.0%
2021 Fall	108	1	0.9%	N/A	N/A

A student is considered "transferred within 2 years" if enrolled in a 4-year institution by the end of the second year following the cohort fall semester. For example, a 2012 fall cohort student will be considered transferred if this student enrolled in a 4- year institution by end of 2014. Same approach is used to define “transferred within 3 years”.

Program Evaluation

During the first year of the ESP, scholars completed a program evaluation survey that contained Likert-scale and open-ended questions regarding participant perceptions of the program. Scholars responded to the effectiveness of academic advising, professional development activities such as seminars and events, undergraduate research, and faculty mentoring in their contribution to 1) creating a diverse and welcoming STEM climate on the FCC campus, 2) increasing participation among economically disadvantaged students, 3) increasing persistence of engineering students along discipline specific pathways to transfer and graduation, and 4) establishment of a transfer support process between FCC and CSU-F. Year 1 program evaluation results indicated that all scholars (100%) rated the ESP as providing excellent or good support towards reaching their academic goals [6]. Scholars rated participation in professional development and faculty mentoring highest, with academic advising and undergraduate research following; all program activities were rated as good or excellent by the majority [6]. Year 1 results also indicated that faculty mentorship contributed to students' sense of belonging, encouraging them to persist through personal and academic challenges, and supported them in building a STEM identity. Scholars provided suggestions for further investing in mentorship through additional mentorship structure, increased meeting frequency, and strategic mentorship pairing [6].

As a result of the evaluation findings from the first year, the ESP adopted a more formal mentorship approach for year 2. This formal approach included the development of a guided mentorship program specific to ESP mentors as ready-made materials for a mentorship training program were not available to meet the unique needs of two-year community college faculty mentors [8]. Results from the implementation of the guided mentorship program indicated that the mentorship materials supported faculty mentors by providing culturally responsive mentorship training and structure for mentoring meetings with scholars. Scholars provided feedback that the mentorship component of the ESP continued to provide critical support and was one of the greatest benefits of the program. This result suggested that further investment and emphasis on mentorship could be made to provide additional support to scholars. Thus, in year 2, the ESP established a peer mentoring program in addition to the existing program components of faculty mentoring, academic advising, undergraduate research, and professional development activities.

During year 3, the first set of scholars transferred to four-year institutions. At the end of the third year of the ESP, scholars currently enrolled in the program and those that recently transferred responded to an evaluation survey aimed at gathering scholar perceptions of the key ESP program components, how well the ESP was supporting academic goals, reflections on program participations, and perceptions of transferring to a four year institution as gauged by feedback from scholars that transferred to a four-year institution. Scholars at FCC reported appreciation for faculty and peer mentor support and contribution to accomplishing goals, having opportunities to engage in engineering fields, and being part of a community [9]. Transferred scholars reported that their participation in the ESP was a key contributor to their sense of belonging in the STEM community and it supported the solidification of their academic and career goals [9].

Transferred scholars also responded to an additional transfer experience survey. This survey included questions pertaining to the impact of the ESP on their transfer experience and collected information on scholars' academic plans/goals, career plans/goals, decisions to apply for research or internship opportunities, academic preparation, STEM community support and membership, satisfaction with the transfer experience, and confidence in complete degree at their current university. Scholars rated the impact of the scholarship funds as the highest contributor to their transfer experience, followed by academic advising, faculty mentorship at FCC, and engagement in undergraduate research, being part of a STEM community, faculty mentorship at their four-year institution, seminars, and being a peer mentor [9].

At the end of year 4 ESP current and transferred scholars were invited to respond to evaluation surveys; one survey was designated for scholar cohorts that were currently participating in the ESP at FCC and the other survey was designated for all scholars of any cohort that had transferred to a four-year institution. All respondents rated participation in field trip/conference/seminar events as excellent, with the quality of assigned faculty mentors, assistance with transferring to a four-year university, and participation in undergraduate research as good or excellent. Additionally, career exploration/major and course selection and the quality of peer mentoring was good or excellent (Figure 1).

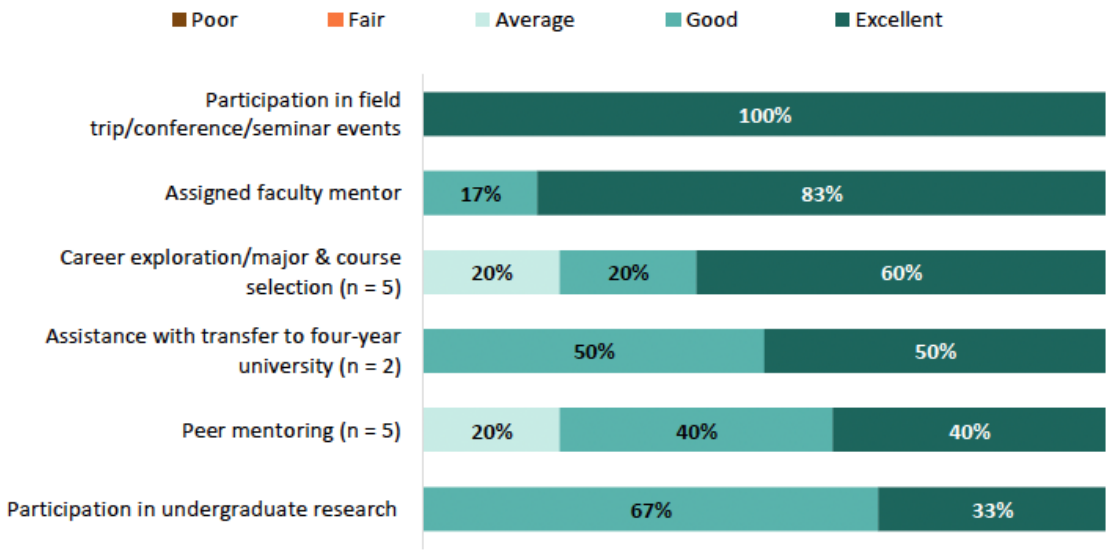

Figure 1. FCC Scholar Perceptions of the Quality of the ESP Overall (n = 6)

Scholars rated the usefulness of seminars to their professional growth. Of those who attended these seminars, which were optional but encouraged, all respondents reported the Natural Disasters and Community Impact, Local Issues and Remote Sensing, Ethics in Engineering, and Research Topics, Readings, and Data Collections seminars were useful or very useful (Figure 2). Scholars also had the opportunity to participate in three extracurricular professional development events during year 4. All respondents (100%) rated their experience with these event, the Geomatics Conference, the Recycling Center Field Trip, and the High-Speed Rail Field Trip, as excellent.

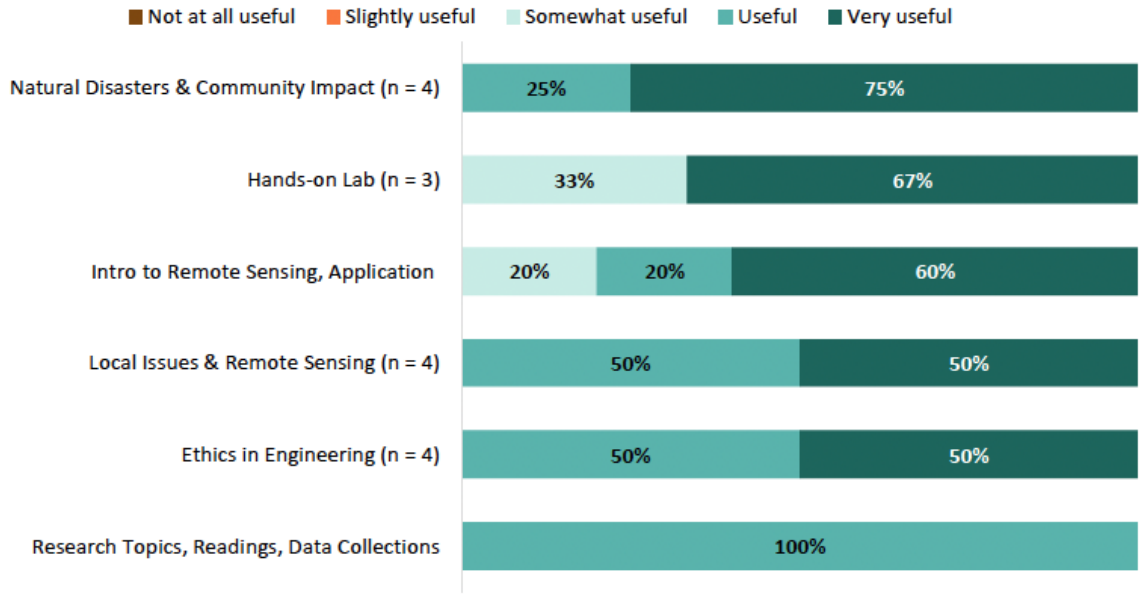

Figure 2. FCC Scholar Ratings of the Usefulness of the ESP Seminars (n = 5)

A key component to the Engineering Scholar program is mentoring from engineering, mathematics, and physics faculty members. Engineering Scholar mentors had access to online training and resources throughout the year to support them in mentoring scholars. All respondents strongly agreed their faculty mentor provided tips and strategies to help them be successful, kept personal information confidential, and was concerned about their academic success. All respondents strongly agreed that they felt supported academically, with the majority of respondents strongly agreeing they felt more motivated to complete their degree at FCC and felt more motivated to transfer to a four-year university and they are gaining a better sense of how to be successful at FCC. Additionally, half of the respondents strongly agreed they have a better understanding of engineering research (Figure 3).

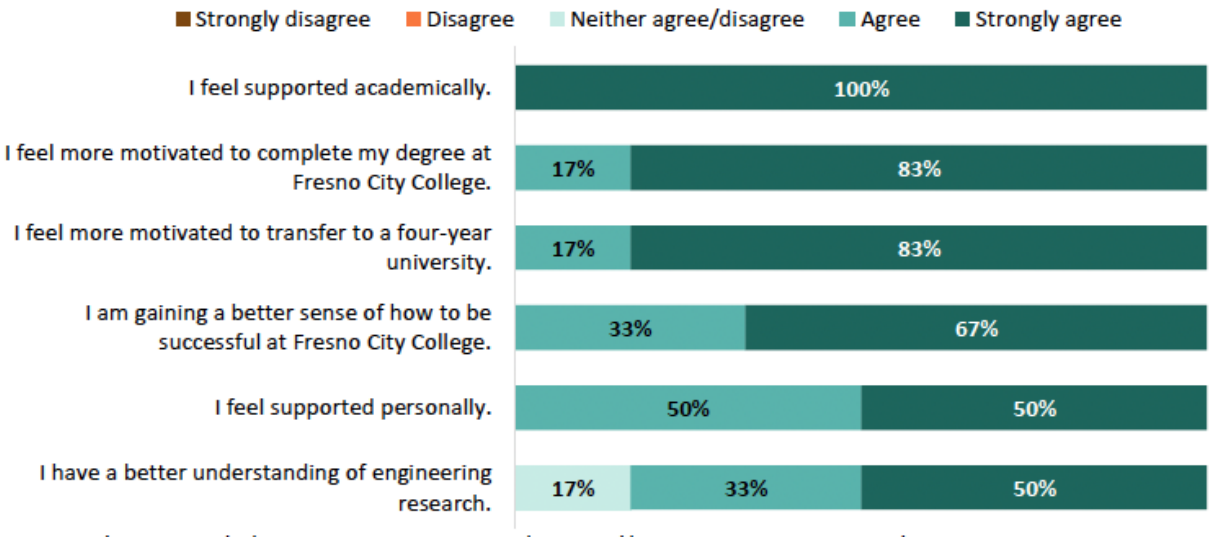

Figure 3. FCC Scholar Ratings of the Personal/Academic Outcomes of Faculty Mentoring (n = 6)

As part of the ESP, scholars had the opportunity to mentor students in subsequent cohorts. Cohort A served as peer mentors for Cohort B in year 2, while Cohort B students provided peer mentor support to Cohort C in year 3, and during the fourth year students in Cohort C provided mentoring to students in Cohort D. An Engineering Scholar faculty team member provided peer mentors with training, during which they learned about effective mentoring, received guidelines on their role, and received resources to support them as peer mentors. The faculty team supported mentors throughout the academic year. Mentor/mentee pairs had their initial meeting in breakout sessions during orientation and continued to meet periodically throughout the year.

All respondents agreed or strongly agreed that their peer mentor provided tips and strategies to help them be successful, kept personal information confidential, and was concerned about their academic success. All respondents also agreed or strongly agreed their peer mentor was respectful, encouraged them to achieve their goals, was dependable, was easy to talk to, and tried to get to know them (Figure 4).

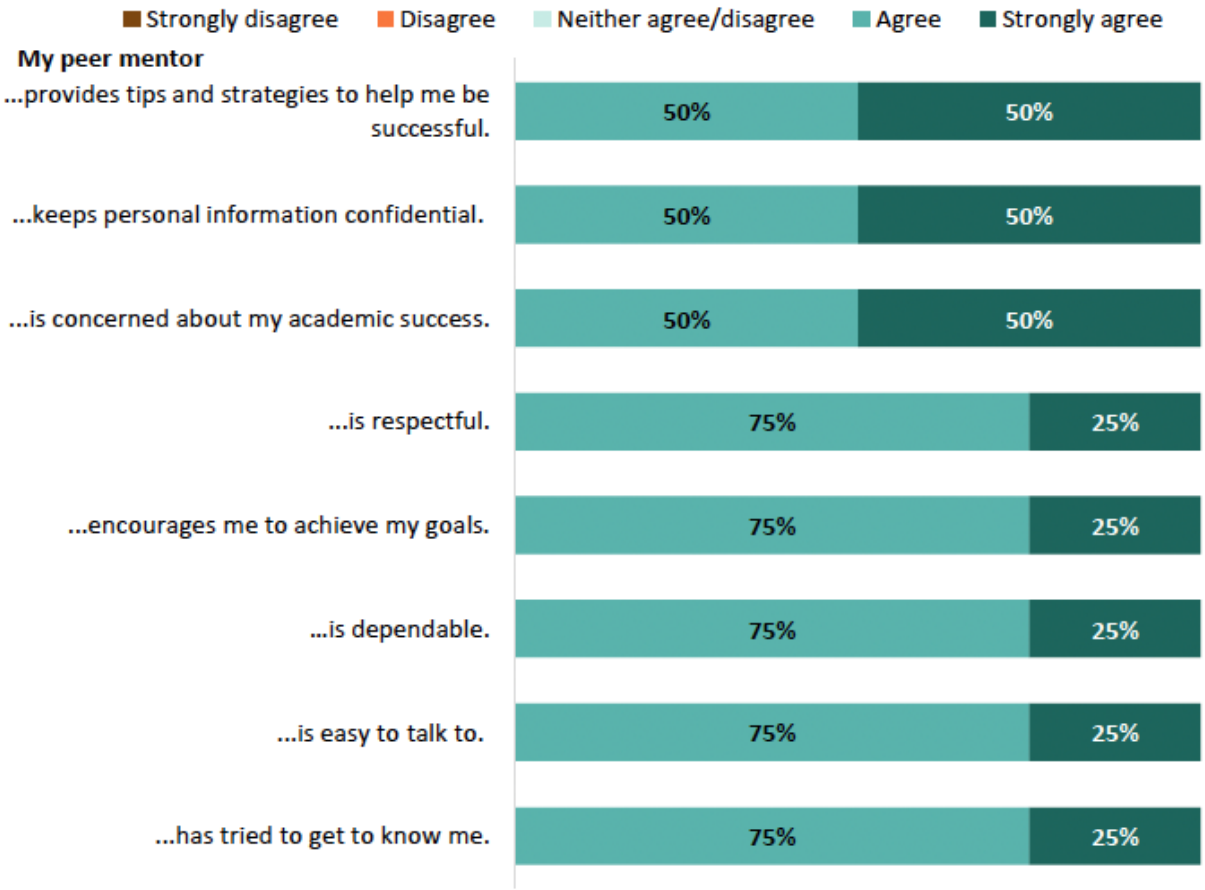

Figure 4. FCC Scholar Perceptions of the Relationships with their Peer Mentors (n = 4)

All ESP scholars had the opportunity to participate in undergraduate research. The undergraduate research project activities were designed to promote (a) an understanding of how scientists and engineers perform their research, (b) exposure to engineering research, and (c) increased interest in STEM fields. All respondents reported the program increased their interest in an engineering career and research however students reported varied perceptions of how the undergraduate research experience effected specific aspects of their understanding and skills related to engineering research (Figure 5).

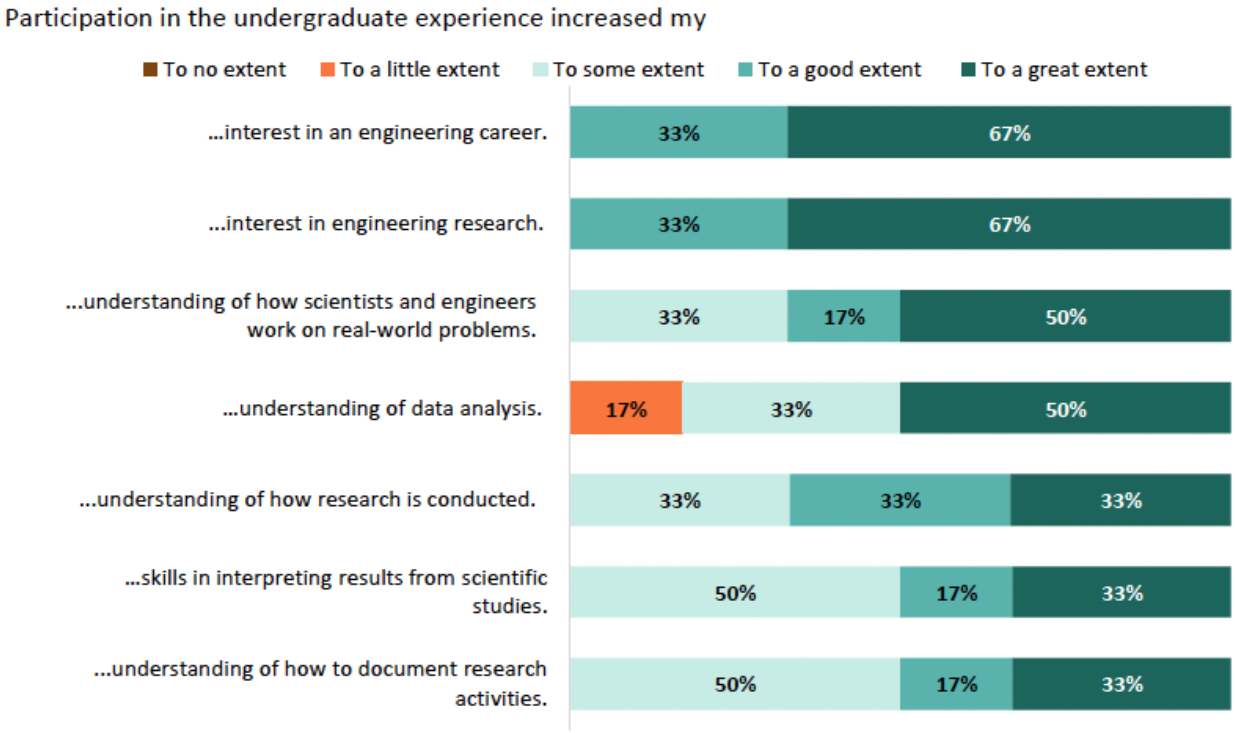

Figure 5. FCC Scholar Perceptions of the Participation in Undergraduate Research (n = 4)

Transferred scholars were asked to report the extent to which the ESP supported them in achieving their academic goals. All respondents reported that scholarship funds, academic advising at FCC, FCC faculty mentors, being part of a STEM community, and the undergraduate research experience supported their goals to a great extent. Students expressed a more varied perspective on their experience serving as a mentor to students at FCC (Figure 6).

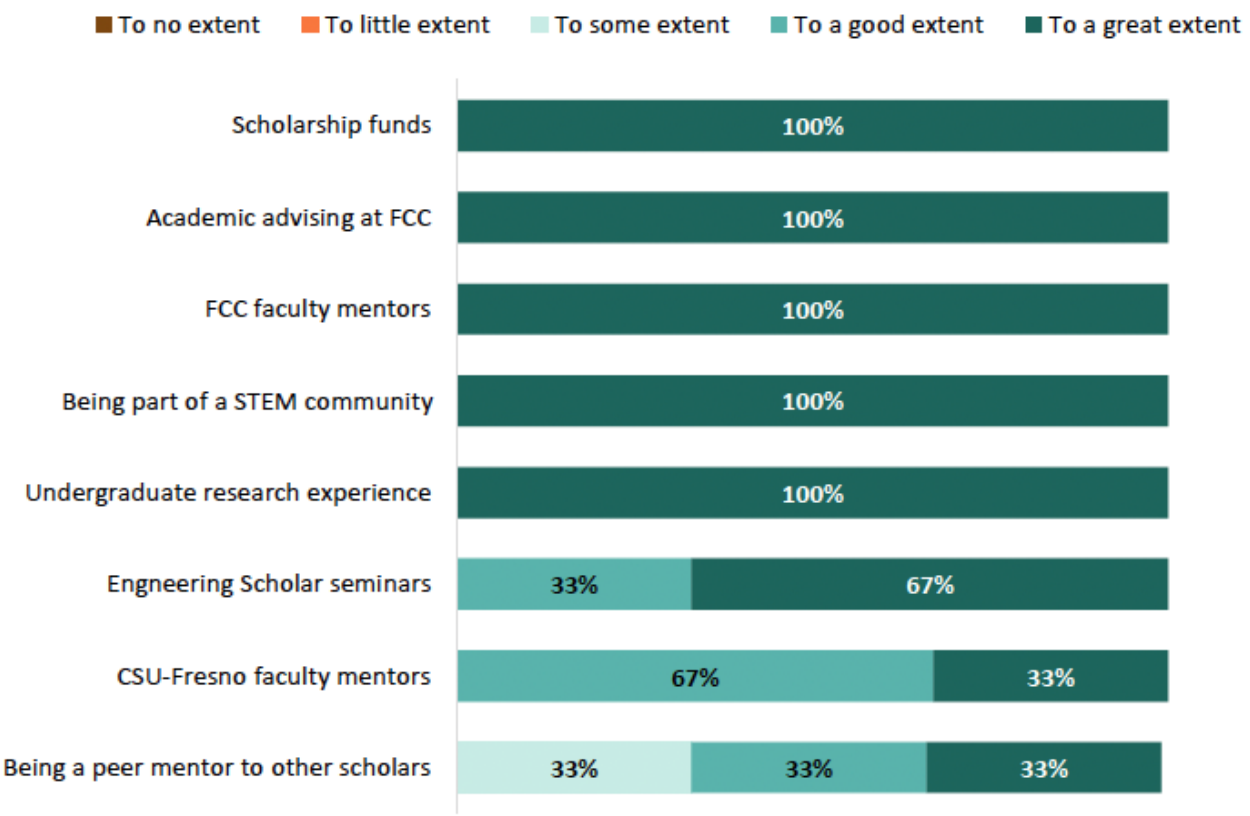

Figure 6.Transferred Scholar Perceptions of ESP in Supporting Academic Goals (n = 3)

All transferred respondents strongly agreed participation in the ESP helped them to solidify their academic and career goals and helped them to feel like a part of a STEM community at FCC. Transferred students also strongly agreed that they felt confident that they will complete their degree at their current university, being part of a STEM community and Fresno City College was helpful in preparing them for their current degree program, and participating in the ESP has helped them feel part of a STEM community at their current four-year institution (Figure 7).

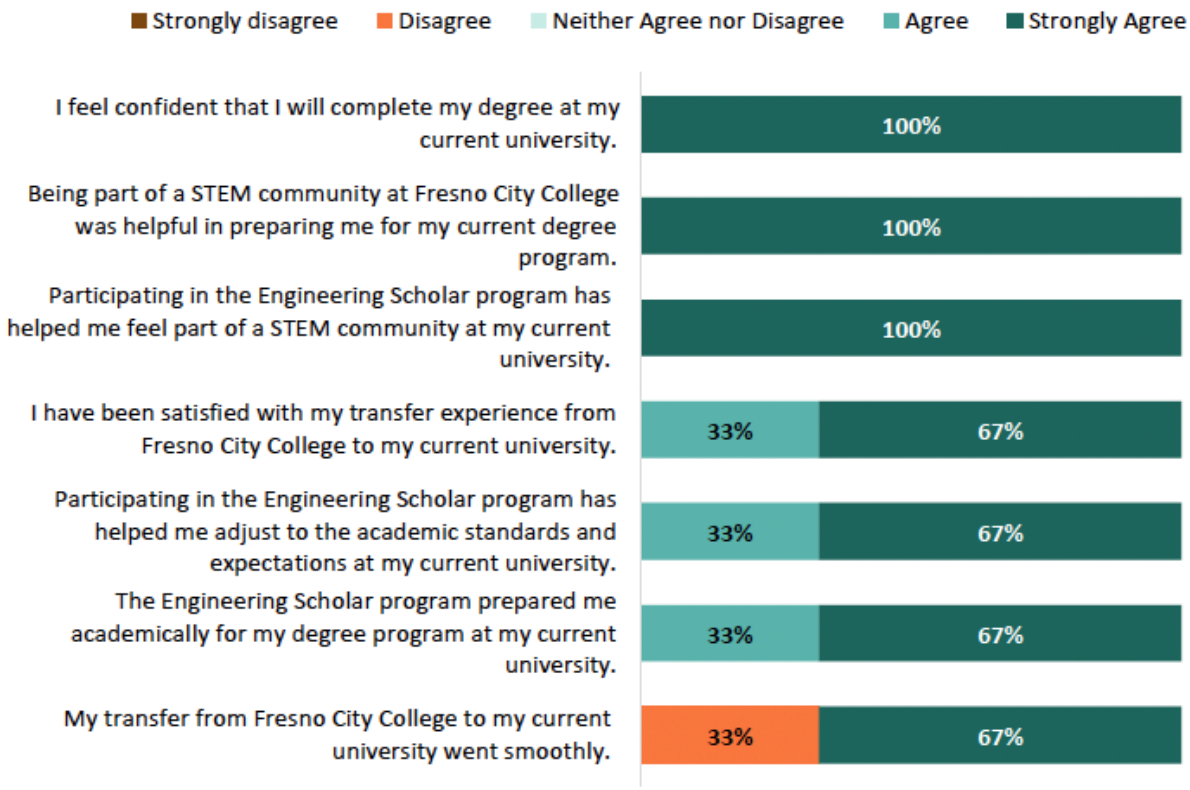

Figure 7.Transferred Scholar Perceptions of ESP Impact on their Transfer Experience (n = 3)

Overall program evaluation feedback indicated that scholars placed value on their participation in the ESP. Connecting with faculty members, peers and being part of a STEM community all supported their progress to their degree and career goals. Several opportunities have been identified for their role in supporting the scholar transfer process outside of the financial support provided in the form of scholarships. These opportunities fell into two major themes: (1) peer-led transfer support inclusive of connecting transferred students and students preparing for transfer with emphasis on navigating different university structures, and (2) collaboration across engineering disciplines to develop and offer interdisciplinary undergraduate research and/or collaborative work on other projects.

Educational Research

To understand how the socio-cultural context of students from an area of concentrated poverty, such as Fresno, California where FCC is located, experience community and develop a STEM identity, the ESP also used a phenomenography-informed approach to articulate the lived experiences of scholars in this program preparing to transfer to a four-year institution. The goal of the research component of this project was to answer two questions: 1) How does participation in collaborative cohort experience contribute to students' membership within a STEM community? and 2) In what ways do students use community membership to construct their own STEM identity? [10].

Research was structured into two phases. For phase 1, the ESP aimed to establish a community of practice (CoP) for scholar cohorts participating in this program. For phase 2, the program aimed to engage students in critical reflections throughout their cohort participation, inclusive of reflection on programmatic components of academic advising, professional development, undergraduate research, faculty mentoring, and after year 2, peer mentoring, as well as reflections on their sense of belonging and development of their STEM identity. The experience of scholars relied on a phenomenography-inspired approach to understand scholars' cohort experience through guided interview questions. Researchers employed narrative meaning-making and reflection of memories of their lived experience of cohorts to generate an understanding of community membership and STEM identity construction from participation in the cohort [11].

During the second year of the ESP, signified by the implementation of an additional peer mentoring component led by scholars of the first cohort, all scholars were invited to participate in interviews to understand the role of the ESP community in the development of scholars' STEM identity and sense of belonging in the STEM community. Results from these interviews indicated that the majority of students found that mentoring contributed most out of any program component to the creation of a STEM community and their sense of belonging in that community. Mentoring was also directly relational to participant's success in STEM, with both faculty mentors and peer mentors provided critical support and encouraging persistence through challenges and continuation on their academic path [7].

At the end of years 3 and 4, FCC scholars reported through interviews that the ESP contributed to their STEM community membership through three key means of impact during scholar interviews. Scholars identified that the ESP had established a shared purpose and inspired their participation through a common thread of becoming engineers by way of transfer from a two-year college to a four-year university. This impact illustrated the structural element domain of a Community of Practice (CoP)]12]. Scholars articulated that their relationships of social learning with mutual respect and willingness to share in a collective experience through faculty and peer mentoring and seminars and events strengthened their collective cohort experience, identified as the CoP structural element of community [12]. Scholars also recognized that the domain-based knowledge the community developed, shared, and maintained together through continued projects, support, and connection indicated that they had constructed the structure element of practice [12]. The existence of these three key structural elements identified by scholars in the ESP indicates that the ESP not only formed a CoP, but that scholars were also members of that community. Scholars shared examples of how their participation in collaborative cohort experience contributed to their membership within the STEM community, citing that a safe learning environment, ownership of their learning, and belonging in the ESP community were enabling factors that supported their movement to the center of the community through legitimate participation in the community itself [9], [12], [13], [14]. Research findings also indicated that the ESP supported the development of their STEM identity [9]. Their identity was formed, in part, by placing a value on scholars' personal and social identities while also affording them the support structures to build their expertise as a STEM member. Scholars found that engagement in new learning opportunities such

as undergraduate research, support by peer mentors, and making new connections in STEM were all enabling experiences for their STEM identity development [9].

At the end of years 3 and 4, CSU-F transferred scholars reported through interviews that during their initial year at their new institution they felt like "outsiders", finding it necessary to advocate for themselves and put in effort to establish a new community [9]. Taking control of the situation was attributed to participation in the ESP and enabled these transferred scholars to establish their own CoP [9]. Transferred scholars indicated that the centrality aspect of their STEM identity was at ease with their new environment whole typicality aspect of identity was most at odds [9]. These scholars interpreted the at-odds typicality aspect of their identity to be a causal condition of the limits of their environment and not their incomplete identity; while they may not appear to be "typical" due to personal outward features at conflict with the outward features of their new peers, they still belonged to the STEM community, and this was validated by engagement in activities through the ESP [9]. At the end of year 5 the research team will explore this finding further through follow-on interviews with transferred scholars in their second and third year at their new institution in addition to interviews with scholars of the last cohort of students that transfer.

Although formal financial support sunsets during this fifth and final year of the ESP, research findings have identified elements of the ESP that participation in collaborative cohort experience contributed to students' membership within a STEM community through the existence of structural elements of a CoP. Additionally, the ESP CoP enabled students to use their membership and working relationship in the community to construct their own STEM identity throughout their participation in the program at FCC and through transfer to CSU-F or another four-year institution. These research findings have also provided a rationale taking action on program outcomes to sustain already-funded elements of the program, including the existence of faculty mentors, opportunity for engagement in engineering discipline discovery, and the connection to transferred scholars. Collaboration between mission-aligned units at both FCC and CSU-F have the potential to continue to meet the needs of scholars at both the two-year college and the four-year transfer university through positioning themselves to offer these identified high-impact opportunities.

Future Work

As this S-STEM project enters its fifth and final year, the project team brings closure to this project by developing and implementing a sustainment plan for the programmatic elements and structures that supported successful student transfer between Fresno City College (FCC) and the primary four-year institution, California State University-Fresno (CSU-F) and student development of a STEM identity in response to membership in a STEM community. Program evaluation results indicated that scholar transfer support was driven by two primary components, a peer-led transferring-transferred relationship that enabled students preparing for transfer to connect with students that have already transferred, which supported student exploration of the differences in the transfer environment and strategies for navigating a new academic landscape, and a structured approach to engagement with a variety of engineering disciplines, enabled by conversations with faculty mentors, attendance at industry-led events, and work in undergraduate research. Research

findings from interviews with pre-transfer and post-transfer scholars provided context for how scholar participation in a collaborative cohort experience exemplified by the Engineering Scholars Program (ESP) community of practice contributed to students' membership within the STEM community. Scholars articulated that they constructed their own STEM identity as a major outcome of this community membership. As a result, evaluation and research findings of this S-STEM project have provided evidence that future work to sustain the program components with the maximum impact on students' community membership and identity construction in addition to supporting the transfer process. These programmatic components included peer connection between transferring and transferred students, engagement in engineering discipline discovery, and faculty mentorship, which were expansion elements of already established activities at FCC and CSU-F packaged in a community of practice for the ESP. This program can sustain its impact and goal of supporting progress towards degree and career goals for traditionally underrepresented students from an area of concentrated poverty through intentionality to support student engagement in peer connection, discipline engineering discovery, and faculty mentorship.

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