



Student Perceptions of a Summer Research Internship Program for Underrepresented Community College Engineering Students

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Abstract

Efforts to remain competitive internationally in engineering and technology require a significant increase in the number of STEM graduates in the United States. Recently there has been an increasing awareness of the important role that community colleges play in educating STEM professionals, especially in broadening participation among students from underrepresented minorities (URMs). Since 2000, underrepresented minorities' shares in engineering and physical science degrees have been flat despite a rapid increase in their representation of the overall US population. In fact, even though URMs currently constitute 30 percent of the US population, they account for only about 12.5 percent of baccalaureate degrees awarded in engineering. One common approach to broaden participation, increase engagement, and boost retention is undergraduate research experiences. Despite a number of growing studies that show the greatest gains are achieved in providing these experiences in the first two years of college, a recent extensive study of Research Experiences for Undergraduates (REU) programs shows that 91% of these research experiences are provided to junior and senior students. Developing successful research programs suited for community college students is challenging, for most of these institutions lack the faculty expertise and facilities to support on-going research programs. To address this large barrier to student success, a small Hispanic-serving community college in Northern California, in collaboration with a large local urban university, developed and implemented a ten-week *Summer Group Research* internship program suitable for sophomore students who have little to no previous research experience and have at least one more year of courses to complete at the community college before transfer. Held in the university's research facilities, the program engages community college students in graduate-level engineering research projects under the supervision of a university professor and a graduate student mentor. This paper highlights the collaborative development of the program, along with results of interviews with students who participated in the 2016 and 2017 *Summer Group Research* programs. The interview protocol is presented along with data from four key areas of inquiry that were identified to examine the internships' impact on engineering self-efficacy and commitment to an engineering career, academic goals and interest in research, career goals, and engagement with professionals from academia and industry. Best practices and lessons learned are shared, along with recommendations for colleges looking to replicate the program.

1. Overview of ASPIRES Program at Cañada College

Cañada College, located in the San Francisco Bay Area, is a Hispanic-serving community college, and is one of three colleges in the San Mateo Community College District. During the 2015-16 academic year, Cañada College enrolled 10,075 unique students. The student body is genuinely multi-cultural with Hispanic students as the largest single group at 45.2%; white students comprise 26.8%, Asians 12.3%, African-Americans 2.8%, American Indian/Alaska Natives 0.2%, Filipinos 4.1%, Pacific Islanders 1.4%, multi-ethnic 4.2%. Approximately 18% attend college full time, taking 12 or more units per semester. Like all California community

colleges, Cañada College is an open-enrollment institution, designed to welcome students of all backgrounds. Cañada College's Engineering Program is a transfer program that offers a comprehensive set of lower-division engineering courses needed to transfer to any four-year engineering program in any field of engineering.

In 2015 Cañada College's Engineering Department collaborated with San Francisco State University (SFSU) School of Engineering and UC Merced Undergraduate Research Opportunities Center to develop and implement the *Accelerated STEM Pathways through Internships, Research, Engagement, and Support* (ASPIRES) project, which is funded by a three-year grant from the Department of Education Minority Science and Engineering Improvement Program (MSEIP). ASPIRES addresses identified barriers to student success using high-impact educational practices that have been shown to enhance interest, increase participation, and improve outcomes for underrepresented minority students in STEM.

Among the main objectives of ASPIRES is to develop an internship program model that is suitable for community college students and provides multiple exposures to undergraduate research opportunities. The ASPIRES internship program has three levels targeting students at different stages in their academic careers. The first level is the ASPIRES Research Scholars Program, which is a two-week program that targets freshmen and rising sophomores. Held during the winter break, the program introduces students to research and covers the following topics: applying for internships; introduction to the research process; university laboratory tours; conducting literature reviews; university transfer process for community college students; presentation skills; and project-specific topics including experimental methods, instrumentation, and data acquisition and analysis.

A focus group of STEM students at Cañada College identified common barriers to a successful research internship program for community college STEM students. For most undergraduate research internship positions, community college students are in competition with upper-division students who have taken more advanced courses, and have had access to research-quality laboratory facilities. Additionally, many of these community college students need to take classes during summer session in order to fulfill the transfer requirements. Due to the diversification of requirements of different majors and different institutions, community college students often take more classes compared to their counterparts in four-year institutions¹. Since most summer research internship positions are full-time, community college students who are interested in participating in internship programs are often faced with the difficult choice between accepting a summer internship position or taking summer courses to ensure their timely transfer.

The ASPIRES Summer Group Internship Program is a ten-week program for sophomore students who have no previous research experience and have at least one more year of courses to complete at Cañada College before transferring to a four-year university. In addition to allowing students to participate in the program as part-time interns, the group setting wherein students work with their peers and faculty they know will give students the supportive learning environment needed to succeed in their first internship experience. A collaborative learning environment has been shown to positively impact minority students—improving cognitive development² and reducing students' feeling of isolation³. The ASPIRES Group Research

Internship program consists of six research groups, each consisting of one full-time student intern and three part-time student interns supervised by one SFSU graduate student and mentored by an engineering faculty.

The ASPIRES Summer Individual Internship Program is a ten-week program for rising junior students who have completed all the required lower-division courses for transfer to a four-year university and are transferring in the fall semester following participation in the program. Students in the program work with researchers from SFSU, UC Merced, Stanford and NASA Ames Research Center.

2. The Pilot Implementation of the ASPIRES Summer Research Internship Program

The ASPIRES Summer Research Internship Program was first piloted in 2016, and continued in 2017. This section of the paper describes program implementation, including the selection of participants in the program, the Summer 2017 research projects, and the results of the implementation of the Summer 2017 program. A total of 33 students participated in the 2017 ASPIRES summer internship program, six for the Individual Research Internship program and 27 for the Group Research Internship program. Of the 27 interns assigned to group research, six were full-time interns (one each for the six research groups), and 21 were half-time interns. All of the Group Research interns and one of the Individual Research interns did their work at SFSU.

2.1 Recruitment and Selection of Program Participants

The engineering program at Cañada College is small, with about 25 to 30 students completing the transfer program and transferring to a four-year institution every year. An aggressive recruitment strategy was employed in order to find qualified applicants for the program, especially students from underrepresented minority groups. Recruitment for the program starts in December through the STEM Center website (<http://www.canadacollege.edu/STEMCENTER/aspires.php>) and the STEM Center weekly *STEM Scoop* sent via email to all students who are members of the STEM Center. In addition, an email invitation was sent to all students registered for any of the engineering courses in both the current Fall and previous Spring semesters. In recruiting program participants, among the program benefits and incentives highlighted are the stipends (\$5,000 for full-time interns and \$3,000 for part-time interns), flexibility of schedule for half-time interns, and the opportunity to attend and present at a professional conference. Student applications were submitted through an online application process that takes into consideration student GPA, intended major, STEM courses completed (minimum requirement is completion of first semester physics course), extracurricular activities, statement of academic and professional goals, statement of research interest, and a recommendation letter from a STEM instructor.

A total of 56 completed applications were received by the February 15, 2017 deadline. Applications were reviewed by two engineering faculty involved in the project. In selecting program participants, priority was given to qualified students who previously completed the ASPIRES Winter Scholars Program (run in Winter 2016 and 2017), a two-week program that introduces students to the basics of research as well as data collection and analysis in engineering. Additional consideration was given to completion of engineering and programming

courses that were directly relevant to the research projects to be assigned to the students. Students who have completed all their courses at the community college and are transferring in the subsequent Fall semester are considered for full-time positions. Among these students, the top applicants were selected for the six Individual Research Internship positions and six full-time Group Research Internship positions.

Table 1 summarizes the demographics of the students who participated in the 2017 ASPIRES summer research internship program. The gender distribution of the selected participants closely reflects that of the applicant pool with 21% of the participants being female compared to 19% female among the applicants. In comparison, among all engineering students in the college during the 2015-16 academic year, only 15% were female students. College-wide over 60% of students were female. The ethnicity distribution of the selected participants also closely reflects those of the applicants with 42% Hispanic, 30% Asian, 24% White, and 3% multiracial. In comparison, among all engineering students in the college, the ethnicity distribution is as follows: 24% Hispanic, 29% Asian, 24% White, and 22% multiracial. The program was successful in recruiting Hispanic students as evidenced by a higher Hispanic representation among program participants (42% Hispanic compared to 24% Hispanic among all engineering students), which more closely represents the over-all college demographics of 45% Hispanic.

Table 1. Demographics of 2017 ASPIRES Summer Research Internship Program participants.

Demographics	# of Students	(%)
<i>Gender</i>		
Male	27	78.8%
Female	6	21.2%
Total	33	100%
<i>Ethnicity</i>		
Asian	10	30.3%
Hispanic	14	42.4%
White	8	24.2%
Multiracial	1	3.0%
Total	33	100%

2.3 Results

In order to assess the success of the research internship program in achieving the program goals, pre- and post-program surveys were developed and administered electronically to the participants. This survey was adopted from the Survey of Undergraduate Research Experiences (SURE), which is as a tool for assessing undergraduate research experiences. The SURE consist of 44 items, including demographic variables, learning gains, and evaluation of aspects of summer programs⁴. An adaptation of the SURE was done for two undergraduate research programs that target underrepresented students (Hispanic, in particular) at California State University, Long Beach⁵. The survey was designed to measure student motivations for engaging

research, student research and academic goals, as well as their perception of the skills needed for research and academic success. This survey was adapted to the needs of the ASPIRES internship program for community college students, and given as part of the electronic pre- and post-program surveys. Additionally, a set of post-program survey questions were asked to measure students' perception of the usefulness of and satisfaction with the internship program, including whether it has been helpful in preparing them for transfer, solidifying choice of major, increasing likelihood of pursuing graduate school, and increasing likelihood of applying for other internships. The responses were given in a Likert scale, "1" for "strongly disagree" and "5" for "strongly agree." The pre-program survey was administered at the beginning the internship program, following the orientation, and the post-program survey was administered immediately following the student final presentations at the end of the internship program.

Results of the survey of student motivation for participating in research are summarized in Table 2. The biggest motivation for engaging in research as selected by students is to gain hands-on experience in research, followed by good intellectual challenge, and clarifying whether they wanted to pursue graduate school. Note that the only statistically significant difference between pre- and post-program responses was observed for gaining hands-on experience in research [$t(1,48) = -2.63, p = 0.22$].

Table 2. Motivation to conduct research:

Post-program prompt: Please indicate the degree to which your internship experience helped you learn or gain each of the following. 1 being the LEAST helpful and 5 being the MOST helpful.

Pre-program prompt: What do you most want to learn or gain from your internship this summer?

1 - Strongly Disagree and 5 - Strongly Agree.

Item:	Post	Pre	Diff
gain hands-on experience in research	4.09	4.79	-0.69*
solidify my choice of major	3.56		
gain skills needed to successfully complete a BS degree	3.88		
clarify whether graduate school would be a good choice for me	3.69	4.15	-0.46
clarify whether I wanted to pursue a STEM research career	4.06	3.79	0.27
work more closely with a particular faculty member	3.75	3.58	0.17
get good letters of recommendation	3.59	4.00	-0.41
have a good intellectual challenge	4.34	4.55	-0.20
read and understand a scientific report	4.03		
write a scientific report	3.97		
ask good questions related to the scientific process	3.97		
set up a scientific experiment	3.56		
work with others to plan and conduct scientific experiments	4.09		
talk to professors about science	4.00		
think like a scientist	4.03		

* = statistically significant

Result of the pre- and post-program surveys on student perceptions of their skills and knowledge needed for research and academic success are shown in Table 3. Of the 21 items in the survey, statistically significant gains (indicated with a *) are observed in three areas: “I can imagine myself continuing after my BS to pursue a Master’s Degree in a STEM field” [$t(1,59) = 2.04, p = 0.35$], “I am ready for more demanding research” [$t(1,56) = 2.04, p = 0.46$], “I understand how scientists work on real problems” [$t(1,62) = 1.95, p = 0.50$]

Table 3. Results of survey of student perception of skills and knowledge for academic and research success. Response Scale: 1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree.

Question: Tell us how much you agree with each of the following statements.	Post	Pre	Diff
I was able to conduct the scientific research that is part of my summer internship.	4.28		
I am confident I will transfer to a four year institution .	4.78	4.64	0.14
I am confident I will complete a BS in a STEM field .	4.69	4.55	0.14
I can imagine myself continuing after my BS to pursue a Master’s Degree in a STEM field .	4.38	3.85	*0.53
I can imagine myself continuing after my BS to pursue a Ph.d. in a STEM field/Medical School/other education beyond the Master's level.	3.72	3.48	0.23
I have a clear career path.	4.16	3.94	0.22
I have skill in interpreting results.	4.22	4.09	0.13
I have tolerance for obstacles faced in the research process.	4.38	4.18	0.19
I am ready for more demanding research.	4.28	3.85	*0.43
I understand how knowledge is constructed.	4.03	3.76	0.27
I understand the research process in my field.	3.81	3.42	0.39
I have the ability to integrate theory and practice.	4.00	3.76	0.24
I understand how scientists work on real problems.	4.13	3.70	*0.43
I understand that scientific assertions require supporting evidence.	4.53	4.33	0.20
I have the ability to analyze data and other information.	4.25	4.09	0.16
I understand science.	4.28	4.12	0.16
I have learned about ethical conduct in my field.	3.84	3.97	-0.13
I have learned laboratory techniques.	3.78	3.76	0.02
I have an ability to read and understand primary literature.	4.06	4.12	-0.06
I have skill in how to give an effective oral presentation.	4.31	4.00	0.31
I have skill in science writing.	4.16	3.76	0.40
I have self-confidence.	4.22	4.27	-0.05
I understand how scientists think.	4.06	3.79	0.27
I have the ability to work independently.	4.50	4.33	0.17
I am part of a learning community.	4.34	4.33	0.01
I have a clear understanding of the career opportunities in science.	4.28	3.97	0.31

*** = statistically significant**

Included in the post-program survey for the ASPIRES program are questions that attempted to assess students' level of satisfaction with the program activities and results. A summary of the mean responses is shown in Table 4. As can be seen, overall the program participants are satisfied with all aspects of the program as evidenced by mean responses that are between *Satisfied* and *Very Satisfied*.

Table 4. Results of survey of student perception of skills and knowledge for academic and research success. Response Scale: 1 – Very Dissatisfied; 2 – Dissatisfied; 3 – Neutral; 4 – Satisfied; 5 – Very Satisfied.

How satisfied are you with each of the following?	Mean
Opening Day at SFSU	4.37
Faculty Adviser Description of Project	4.11
Meetings with Graduate Student Mentor	4.24
Meetings with Faculty Adviser	4.13
Mid-Program Presentations	4.14
Final Presentations	4.48
The results of your project	4.19
Your final poster	4.00
Your final presentation	4.43
How much you learned from the program	4.28
Your group mates	4.50
Your faculty adviser	4.35
The Summer Internship Program as a whole	4.13

3. Qualitative Evaluation of Research Internship

In addition to pre- and post-program surveys, interviews were also conducted with participants in the 2016 and 2017 ASPIRES Summer Internship program to gain further insight into the internship experience and its benefits from the student perspective. The methodology and research design are first covered, followed by a review of key findings, including students' ideas for how to strengthen the internship program. Recommendations are provided in the conclusion.

Methodology

A list of ten potential interviewees were identified by the ASPIRES leadership and their contact information was given to the team's external researcher who emailed each student inviting them to participate in a 30-minute conversation about their summer internship experience. The email emphasized the voluntary nature of the interview. Among the 10 students contacted nine responded and eight agreed to the interview with one student declining. The interviews were conducted in July and August 2017.

The interviews were guided by a research protocol that was developed by the researcher in collaboration with the ASPIRES leadership team. Through discussion on intended outcomes and program goals, the ASPIRES team identified four areas of inquiry to examine the internships' impact on interviewees:

- engineering self-efficacy and commitment to engineering as a career
- academic goals, including interest in research
- career goals
- network of/engagement with professionals from academia and industry

Participants were also asked for input and ideas on how to improve the internship experience.

Key findings

Impact on engineering self-efficacy and commitment to engineering as a career

Analysis consistent in every interview indicates that the interns were already highly committed to engineering as a career. The internship experience broadened their thinking about career opportunities they can pursue to include graduate level studies and academic research in engineering. The internships taught students how to work in teams and how to “figure out how to make things work.” One student commented that he learned a lot by having to explain his part of the research project to the other members of his team and to the graduate student supervisor. Another student described how well the team worked with “each person focusing on tasks that were assigned to them by the full-time intern group leader.” The student also spoke with enthusiasm about how the students would meet to brief each other on the progress they had achieved on their part of the overall project and how all the pieces came together in the end – “we were like a professional team working together to make a product.”

Before applying to participate in the Summer Internships, most participants were already part of Cañada College’s STEM community — engaged in the STEM Center and in STEM activities outside of the classroom, including STEM clubs. The internship experience connected the students to an expanded network of STEM students and faculty that included potential university role models and advisors.

While many students spoke of how nervous they were about the internships – including a student who was so afraid of failing that she almost withdrew the week before the experience started – they all gained confidence and additional perspective from the experience. Several students mentioned the mid-program and final presentations as both a source of great anxiety and – after they were delivered – a source of great pride.

Impact on academic goals and confidence, including interest in research

Several students explained the internship (and for some the preparatory ASPIRES winter experience) marked their introduction to academic research. Three students commented on how spending time with their graduate student supervisor made them realize how exciting and relevant academic research can be. Further, one student noted that: “the graduate students we met made it clear that you have more opportunities if you have a Master’s Degree.”

One student who had participated in a field trip to University of California, Merced said the opportunity to meet students engaged in academic research was a revelation. “I did not know what research was until I had the experience in Merced where students in a lab talked about what

they were doing.”

Two students spoke enthusiastically about how inspired they had been by their graduate students’ accounts of what their undergraduate studies were like and what made them decide to continue their studies after getting their BS.

Several interviewees commented that the internship experience represented their first opportunity to “really do something in a real world context.” One student said that the research project showed him that “you can work with something that has not been out there before.” He added that he saw how graduate students “came up with an idea and tested it to see if they could pull it off.”

Two students explained with great satisfaction how they had been assigned to projects in new and emerging disciplines – cloud computing and deep learning. Both students felt confident that they had gained valuable, marketable skills.

One student who had an internship at the University of California Merced noted proudly that the community college students did really well and, especially in the final presentation of the internship project, “really stood out” for their accomplishments. Students who had the opportunity to present at professional conferences felt the experience helped them gain confidence and discover that they could in fact become members of an academic research community. One participant, now a transfer student, explained that his 2016 internship experience had played a key role in helping him successfully compete for a three-year scholarship that includes a paid summer internship at Intel. The same student also has an NSF scholarship so “his college has been all paid for at this time.”

Several students also mentioned how important it was for them that the internship was paid. The impact of having enough money on academic persistence and outcomes was illustrated by one successful intern who explained he had dropped Calculus I twice because his dad needed him to help out with the family construction business. The third time, the student was able to prioritize school and passed Calculus.

Impact on career goals

Focusing and strengthening students’ career goals was one of the objectives of the ASPIRES project. Student testimonies indicate positive impact. One student said the experience had made her change her major from Bio-Engineering to Computer Science. “After talking to my mentor who is pursuing a Master’s Degree in CS, I started to see this was something for me.” The student said she had realized she likes research and wants to pursue a Ph.D. in CS. Her goal is to use her skills in a medical field so she can help others. She speculated that she could create software for hospitals to make them process data more efficiently. Two participants in the ASPIRES 2016 internship reported having obtained paid summer internships during the summer of 2017. One of the participants was working at United Technologies and the other at Intel.

One student describing himself as “older” (he is 26) said that “older” students really need the internship experience to strengthen their transfer applications and to help them in their future career. The student is applying to the Navy noting “he wants to serve.”

A majority of interviewees expressed a commitment to “give back.” Two students said they had been inspired by all Dr. Enriquez (Dr. E, as they call him) had done to encourage and help them succeed and that they now felt inspired to do the same for others through teaching. “Dr. E had a huge impact on me,” one student commented. “First, I want to get my BS and then a Master’s Degree and also work for a while. In the longer run, I’m interested in becoming a professor and inspire and encourage others. I want to repay what Dr. E did for me.” As their quotes presented in this report reveal, several other students also expressed a desire to contribute and use their engineering skills to help others.

Impact of/engagement with professionals from academia and industry

Two students explained that the internship experience had persuaded them to transfer to SFSU, including one student who had initially been headed for San Jose State University. “This is the best decision I ever made,” said the student who is now a junior at SFSU. He added: “The transition was great. I already knew a bunch of [SFSU] students here from the internship. They told me how to register and which faculty were best at explaining things and most supportive. Also, I already knew some faculty from the research lab.” This student appears to have had little to no “transfer shock”, as result of participating in the ASPIRES program and continued undergraduate study at SFSU.

One student noted that his mentor was a UC Merced graduate student and that they stayed in contact after he concluded his 2016 internship. The student said that the graduate student helped him with homework during his first year at UC Merced. This was particularly helpful because the student, who had been used to ask friendly Cañada College STEM faculty for help, felt a bit overwhelmed by UC Merced’s very large School of Engineering and faculty members who were “hard to connect with.” One student spoke with satisfaction about the clear and goal-driven assignment her team had been given by a SFSU professor. “This made it easier for my team,” she explained, continuing: “I knew of several other groups that did not have a clearly defined outcome and where the mentor did not know what they were doing and therefore the interns did not know what they were supposed to do.”

Several students spoke of the importance of learning how to deliver presentations in front of faculty and other researchers. One student spoke of how he and other interns had formed a community that they had continued when they returned to Cañada College where they had shared with other students the posters and presentations they prepared and delivered during the internship.

Ideas and input for improving the internship experience

All interviewees were solicited to provide any ideas they had on improving the internship experience. The most common concern was that some students were assigned to projects outside of their major. While this was not the case for the majority of the interviewees, most of them were aware that some students complained about this situation. This included one student who, one intern said, “simply did not do anything.” One interviewee had been assigned to a project outside of her major. She explained how at first she was discouraged, but then decided to make

the best of it. She ended up “learning a lot about writing code and team work and it all worked out really well.”

Another common concern was lack of guidance from the faulty supervisor. While some faculty supervisors provided clear guidance on the summer projects, others were largely absent and/or they failed to clearly articulate what the students were expected to do/produce in their projects. Overall the commitment level of the faculty supervisors seems to range from highly engaged to not very engaged.

Two students also spoke about how they had friends in other groups whose mentors were unable to provide much guidance. “They [the group members] did not understand what they were supposed to do and for this reason they did not finish off well,” the student noted. “In the final project presentation you could see who had been kind of lost and you could see who really accomplished something.”

Some students who worked on simulations said that while they learned a lot, they “would have liked to build something (tangible).” One student who also participated in the 2016 internship said that while last year his assignment was based on simulations, he was fortunate this year to be doing hands-on experiments. “I really love the hands-on,” he said.

With respect to the final presentations, two students felt the concluding day featured so many presentations that (a) “nobody was paying attention at the end,” (b) the volume of information “started to be overwhelming,” and (c) the teams presenting last faced an exhausted and less engaged audience.

Recommendations from the researcher

After conducting the interviews and reviewing responses, the team researcher gave recommendations to the ASPIRES leadership. Her first recommendation was regarding extra information to include in the preliminary notification on being selected for the internship. She noted that when students are notified that they have been selected to participate in the program, they should be informed very clearly that (a) this is a great honor and achievement; (b) they may be assigned to a project which is not in their major; and (c) regardless of whether the project is in their major, there will be opportunities to learn how to work in teams, learn how to conduct academic research, spend time with graduate students and learn survival strategies to succeed in junior and senior level STEM courses. While these benefits are already presented to the students, more should be done to make it very clear that those who don’t want to be in an internship that is not directly related to their major should leave the space and opportunity for somebody else. She also noted that it may be useful to include in the information a story about a student who did not fully understand that she could be assigned to a project outside of her major and whose disappointment undermined the experience for her team members – with a message: if you feel this way or think you may feel that way, now is the time to let us know. Additionally, the team could include another case study about the student interviewed who made the best of an assignment outside of her major, in effort to demonstrate options.

Another item identified is that spending time with the students’ graduate student supervisor is

extremely valuable to the interns. The researcher noted that it might be useful to ask all the graduate students who participate in the internship program to make sure to share their own academic journey with their interns and to include in this account difficulties they encountered and how these were overcome. The graduate students also represent to the interns a source of valuable information for what it will be like to transfer to a four-year college. Any advice graduate students can provide is useful and highly appreciated. The project coordinators may therefore want to encourage all the graduate students to talk about life at a four-year college, the STEM courses they took, and how they managed. The graduate students could also be encouraged to talk with the interns about the importance of joining STEM clubs, applying for scholarships and going to office hours.

Many students – likely a majority of community college STEM students -- have never been introduced to academic research and do not think of it as something in which they could possibly partake. Even a one-day field trip to a lab at a university where students are working on research projects can help community college students see themselves as potential participants in a research team. To the extent possible all community college STEM students should have the opportunity to visit a research lab and talk with students engaged in research projects.

Several interviewees revealed that they feel nervous about transferring because they went to a community college. To the extent possible, the project should try to hire graduate student supervisors who were themselves transfer students and to find other graduate students and faculty members who attended community colleges who are willing to share their own academic journey with the interns. Possibly, a brown-bag lunch with graduate students who transferred from a community college could become part of the program.

4. Conclusion

Two years of implementation of the ASPIRES Summer Internship program has been successful in creating opportunities for students, especially those from underrepresented minority groups, to engage in advanced academic work that develops research skills and applies concepts and theories learned from their classes to real-world problems. The program was successful in recruiting students from underrepresented minority groups as evidenced by the higher participation rate among Hispanic students compared to the overall engineering enrollments. The unique design of the program, i.e., including individual and group research internship opportunities as well as half-time and full-time positions, has made these opportunities available to community college students who would otherwise not consider research and internship positions. The individual research internship positions were designed for students who have completed the community college courses needed for transfer, as well as students who have had previous internship and/or research experiences. The group research internship positions were designed for students who have not any prior research or internship experience. The group setting wherein students work with their peers and faculty they know will give students the supportive learning environment needed to succeed in their first internship opportunity. The half-time positions were targeted towards students who have at least one more year of courses to complete at the community college before transferring to a four-year university to allow students to take summer courses they need for transfer as well as accommodate the work schedule of

working students. For the 2016 cohort of program participants, of the 18 half-time interns, 13 were working at another job, and 12 were taking summer courses during the duration of the program. Without these half-time internship positions, many of these students would not have been able to participate in the program.

Results of the survey of program participants also showed that the program has helped students in solidifying their choice of major, improving preparation for transfer, enhancing student self-efficacy in pursuing careers in engineering, and acquiring knowledge and skills needed to succeed in a four-year engineering program. As a result of their research experience, the participants have also expressed that they are now more likely to apply for other internships and consider pursuing graduate degrees in engineering.

The research internship program has also provided opportunities for students to be engaged in advanced levels of academic and professional activities and achievements—opportunities that are not commonly available to freshmen and sophomore undergraduate students, especially in community colleges. Even students with little or no background in engineering courses or the research topics were able to succeed in the program. The research work done by the students has resulted in a number of student conference paper and poster presentations at professional conferences such as the Society of Hispanic Professional Engineers (SHPE), the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) and the American Society for Engineering Education.

Although results from the last two years of the ASPIRES program have shown positive impact on students as evidenced by gains in research skills acquired, ability to work independently and collaboratively, enhanced self-efficacy for transfer success, and increased interest in future research and advanced studies, further analysis is needed to determine if these gains result in improved academic performance. Additionally, the perspectives of the research mentors and faculty advisors need to be integrated into improving future iterations of the program to further promote success and achievement among underrepresented students.

The collaboration between Cañada College, SFSU School of Engineering, and UC Merced developed through the ASPIRES program, which has created opportunities for community college students to engage in research, has been mutually beneficial to all the partner institutions. Research activities that were directly developed by the ASPIRES program participants enriched academic experiences of students at all institutions while enhancing the research capabilities of the universities and strengthening the engineering transfer program at the community college. The success achieved through the partnership has also been instrumental in securing additional funding—both individually and collaboratively—to further strengthen the partnership, better promote STEM education and improve the programs and services offered at both institutions, and serve as a model of collaboration for improving STEM education at public institutions of higher education.

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