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Board 277: Enhancing the Transfer Experience through a Collaborative Cohort Program for Engineering Scholars, Years 3 and 4 of an NSF S-STEM

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Enhancing the Transfer Experience through a Collaborative Cohort Program for Engineering Scholars, Years 3 and 4 of an NSF S-STEM

Abstract

This paper reports on activities and outcomes from years three and four of a 5-year NSF Scholarships in Science, Technology, Engineering and Mathematics (S-STEM) award at a two-year college. The college is a minority-serving institution located in a metro area with high rates of concentrated poverty and low levels of educational attainment. Through the program scholarships are awarded to cohorts of students majoring in engineering selected each fall semester from applications collected the previous spring. After completing transfer preparation curriculum at the two-year college, select scholars who transfer to the local four-year university may remain in the program for continued support. Students in each cohort, including those who remain in the program after transfer, are supported with annual scholarships of up to $6000, depending on financial need. In addition to scholarship money, students participate in a variety of program activities throughout the school year in the form of academic seminars, extracurricular events, professional development, faculty mentoring, peer mentoring, academic advising, and undergraduate research opportunities. Noteworthy elements of the program in years three and four include 1) the selection and award of the fourth and final cohort entering the program, 2) a transition of leadership to a new principal investigator for the program at the two-college, and 3) the increase in number of students who have continued with the program after transfer to the local four-year university.

During year three of this five-year program, the first cohort of students successfully transferred and completed a full year at their new four-year university. Supplemental funding has enabled the program to expand support for additional students at both the two-year college and the four-year university after transfer. This has reduced financial burdens and addressed the unanticipated challenge that some students would need more than two years to transfer due to delays brought on by the COVID-19 pandemic. Program evaluation findings identified requests from students that would enhance the program approach and further prepare for transfer. These included establishing a transferred student panel for students preparing to transfer, seminars on maintaining a positive work/life balance and differences in university systems, further support for peer mentorship for both mentors and mentees, and additional opportunities for collaboration across engineering disciplines. Research findings from interviews conducted with transferred students identified several opportunities to further enhance the transfer preparation approach and support structures needed for success at their new institution. These include intentional preparation for establishing membership in a new community, identification of systems and processes for support at their new institution, including how these may differ from their previous institution, and opportunity to serve as a mentor and engage with students preparing to transfer.

In addition, in year 4 program leadership transitioned due to a new role at new university and more students support requests of leadership at both the two-year college and the four-year transfer university than originally anticipated. This has resulted in reflection on the program administration and the people and structures that sustain it. This poster will include summaries of scholar activities, transition in and impact on program leadership, program evaluation results, and research findings from the first cohort of students that have transferred and completed a full year at their new institution.

Introduction

The Engineering Scholar Program (ESP) project aims to increase the graduation and persistence of engineering students along pathways to transfer, with a collegiate career beginning at Fresno City College (FCC). This program, 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), has overcome many challenges in its first three years. The COVID-19 pandemic coincided with year one of the ESP, bringing cascading impacts to student success, mental health, and financial stress. In response to unanticipated additional student needs, a supplemental funding request was submitted to support students facing additional hardships. Supplemental funding was awarded, enabling the program to support more students at FCC, providing these students the opportunity to take longer than the original two years to complete their pre-transfer courses. Furthermore, the supplemental funding helped in supporting additional scholars at the local four-year university, California State University-Fresno (CSU-F) post transfer.

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. At the center of one of the most racially and ethnically diverse regions in the state, many of the more than 500,000 residents of Fresno face challenges of concentrated poverty [1], with 30.0% percent of the city's total population living poverty [2,3] and 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; enrollment for fall 2022 at FCC was 21,338 with 59% of these students qualifying as low income 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 and exhibiting financial need. In fall 2022 there were 531 active engineering majors and 314 (59%) of them qualified as low income [4].

Program Goals and Objectives

The ESP places emphasis on building a supportive community centered around student scholar cohorts. The activities developed for the program support 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.

With these goals in mind, ESP's success is evaluated based on achieving the following objectives:

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. The ESP initiated in fall 2019. As such we do not yet have data on completion rate impact (Table 1). However, despite the impact of the pandemic, in the remaining years of the project we expect to see an increase in both 2- and 3-year completion rates. The increase in degree and certificate achievement within recent semesters is encouraging and suggests that students are utilizing the engineering curriculum roadmaps to efficiently navigate their time at FCC.

Table 1. 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%	N/A	

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

There have been significant increases in the number of earned degrees and certificates in engineering since ESP implementation. Although the average number of semesters to completion is still higher than our projected goal of 8 semesters, the average is beginning to trend downward (Table 2). As the impacts of the pandemic continue to decline, we anticipate that the average time to completion will decrease as the number of earned certificates and degrees continues to increase.

Table 2. 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
Overall	93	10.5	8

Transfer data for years potentially impacted by the ESP implementation is not yet fully available (Table 3). As with degree and certification completion rates, it is anticipated that time to transfer will be accelerated and that more students will be transferring within two and three years after starting at FCC in engineering.

Table 3. 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	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”.

Research Goals and Phases

The ESP also aims to understand how the socio-cultural context of students from an area of concentrated poverty, such as Fresno, California, experience community and develop a STEM identity. Using a phenomenography-informed approach, the goal of this research is to answer: 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? [5].

Research has been structured in two phases; in phase 1 the ESP establishes an online community of practice (CoP) and in phase 2 students are engaged in critical reflections throughout their cohort participation in the program. To develop and sustain connections with one another, scholars will need to establish a community in addition to participating in the required scholarly activities. We recognize that the greatest issue with online-based CoP is participant attrition and lack of engagement [6]. The ESP intentionally mitigates this effect by designating cohort faculty mentors and peer mentors as intervening communication facilitators in this phase.

For phase 2, to capture the experience of the scholars, a phenomenography-inspired approach was used. Scholars reflected on their cohort experience by addressing questions asked during an individual interview at the end of the year. Analysis has employed narrative meaning-making and reflection of memories of their lived experience to generate an understanding of community membership and STEM identity construction from participation in the cohort [7].

Scholarly Activities and Community Building

In addition to receiving scholarship money, the engineering scholar cohorts engage with an array of strong academic supporting components, including academic advising, seminars and events, undergraduate research, faculty mentoring and peer mentoring (Table 4).

Table 4. Key Components of the Engineering Scholars Program.

Academic Advising	Each semester engineering scholars meet with FCC Transfer Center Director to update their student education plan and review and discuss transfer application deadlines.
Seminar and Events	Engineering scholars are provided seminar and event opportunities each semester, these include attendance at professional conferences, presentations, and workshops, outreach activities, and tours of California High Speed Rail construction sites.
Undergraduate Research	Scholars engage in multi-semester undergraduate research projects that include scaffolded learning workshops and seminars with sociology and engineering faculty at FCC and CSU-F.
Faculty Mentoring	Each scholar is assigned a faculty mentor from physics or mathematics to meet with monthly (at minimum.) Students on academic probation (GPA below 2.75) are provided with additional half-hour mentoring meetings with the PI twice a month.
Peer Mentoring	Established in year 2 of the ESP, scholars in preceding cohorts serve as peer mentors for succeeding cohorts and meet at least monthly with their mentees.

Awards and Cohort Composition

Current cohort composition consists of multi-institution scholars, with scholars at FCC and CSU-F (Table 5). Eligibility requirements remained the same each year with the exception that scholars are now allowed to be enrolled as part-time students (Adams et al., 2021; French, 2020).

Table 5. Awarded Scholarships by Program Year.

Year	Semester	Cohort A	Cohort B	Cohort C	Cohort D	Total
Year 4	Fall 2022	1	5**	6	7	37
	Spring 2023	1	5	5	7	
Year 3	Fall 2021	4*	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				

*including 3 that transferred to CSU-F

**including 2 that transferred to CSU-F

Seminars and Events

Each semester begins with a Program Orientation attended by all faculty mentors and scholars, as well as the academic advisor for the program. At orientation, scholars are briefed on program eligibility requirements and expectations, have the opportunity to meet other scholars, and are introduced to the program faculty members. In year 4, seven new scholars joined the program as part of Cohort D. This required adding two new faculty mentors to the program. Accordingly, in year 4, scholars that have been with the program longer were assigned to the new faculty mentors. This also provided the opportunity for our scholars to connect with different faculty.

In addition to orientation, each semester scholars participate in seminars, workshops, professional development activities, and undergraduate research in collaboration with CSU-F faculty. In Fall of year 4, eight seminars were held, all were in-person except for one (Table 6). Scholars also had the opportunity to participate in two instructional field trips with the California High Speed Rail 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 2022 semester kicked off with the *CSU-F 61st Annual Geomatics Engineering Conference* held at the CSU-F campus and ESP scholars presented their research posters. However, the conference was postponed and took place on 12th and 13th of January 2023.

Table 6. Fall 2022 Seminars and Events.

Subject	Cohort(s)	Location
Program Orientation	A, B, C, D	Fresno City College
Sociological Perspective	D	Fresno City College
Time Management / Study Skills / Mental Health	A, B, C, D	Fresno City College
Engineering Research; Research Methodology	C, D	Fresno City College
Geometry and Digital Cameras	C, D	Zoom
Remote sensing and Poster discussion	A, B, C, D	CSU- Fresno
Ethics in Engineering	C, D	Fresno City College
End of Semester Celebration	A, B, C, D	Fresno City College

Undergraduate Research

Undergraduate research opportunities in collaboration with CSU-F made up much of the seminar schedule during year 4. 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 the program's research faculty mentors from both FCC and CSU-F. Technical specifications for the research are designed by a CSU-F Assistant Professor of Geomatics Engineering. An FCC Sociology Instructor helps students connect the dots between socio-cultural content and engineering-led problem solving related to the semester projects.

Fall 2022 semester with a primary goal of helping students understand how remote sensing methodologies can be used to manage issues faced by local communities including natural disasters and the impacts of agriculture on water resources. The series of seminars - the sociological perspective, research methodology and engineering research and ethics in engineering, and technical workshops on remote sensing guided students how to prepare scientific project and posters. Three posters were presented at the 62nd Annual Geomatics Engineering Conference at California State University at Fresno focused on the Creek Fire, Flooding in Valley Communities, and Decrease of Farmland in the Central Valley.

Spring 2022 were designed to expend value in understanding the world we live in, and share with others, from many different perspectives so that cultural norms, as well as cultural bias, can be better understood. To make a connection to technical research workshop, 'Remote sensing' and 'Stereo Viewing' followed and new research project topics were discussed and presented.

Faculty Mentoring

Faculty mentor training in fall 2021 included participation in a general program kickoff meeting with all of the program faculty followed by a 3-hour LGBTQ Cultural Competence Training workshop. The training is part of the FCC Safe Space Ally Program where participants learn the basics of sexual orientation and gender identity, as well as strategies for increasing competency and addressing homophobia, transphobia, and biphobia. After the training is completed,

participants have the option of signing up to be part of the Safe Spacy Ally campus network. Faculty mentor training in spring 2022 consisted of a 90-minute in-person session during which faculty shared reflections on their mentoring experiences during the pandemic followed by short discussions on the common challenges and lessons learned. To cap the training, faculty engaged in brief a discussion of microaggressions in the classroom, including instances of microassaults, microinsults, and microinvalidation [10].

Faculty mentor training in fall 2022 included a one-hour orientation and welcome for new FCC faculty mentors. There are now six faculty mentors from FCC, four physics faculty and two math faculty, serving the 15 active ESP scholars at FCC and five ESP scholars at CSU-Fresno. The training and orientation time was used to assign mentees, review the program background, and discuss expectations. Faculty mentors support one another throughout the year with monthly 30-minute zoom meetings to share successes and challenges.

Faculty mentoring efforts have largely been focused on helping students through academic and personal challenges. Mentors and mentees meet at least monthly and, in many cases, biweekly, as requested by student mentees. Meeting topics ranged from discussions on current courses, academic goals, study habits and internships, to hobbies and personal interests. Mentors also supported scholars in areas of personal and emotional well-being, including providing referrals to campus support services from which mentees reported positive experiences and outcomes.

In addition to regular meetings with their mentees, faculty mentors worked to build community within the program through activities such as redesigning of the program's Canvas course to provide streamlined communication and better interactivity among cohorts, promoting internship and scholarships opportunities, and providing space for scholars to share their volunteer and internship experiences with others.

Peer Mentoring

During year 3, the ESP implemented an additional mentoring component with peer mentors. This new program component has continued into year 4 and addresses findings from previous years to address scholars' desire to build community with their peers in addition to faculty mentors [11]. Peer mentors comprised of preceding cohort members assigned to mentees of following cohort members.

Peer mentor training was provided at the beginning of the fall 2021 semester. 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. Through year 4 peer mentors have been supported through monthly meetings with faculty mentors at both FCC and CSU-F.

Fall 2022 began with six transferred scholars attending CSU-Fresno and acting as peer mentors. Two of the scholars have left school for personal reasons and are no longer participating in the ESP.

A significant peer mentoring event is the Transfer Students Panel presentation, held in spring 2023. During this ESP wide event the current transferred ESP scholars from CSU-Fresno present

important information based on their personal transfer experiences – they offer advice (things that are good know before you transfer, questions that are helpful to ask before transferring, and resources to seek out after transfer) and answer questions from the scholars that are preparing for transfer.

Challenges and Opportunities

As a result of the pandemic, many scholars were forced to extend their time to transfer from FCC to a four-year university. During recent semesters, several scholars at FCC dropped to below full-time status because of increased stress due to working from home; e.g., crowded homes and lack of study space, family members and students themselves getting sick from COVID-19, extra family responsibilities for younger siblings and/or children at home, loss of employment. This drop increased students' time to transfer and graduation, and subsequently increased their financial need. Also, the original budget provided funding for only one student from Cohort A for an additional two years of support at CSU-F. However, due to the pandemic, a more than anticipated number of FCC transferring students chose to stay local, and three of the four remaining Cohort A students transferred to CSU-F in fall 2021.

In addition to dropping below full-time status, some scholars are struggling to keep their grades up. Entering the spring 2022 semester there were four scholars from Cohort C who are on academic probation. These students faced an array of hardships in 2021 and worked closely with program mentors during the spring 2022 semester to identify barriers to success early on.

Due to these challenges, a supplemental funding request was submitted to support more students, addressing the need for students to take longer than the original two years to complete their pre-transfer courses, and the need to support additional students who chose to stay local and transferred to CSU-F.

Thanks to the supplemental funding award at the beginning of year 3, we were able to support all three of students that transferred locally, as well as a larger cohorts at FCC as students from earlier cohorts are staying longer. Not only did this supplemental award provide financial support for FCC and CSU-F students, but it also enhanced the learning environment for all engineering scholars through additional faculty mentor development and increased student seminar opportunities. This supplemental award has allowed the ESP to create opportunities out of challenges.

Adjustments to Recruitment Strategies

In the fall of 2021, we had additional available funding for the third cohort and had exhausted the application list from spring 2021. The scholarship selection committee members met and opted to employ a mid-semester recruitment strategy for additional scholars. We took nominations directly from program faculty mentors who had eligible students in their classes. From that pool three additional scholars were added to the program, and one scholar from Cohort A who is still attending Fresno City College was reinstated.

For year 4 Cohort D, we utilized a mix of direct recruiting through communication with individual students, email blasts to students within specific majors, and arming financial aid and academic counseling staff with scholarship information and links. The application posted online and opened for a 10-week period during the spring 2022 semester. Recruitment of current FCC students was

done within engineering, math, and physics courses via instructors directly discussing the opportunity with classes. Further, 1075 email announcements were sent to current FCC students with declared majors in Engineering, Math, or Physics. Incoming high school students are also targeted through emails; email announcements were sent to 302 high school seniors who would have been attending FCC the following year and have declared a major in Engineering, Math, or Physics.

The scholarship selection committee members agreed on seven new scholars for Cohort D. Additionally, three scholars that have transferred to CSU Fresno, two from Cohort B and one from Cohort C, were awarded while continuing supporting one previously transferred scholar from Cohort A.

Leadership Transition

Before the start of year 4, a program leadership transition took place as a result of the PI moving to a different institution. The new PI program leader is a full-time engineering instructor at FCC. Before beginning tenure at FCC, the new program leader worked at CSU-Fresno within the Lyles College of Engineering. This experience and background that has been very beneficial in preparing students for transfer, particularly with CSU-Fresno.

Prior to the leadership transition, the new program leader had been an active leader within the ESP, participating in PI/Co-PI meetings, serving on the scholarship selection committee, and had been involved in everyday operations and decisions regarding activities associated with the grant. In addition, the new leader previously served as a program advisor and mentor to scholars, had organized and hosted or co-hosted multiple seminar events, and assisted with the program's annual report and submitted regular S-STEM.org reporting data.

During the leadership transition, the former PI and new PI worked to transfer administrative tasks and responsibilities needed to award scholarships each semester. The biggest administrative challenges were associated with FCC awarding scholarships to students at CSU-Fresno. Leadership knowledge transfer continued through fall 2022 and was completed by spring 2023. The former PI remains involved as needed for support.

Transferred Student Support

In addition to being assigned peer mentors, scholars transferred to CSU Fresno are assigned the faculty leading the undergraduate research for the program as a faculty mentor. In continuing efforts on helping transfer students smooth transition to four-year degree program, 1) all S-STEM scholars were invited to workshops and seminars which enabled friendly environment for active peer mentorship, 2) introducing school resources and opportunities in four-year degree program, 3) group meeting and advising session, especially for those who struggle in adjusting.

Key Findings and Future Work

Research and evaluation findings have been used to inform opportunities to better understand and better serve the communities of interest through refinement of the strong academic and community supports contributing to the ESP. Findings from the program evaluation have informed areas where the program is as its strongest, has opportunity for improvements, and additional considerations for future development. Research findings have informed the efficacy in establishing a Community of Practice (CoP) for Science, Technology, Engineering and Mathematics (STEM) students

preparing to transfer from a two-year college to a four-year university, including strengthening their sense of belonging in STEM.

Evaluation Findings

Six current scholars (Cohort C) and four transferred scholars (Cohort B) responded the program evaluation survey at the end of year 3. The program evaluation survey aimed to gather perceptions of the key ESP program components, including seminars, workshops, events, undergraduate research, faculty mentoring and peer mentoring from current scholars and career goals, how well the ESP supported academic goals, reflections on participating in the program and perceptions of transferring to a four-year institution from transferred students. The evaluation survey included Likert-scale and open-ended questions.

Overall Program Quality

Current scholars rated the overall quality of the program in providing them with the support to reach their academic goals. Eighty percent of scholars found the quality of the program to be excellent and the remaining scholars (20%) rated the program good. When asked if they would recommend the program to a peer, every current scholar said they would recommend it.

When asked what they appreciated most about participating in the ESP, current scholars commented on the following:

- support from faculty mentors, peer mentors in order to accomplish goals
- having opportunities to volunteer and prepare for working in the engineering field
- being part of a community and team of people who share the same qualities

Some current scholars suggested recommendations for improvements and/or additions to the program, including:

- opening the program to others to provide more interaction
- being more organized in group projects
- more collaboration among students in the cohort

"I would like to have seen a project done by the entire Engineering Scholar program cohort. We did individual group for single topics which was really educational, but in the Engineering world you have Environmental, Civil, structural, Mechanical, Electrical and Architects all working together to make a building. A project where we are do a part to make something whole would be really cool! Just something that shows what happens when the sum of everyone's contribution is put together."
—Current Engineering Scholar

Transferred scholars reflected back on the extent to which the ESP supported them in achieving their academic goals. Transferred students rated scholarship funds and academic advising highest followed by mentoring and being part of a STEM community. All transferred scholars strongly agreed or agreed that the ESP helped them feel like a part of a STEM community at FCC and participation helped them solidify their career goals. Eighty-three percent of transferred scholars strongly agreed or agreed that participation helped them solidify their academic goals while 17% neither agreed nor disagreed.

Overall, transferred scholars were satisfied with their transfer experience. All agreed or strongly agreed that they will complete their degrees, and that being part of STEM community at FCC

helped prepare them for their current degree program. Of the respondents the majority (83%) are satisfied with their transfer experience, and felt it went smoothly.

Transferred scholars responded to an open-ended question reflecting on their participation in the program and what they most valued. They noted the following:

- support for transferring to the university
- overall faculty academic and personal support and mentoring
- resources and support from the engineering community
- sense of belonging to a STEM community
- better understanding of the work and practices of engineers

"The care and support I received from the faculty were invaluable and something I will continue to experience after my time with the program ends."
—Transferred Engineering Scholar

When asked about how, in reflection, the program could be improved for current and future cohorts, three of the six respondents noted that they felt the program was helpful as is. One individual felt that students could benefit from more information on how university schedules and expectations differ from those of a community college. And finally, one individual felt that undergraduate research projects should go beyond civil engineering, and offer research opportunities to engage mechanical and electrical engineering students. This individual also suggested that the faculty mentors reach out to transferred students to check-in more frequently after they transfer from FCC.

Seminar and Events

As part of the program, scholars attend seminars supporting their understanding of engineering research. On the survey, Cohort B and C scholars rated the usefulness of these seminars in supporting their learning on a five-point scale from 1, not at all useful to 5, very useful. The fall 2021 seminars were intended to develop student skills that would then be further developed and applied to research projects during the Spring 2022 semester. Not all students attended each seminar. Of those who attended the fall 2021 seminars and rated those items, at least two-thirds (67%) of scholars reported they were useful or very useful for all seminars except Measurements Using Your Phone for which 60% indicated it was useful or very useful (Figure 1).

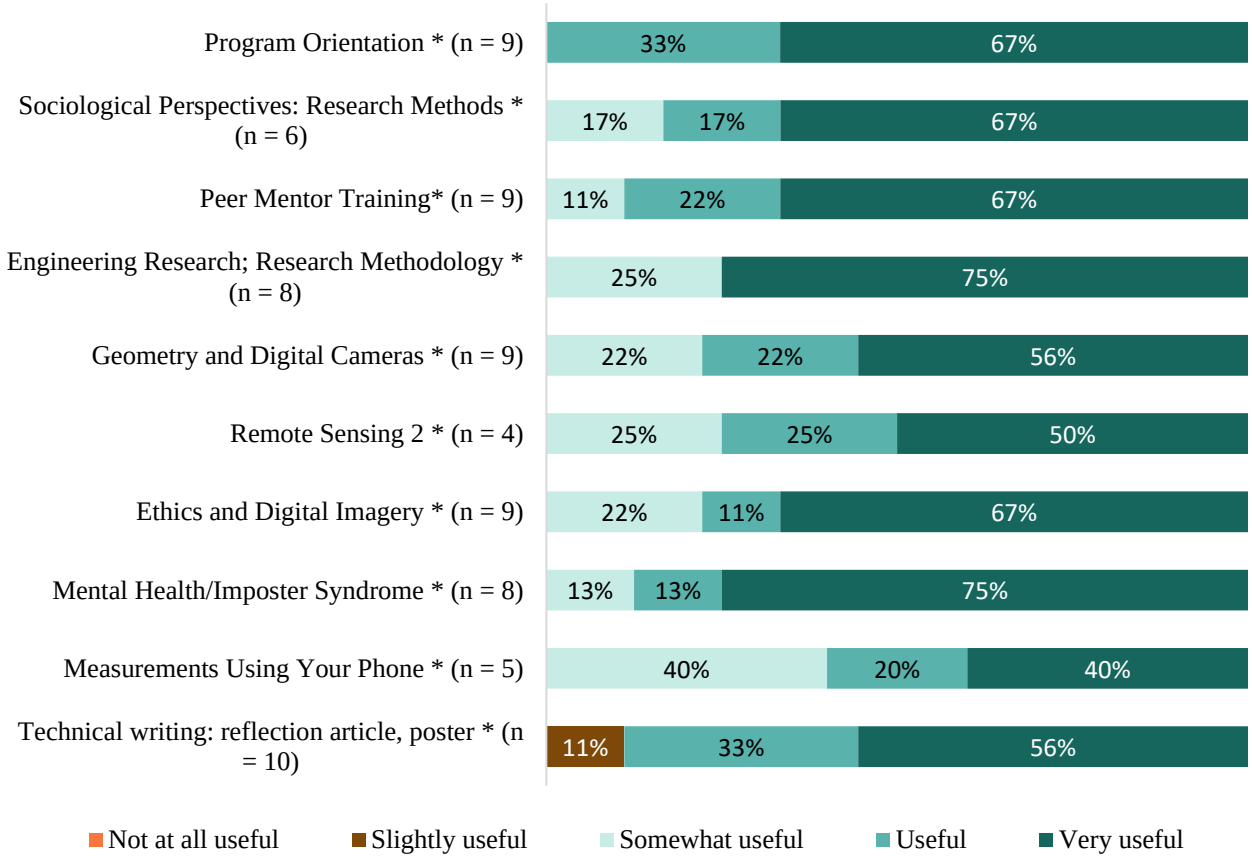

Figure 1. Scholar Perceptions of Fall 2021 Seminars and Events (*Presented in Chronological Order).

Of those who attended the spring 2022 seminars, all scholars indicated the Local Issues and Remote Sensing, Agriculture and Water in Fresno, Lab, Engineering Teamwork and Leadership, Natural Disasters & Community Impact, and Ethics and Social Responsibility were useful or very useful. The majority of scholars (85%) indicated the Hands-on Lab: vegetation, water, snow, wildfire was useful or very useful. A lesser majority of scholars (78%) indicated the Intro to Remote Sensing, Application was useful or very useful (Figure 2).

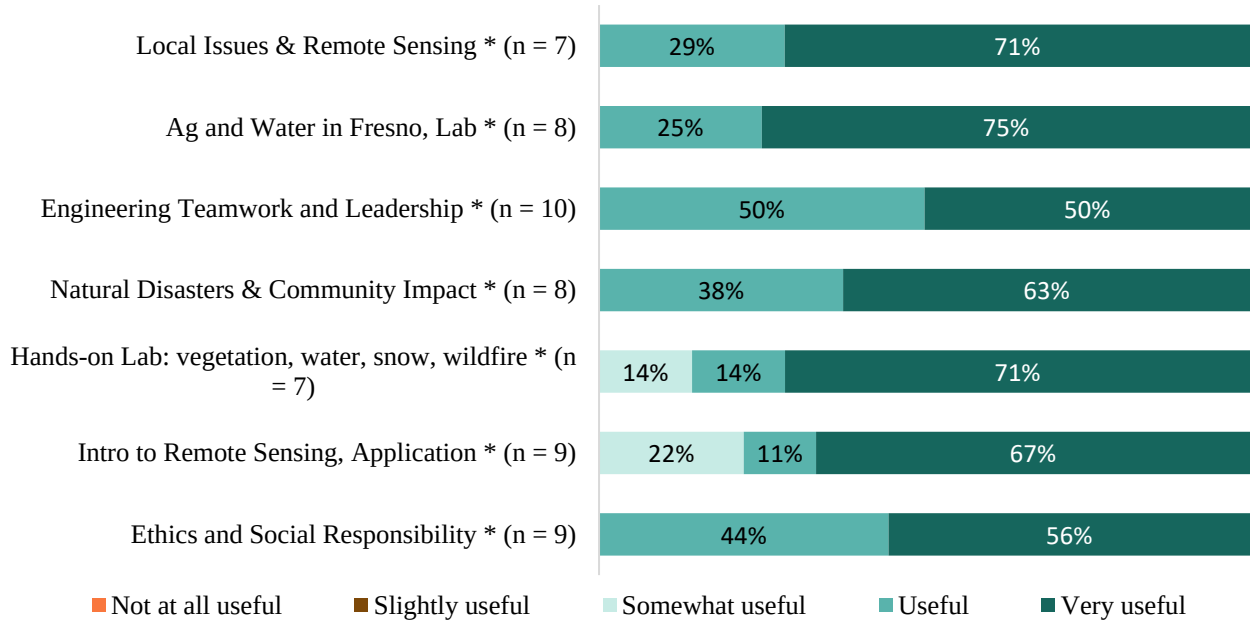

Figure 2. Scholar Perceptions of Spring 2022 Seminars and Events (*Presented in Chronological Order).

Undergraduate Research

For the 2021–2022 academic year, the majority of workshops and seminars supported Cohort B and C scholars in their undergraduate research opportunities in collaboration with Fresno State. The undergraduate research project activities were designed to foster among the Engineering Scholars 1) an understanding of how scientists and engineers perform their research, 2) exposure to engineering research, and 3) increased interest in STEM fields.

Scholars rated the extent to which participation in undergraduate research affected various attitudes and skills on a five-point scale ranging from 1, *to no extent* to 5, *to a great extent*. The majority of scholars stated that the experience increased their understanding of data analysis (90%), their understanding of how scientists and engineers work on real world problems (90%), and their skills in interpreting results from scientific studies (90%) to a *good* or *great extent*. A lesser majority of scholars (80%) stated that the experience increased their understanding of how research is conducted, their understanding of how to document research activities, their interest in engineering research, and their interest in an engineering career to a *good* or *great extent* (Figure 3).

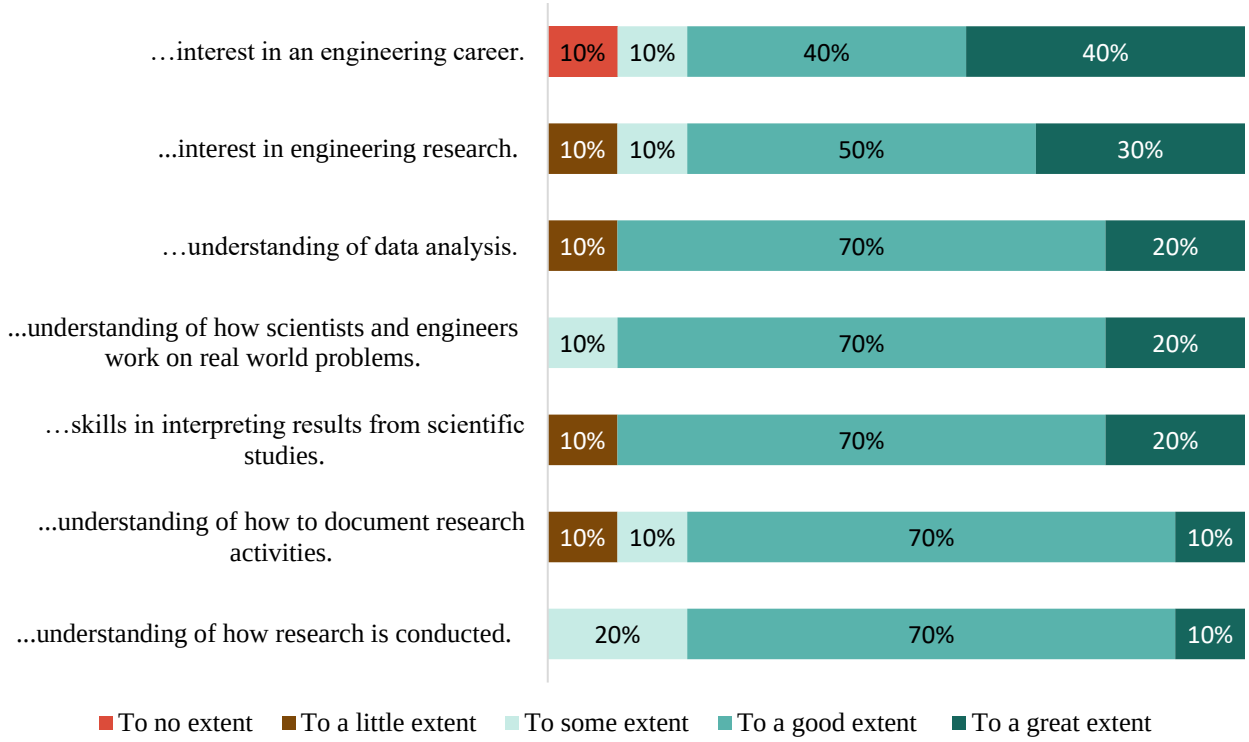

Figure 3. Scholars Perception of Participation in Undergraduate Research.

On the survey, scholars responded to an open-ended question about their greatest learning from participating in undergraduate research. Participating scholars described many impacts of the experience including the following:

- learning new skills
- understanding the commitment and the level of work that is expected
- providing them with opportunities to think about their future career paths
- working as a team toward a common goal

Faculty Mentoring

A key component to the Engineering Scholar program is high touch 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 students. On the survey, Cohort B and C scholars responded to questions about how often they met with their mentor over the course of the year, their views of their faculty mentors, and their perceptions of the support they received.

Scholars rated their level of agreement with statements regarding the outcomes of faculty mentoring on them personally and academically on a five-point scale from 1, strongly disagree to 5, strongly agree. Of the scholars, 90% were positive regarding feeling more motivated to complete their degree at Fresno City College, being supported personally, feeling more motivated to transfer to a four-year university, gaining a better sense of how to be successful at Fresno City College,

and having a better understanding of engineering and research. A lesser majority of scholars (80%) were positive about feeling supported academically (Figure 4).

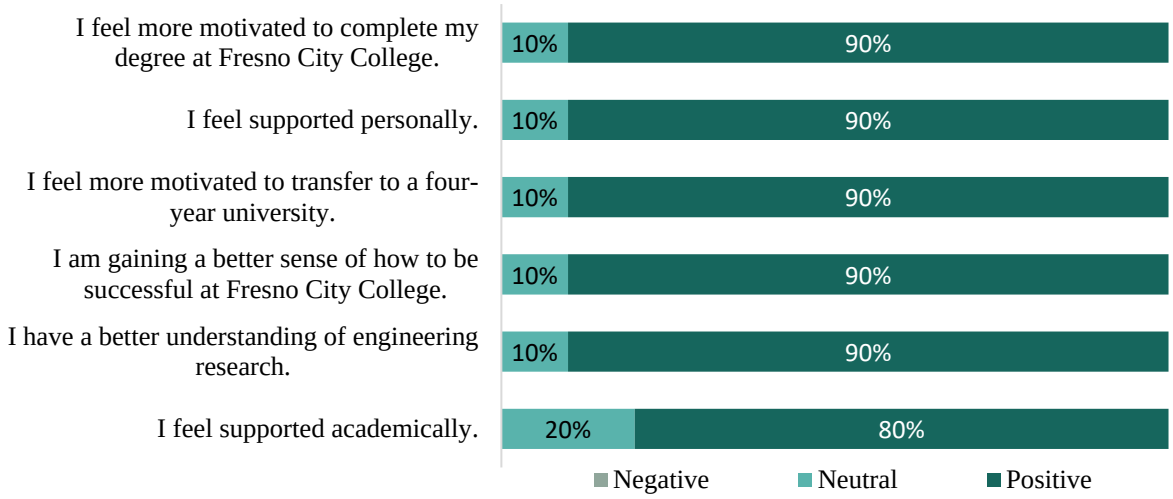

Figure 4. Scholar Perceptions of Faculty Mentoring.

In open-ended responses, scholars commented on how they were supported by their faculty mentor. They shared that their faculty mentor provided them with the following:

- advice with scheduling and work load management
- supporting them when struggling
- being available at all times

Scholars also shared ways in which their faculty mentors supported them personally:

- listening and inspiring
- being consistent in their support
- caring about their success
- checking in to make sure students were on track with their courses

Peer Mentoring

During the third year of the Engineering Scholar program, Cohort B students acted as peer mentors to Cohort C scholars. An Engineering Scholar faculty team member provided peer mentors with training where 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 the opportunity to meet one another in breakout sessions during orientation, and then met periodically throughout the year.

Students held highly positive views of their peer mentors with the majority (90%) *agreeing* or *strongly agreeing* that their peer mentors provided tips and strategies to help them be successful and were respectful. The majority (80%) felt that their peer mentors kept personal information

confidential, encouraged them to achieve their goals, are dependable, are easy to talk to, have tried to get to know them, and are concerned about their academic success (Figure 5).

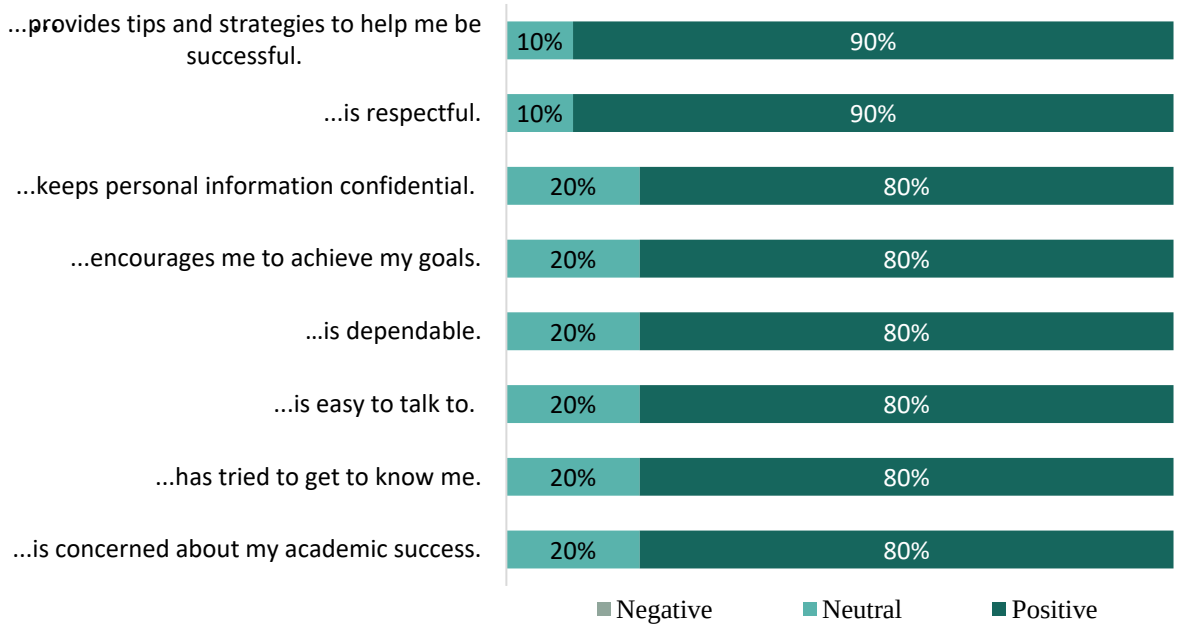

Figure 5. Scholar Perceptions of Peer Mentoring.

Scholars described being supported by their peer mentor including:

- having someone to relate to and who understands what they are going through
- encouraging them to succeed
- giving them opportunities to learn about relatable experiences and receive advice

Four individuals responded to questions about serving as a peer mentor. Of those, one student (25%) felt that mentoring another student provided them with a sense of fulfillment by supporting another student to succeed, was valuable to their personal and professional growth, made them more motivated, academically, helped improve communication and leadership skills, and reinforced their own knowledge and skills about engineering and engineering research. The remaining three individuals (75%) indicated they felt neutral for each item.

Transferred Students

Mid-spring 2022 semester, the ESP External Evaluator sent a transfer experience survey to scholars that transferred to a four-year university in the fall 2021 semester. The transfer experience survey included questions to collect information about scholars' current degree and career goals at their transfer institution, any sustained involvement in the ESP and related barriers or challenges to participating in the ESP while at another institution, and a reflection on their experiences when participating in the ESP at FCC. The survey also included questions pertaining to the impact of the ESP on the transfer experience, including impacts to 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 current university. Scholars were also invited to rate the importance of the ESP

program components for their contribution to a successful transfer and reflect on the value of and their participation in the ESP in open-response questions.

On the transferred student survey, scholars reflected back on the extent to which the Engineering Scholar program at FCC supported them in achieving their academic goals. Transferred students rated scholarship funds and academic advising highest followed by mentoring, and being part of a STEM community (Figure 6).

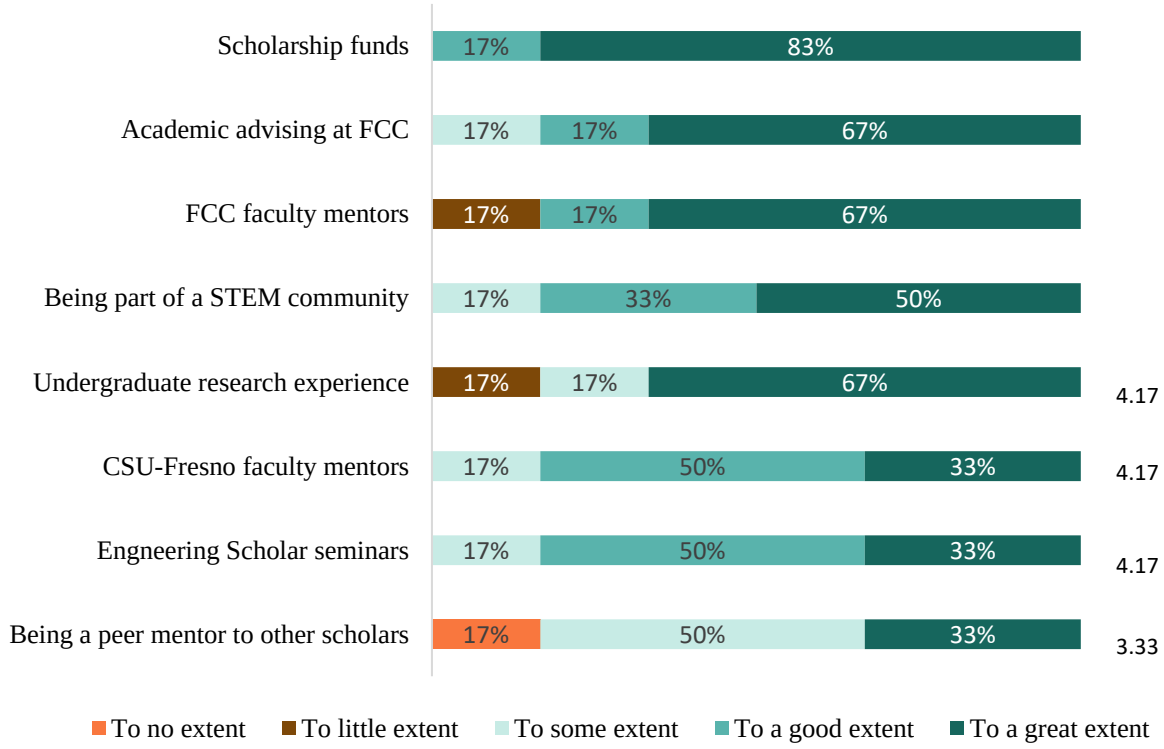

Figure 6. Transferred Scholar Perceptions of the Engineering Scholars Program.

Transferred scholars responded to an open-ended question reflecting on their participation in the program and what they most valued. They noted the following:

- support for transferring to the university
- overall faculty academic and personal support and mentoring
- resources and support from the engineering community
- sense of belonging to a STEM community
- better understanding of the work and practices of engineers

Summary

Overall program feedback indicates that all current and past scholars value the Engineering Scholar program, and all would recommend it to a peer. They appreciate the opportunity to connect with supportive professors and other students with similar interests, and being part of a STEM community. In summary, the Engineering Scholar program at Fresno City College is successfully supporting traditionally underserved, low-income students to persist in engineering pathways.

Seminars and undergraduate research experiences are providing a window into scholars' futures as engineers. The high-touch mentoring component of the program continues to provide personal as well as academic support to increase the probability that students will be retained and continue to a four-year degree program.

Research Findings

In addition to providing scholar support through scholarships and key academic program components, the ESP also aimed to build knowledge around the individual and contextual factors that explain the ways in which students become members of a community of practice and how the construct of STEM identity forms in relation to their community membership. Using a phenomenography-informed approach, research questions are: 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? To answer these questions, the ESP first established a community of practice whereby student scholars and faculty mentors engaged in collaborative STEM activities. Scholars then participated in critical reflections throughout their cohort participation via semi-structured interviews.

Community Membership

Communities of Practice (CoP) have been used to enhance students' ability to move to the center of a community through legitimate participation, implicating learning during the process [12,13] Students that participate in CoP are more likely to persist to the following academic year than their peers because learning communities establish a safe environment to learn, encourage students to take ownership of their learning, and create a sense of belonging to a larger community [14].

Scholars shared the following about their collaborative cohort experience and their STEM community membership:

> *"The first year was a lot easier to build that community just because we are all in person, taking some classes. Yeah, you did his homework man, you know I didn't I know me too let's get together let's. So, if you brought people together and gave them a place to do so everyone was just excited about engineering and science, it was just like a bunch of marriages have free reign of alive and we just all got together and had a bunch of fun a lot. So, I think the Community was really great man, a great difference, especially in you got to make those connections fast. I feel like almost most of the aspects were encouraging in some form or another to reach out to your resources which are your peers."*

> *"I think well obviously meeting regularly [with other ESP students] really did help because I got a chance to know the students that were that were in in that we're in it with me. Some of them, I do have it, I did have in my classes, some of them identify a lot of them I didn't. So, I didn't really know them, but being able to meet her and being able to interact it wasn't just you know sit down and I'm going to teach you some of them were like that, but a lot of you know a lot of the meetings that we had were of you let's in our let's talk amongst each other. Especially for the ones with messaging and there was a lot of discussion, a lot of a lot of opportunity to talk in and communicate with each other and then with this last project. You know,*

because it was difficult, we did have a chance to talk to each other, and we did have a chance to interact with each other and, and so I did offer help if anybody needed any anything so that really helped bring us together."

"The program was a huge thing for me because I'm a very introverted person. Initially I was I'm a lot better now because of the program helped me get out of my comfort zone. Gave me community, people to reach out to, and when I struggled, and I did, I had the support group and people, the system to reach out which I wouldn't have had otherwise so I'm very grateful to them."

"The professors are really cool so we're like it's not it doesn't feel like another classroom it doesn't feel like another lecture you know it feels like hey we're hanging out, and so, once you know the students were able to pick up on that you know, especially having a professor come from Fresno State, and you know conduct research. You know, once the students were able to pick up on that it became like kind of like a little at times, I mean, of course, we had to take care of business right like we couldn't just be all, but you know when the times were fun, I think that that brought it a little closer together."

Scholars report that the ESP has established 1) a shared purpose and exploration that inspires participation through centrality around becoming engineers through transfer from a two-year college to and four-year university (domain), 2) relationships of social learning with mutual respect and willingness to share in a collective experience through faculty and peer mentoring, and seminars and events on challenging topics to support personal well-being that strengthened the collective cohort experience (community), and 3) domain-based knowledge the community develops, shares, and maintains together through continued projects, support and connection that scholars have sustained through life experiences brought one by a pandemic and as they between transfer institutions (practice). A valuable CoP is defined by the existence of these three key structural elements [12].

Students, particularly those from underrepresented groups, often cite mentorship as having the largest impact on their academic performance in addition to a sense of belonging within a supportive community, emphasizing the importance of engaging trained mentors within the CoP described herein [15]. Because CoP are inherently self-defined and self-managed, we will not impose rigid structures on community cohort but will work to engage key mentors (Cohort Faculty Mentors, Research Mentors, and Academic Advisor) to lay groundwork regarding mutual benefits of the community [12] and allow for students to establish and grow their personal STEM identity within their cohort.

STEM Identity

A CoP provides support structures for tackling the challenges of purpose-driven work, processes to engage expertise, and the construction of collective confidence that have long-term impacts on students' identity development [15]. Scholars suggest that the ESP has supported their STEM identity by purposefully valuing their personal identity through culturally responsive practices in mentorship and academic activities, supported their social identity through engagement with others that have relatable characteristics, and afforded them the support structure to build their expertise

as a STEM member through encouragement in new STEM tasks (e.g., undergraduate research), cheering on performance in STEM (e.g., peer mentoring), recognition as being good at STEM (e.g., faculty mentoring), and desire to think about STEM in new ways (e.g., sociology of engineering) [16].

Scholars shared the following about the construction of their STEM identity:

> *"When it comes down to, I think is resilience. You know. On and you know this stuff is real hard so and it's not about the whole you got to be smart be smart about it, you have to be born with that intuition it's like that you just have to have the endurance to keep going when you when you mess up on the homework four times five times six times in a row."*

> *"It's very easy to get caught up in that feeling man I shouldn't be here, I don't deserve this, but I think in STEM eventually you get to that point you're like you look back and you've taken count one, two and three. And you're like man I deserve this you know, like that's the thing. You get to that point where it's like I've already done all this hard stuff what's a little more. It kind of helps with the anxiety that some of the students may face when transferring. Absolutely, it is a big leap, you know."*

> *"I think that's the biggest one is the fact that I am a non-traditional student, so I had to work a little bit harder. You know my way to this was a little bit it wasn't a straight shot; I took the scenic route what I say. So that sort of perseverance that sort of the flexibility also the really, I think it's something that I've learned with all the challenges to benefits that flexibility of I need to be flexible with myself and I need to be kind to myself if something doesn't go as planned. Though it really has helped a lot and that's something that I haven't that I learned from my mentor actually if you have to be kind to yourself and so it's that the ability to be flexible, so um you know, during this transfer thing if I don't get the classes, that I want, and you know that's okay that's all right. I know the process now, and I know right, where I can go and who I can ask I don't have to know everything right, but as long as I know who to ask and who to go to."*

Scholars have indicated that multiple program components are contributing to their movement from the learning periphery to the learning center of the community where learning is a collective experience guided by community membership and the learner is supported to build performance, competence, recognition, and interest characteristics, strengthening their personal identification with STEM, without losing their personal and social identities in the process. We continue to seek an understanding of how the ESP students transfer their STEM identity with them to CSU-F or another four-year university.

Transferred Scholars

At the end of the spring 2022 semester scholars that transferred in fall 2021 were invited to participate in an interview about their STEM identity, sense of belonging in the STEM community, and transfer experiences from their first year at their four-year institution. The interview questions

were designed to gather information on the transferred scholars' lived experience, building a narrative around their participation in the ESP during their tenure at FCC and involvement at their new institution, how this participation, if any, contributed to their membership in the STEM community and in what ways their community membership was used to construct their own STEM identity. The semi-structured interview was designed to last approximately one hour and consisted of twenty questions, five questions on the transfer experience, eight questions related to membership in the STEM community, and seven questions related to the STEM identity construct. Scholars could choose to skip questions or end the interview at any time. Interviews were conducted virtually and recorded for coding purposes. Scholars selected a pseudonym at the beginning of the interview and the interviewer referred to the interviewee by the pseudonym for the entirety of the interview.

On average, the interviews lasted ninety minutes. The two scholars interviewed, pseudonyms Abby and John, reported a sense of cathartic gratitude in the formality of reflecting on their transfer experience through an interview. At the end of the spring 2021 semester, the summer prior to transfer, Abby indicated that preparing for the experience was akin to feeling "like I'm leaving home" whereas John indicated that "getting into the big leagues" was an accurate representation of his feelings towards transfer. Both scholars indicated that they were about halfway through their four-year degree program from a credit perspective because of transfer credits, though it will take them one to two additional years to complete their requisite courses as not all transfer credits will apply to their degree path.

Abby and John both reported a sense of feeling like an "outsider" at their transfer institution during their first year. Abby shared that most students have people that they started with from the very beginning, and it was challenging to become a new member of a group. Conversely, John says the pedagogical and classroom environment differences left him feeling like an outsider for an entire year. Both John and Abby found it necessary to advocate for themselves by leading in their new environment through the formation of study groups and connection with their new community for academic and social pursuits. Both individuals attributed their participation in the ESP to their persistence in this new environment, taking control of the situation and creating a community when they did not land in one. This finding is supported by CoP participation research [14].

Furthermore, when Abby and John were asked questions relating to the construction of their STEM identity supported by their membership in the STEM community, both scholars shared that the aspects of their STEM identity that were most at ease were centrality, while the aspects relating to typicality were most at odds in their new environment. For example, John reports that he identifies as an engineer in his self-concept of his identity (centrality), however outwardly he states that he does not look like as a "typical" engineer (typicality) and backs up this statement with the reaction his new peers have that prompts them to routinely ask him about his physical appearance. This was an occurrence that John reports did not happen at FCC as more people looked like him. Comparing and contrasting the different reactions to facets of identity between institutions allowed John, as he reported, to see that although he was not a prototypical member of the STEM community within his new institution, he was a member of STEM community at large as validated through participation in the ESP [18].

Analogously, Abby reported that she also did not look like a "typical" engineer as she was older than her peers (facet: typicality), but her experiences at FCC and through STEM community membership as participant in the ESP reinforced her self-concept of STEM identity (facet: centrality0 and supported the concept that she identified as an engineer despite differing reflections in her new environment [18, 19]. Both Abby and John credited their STEM identity to their membership in the ESP at FCC, further suggesting that cohort participation influenced not only their strategies to overcome obstacles but also their strive for success as a STEM professional at their four-year institution.

Future Work

During the spring 2023 semester, first- and second-year transfer scholars, those that transferred in fall 2021 and fall 2022, will be invited to participate in follow-on interviews to further build on the learnings around the individual and contextual factors that explain community membership and STEM identity construct. These transferred scholars will also be invited to share their experiences via a transfer experience survey. Additionally, current scholars at FCC will be invited to share their ESP experiences. This information will be used for programmatic adjustments and planning for the final year of this S-STEM project.

References

1. United States Census Bureau. (2010). Quick Facts Fresno city California. Retrieved from: https://www.census.gov/quickfacts/fact/table/fresnocitycalifornia/PST045217.
2. Kneebone, E. & Holmes, N. (2016). U.S. concentrated poverty in the wake of the Great Recession. *The Brookings Institution, Report.* Retrieved from: https://www.brookings.edu/research/u-s-concentrated-poverty-in-the-wake-of-the-great-recession/.
3. Berube, A. (2006). Confronting concentrated poverty in Fresno. *The Brookings Institution, Presentation.* Retrieved from: https://www.brookings.edu/on-the-record/confronting-concentrated-poverty-in-fresno/.
4. Fresno City College, Office of Institutional Research, Assessment, and Planning (FCC OIRAP). (2020). ATERM Data, Fall 2017.
5. Marton, F. (1981). Phenomenography—describing conceptions of the world around us. *Instructional science*, *10*(2), 177-200.
6. Johnson, C. M. (2001). A survey of current research on online communities of practice. *The internet and higher education*, *4*(1), 45-60.
7. McLean, K. C. (2005). "Late adolescent identity development: narrative meaning making and memory telling." Developmental psychology 41(4): 683.
8. Adams, E. A., & Haden, C., & Dancz, C. L. A., & Ahn, Y., & Willis, K. (2021, July), *Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) Engineering Scholars Program at a Two-Year College: Preliminary Interventions and Outcomes* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. https://peer.asee.org/37700
9. French, Jamie (2020). *Awarding NSF S-STEM scholarships to students enrolled at least half-time*. Email message to NSF S-STEM Principal Investigators. April 29, 2020.
10. Neimann, Y. F. [Focused.Arts.Media.Education] (2017, May 17) *Microagressions in the classroom* [Video]. YouTube. https://youtu.be/ZahtlxW2CIQ

11. Dancz, C. L. A., & Adams, E. A., & Haden, C., & Ahn, Y., & Willis, K., & Craig, D. (2021, July), *Implementation of a Guided Mentorship Program in a STEM Community of Practice at a Two-Year College* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. https://peer.asee.org/37296
12. Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge university press.
13. Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge university press.
14. Engstrom, C., & Tinto, V. (2008). Access without support is not opportunity. *Change: The magazine of higher learning*, *40*(1), 46-50.
15. Kendricks, K. D., Nedunuri, K. V., & Arment, A. R. (2013). Minority student perceptions of the impact of mentoring to enhance academic performance in STEM disciplines. *Journal of STEM Education: Innovations and Research*, *14*(2), 38.
16. Wenger, E., McDermott, R. A., & Snyder, W. (2002). *Cultivating communities of practice: A guide to managing knowledge*. Harvard Business Press.
17. Hazari, Z., G. Sonnert, P. M. Sadler and M. C. Shanahan (2010). "Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study." Journal of Research in Science Teaching **47**(8): 978-1003.
18. Leach, C. W., Van Zomeren, M., Zebel, S., Vliek, M. L., Pennekamp, S. F., Doosje, B., ... & Spears, R. (2008). Group-level self-definition and self-investment: a hierarchical (multicomponent) model of in-group identification. *Journal of personality and social psychology*, *95*(1), 144.
19. McDonald, M. M., Zeigler-Hill, V., Vrabel, J. K., & Escobar, M. (2019). A single-item measure for assessing STEM identity. In *Frontiers in Education* (p. 78). Frontiers.