Developing a Summer Research Internship Program for Underrepresented Community College Engineering Students

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Abstract

For the past several years, institutions of higher education have devoted resources towards increasing the number and diversity of engineering graduates by addressing the retention problem in the first two years of college. One of the strategies commonly employed in improving undergraduate STEM education is providing students access to research experiences. There are many studies documenting the benefits of research opportunities for undergraduate students including increased student engagement in their education, enhanced research and laboratory skills, improved academic performance, increased student self-efficacy, and increased understanding and interest for their discipline. These studies also show that early and multiple exposures to undergraduate research experiences offer the greatest benefit. However, a recent extensive study of Research Experiences for Undergraduates (REU) programs shows that the vast majority of these research experiences are provided to junior and senior students. Developing successful research programs is particularly challenging in community colleges, most of which do not have on-going research programs.

This paper is a description of how a small engineering transfer program at a Hispanic-Serving community college in California developed a three-tier research internship program suitable for community college students at different stages of their academic careers. The first part of the program is a two-week *Winter Research Scholars Program* held during the winter break for students in the beginning stages of their studies. The second part is a ten-week *Summer Group Research Internship Program* for sophomore students who have no previous research experience and have at least one more year of courses to complete at the community college before transfer. The *Summer Individual Research 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 their participation in the program. The paper will highlight the development of partnerships with neighboring universities and research institutions, the results and lessons learned from the pilot implementation of the two summer internship programs, and future plans to improve the programs and maximize their impact in enhancing the academic success of community college engineering students and strengthening community college engineering transfer programs.

1. Introduction

Despite years of investments and resources devoted by the federal government and institutions of higher education towards broadening participation of underrepresented minorities (URMs) in science, technology, engineering, and mathematics careers, significant progress has not been achieved. For instance, 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[1]. In addition to recognizing the need to increase interest in the engineering profession among college students and addressing the attrition problem in the first two years of

college, there is increasing recognition of the critical role that community colleges in increasing the number and diversity of the future engineering workforce. Community colleges enroll over 60% of Native American students, over 55% of Hispanic students, and over 50% of African American students attending institutions of higher education in the US[2]. In fact, almost three-fourths of all Latino students and two-thirds of all African-American students who go on to higher education begin their postsecondary education in a community college[3].

Improving post-secondary student retention and success has been the subject of many studies. For example, Kuh's multi-phased study identified high-impact practices including first-year seminars and experiences, common intellectual experiences, learning communities, writing-intensive courses, collaborative assignments and projects, undergraduate research, diversity/global learning, service learning/community-based learning, internships, and capstone courses and projects.[4] Another study published by the California State University Chancellor's Office shows that "Participation in high-impact practices has been shown to improve both learning and persistence for all students, but especially for the historically underserved."[5] This study also indicates that participation in more than one high-impact practice increases the benefits for these students. Other specific strategies that have been proven effective in improving student outcomes for minority students include mentoring programs,[6] alternative instructional strategies,[7] summer programs,[8] and peer mentoring.[9]

Among these high-impact practices that have been proven to be successful in four-year universities but are less commonly employed at community colleges is summer research internships. There are many studies documenting the benefits of research opportunities for undergraduate students. Independent research experiences increase student engagement in their education[10-12], enhance research and laboratory skills[10-14], improve academic performance[12,13], increase understanding and interest for their discipline[10-13,15], strengthen oral and written communication skills[15,16], enhance problem solving and critical thinking skills[35], and enhance self-efficacy[16,17]. For students from traditionally underrepresented groups, the benefits may be even greater when compared to students from majority groups[11]. For underrepresented students, deep engagement in undergraduate research with a faculty mentor is positively correlated with improvement in student grades, retention rates, persistence to graduation, and motivation to pursue graduate school[18-20].

A growing number of studies show that early and multiple exposures to undergraduate research experiences offer the greatest benefit. However, 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[21]. Developing successful research programs is particularly challenging in community colleges, most of which do not have on-going research programs. Establishing collaborations between research universities and community colleges is key to engaging students in research early in college.

This paper is a description of how a small engineering program in a Hispanic-Serving community college has developed a research internship program that is specifically designed for community college students. The paper will also highlight the results of the first year of implementation of the program and future plans for improvement.

2. 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 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 the University of California Merced (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 Winter 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 institutions[22]. 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 Research Internship Program is the second level 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 development[23] and reducing students' feeling of isolation[24]. The ASPIRES Group Research Internship program consists of five 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 third level, ASPIRES Summer Individual Research 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 San Francisco State University, UC Merced, and NASA Ames Research Center.

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

In 2016 the ASPIRES Summer Research Internship Program was piloted. This section of the paper describes the selection of participants in the program, their research projects, and the results of the implementation of the program. A total of 29 students participated in the pilot implementation of the ASPIRES summer internship program, six for the Individual Research Internship program and 23 for the Group Research Internship program. Of the 23 interns assigned to group research, five were full-time interns (one for each of the five research groups), and 18 were half-time interns. All of the Group Research interns and two of the Individual Research interns did their work at SFSU.

3.1 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 started in December 2015 through the STEM Center website (http://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 Fall 2015 and Spring 2016. 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 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 47 completed applications were received by the deadline on February 15, 2016. Among the 47 applicants, 9 were female (19%) and 38 were male (81%); 45% were Hispanic, 26% Asian, 17% White, and 13% multiracial. The most popular major among the applicants was Mechanical Engineering (35%), followed by Electrical Engineering (19%), and Civil Engineering (17%). Seven of the applicants declared a non-engineering major, three for Computer Science, two for Applied Math, and one each for Biology and Chemistry. Thirty out of the 47 applicants (64%) had completed their courses at the community college and were planning to transfer to a four-year university in Fall 2016.

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 2016 ASPIRES Winter Scholars Program, 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 Fall 2016 were considered for full-time positions. Among these students, the top applicants were selected for the six Individual Research Internship positions and five full-time Group Research Internship positions.

Table 1. Demographics of 2016 ASPIRES Summer Research Internship Program participants.

Demographics	**# of Students**	**(%)**
Gender		
Male	23	79%
Female	6	21%
Total	29	100%
Ethnicity		
Asian	8	28%
Hispanic	12	41%
White	5	17%
Multiracial	4	14%
Total	29	100%

Table 1 summarizes the demographics of the students who participated in the 2016 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 41% Hispanic, 28% Asian, 17% White, and 14% 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 (41% Hispanic compared to 24% Hispanic among all engineering students), which more closely represents the over-all college demographics of 45% Hispanic.

Table 2 provides a summary of the academic characteristics of the 2016 ASPIRES Summer Research Internship Program participants. With respect to their declared majors, the most popular major among the program participants was Mechanical Engineering (38%), followed by Electrical Engineering (21%), and Civil Engineering (17%). Two of the program participants were non-engineering majors, one Applied Math, and one Computer Science. Eighteen out of the 29 selected participants (62%) had completed their courses at the community college and were planning to transfer to a four-year university in Fall 2016. Among these 18 students ready to transfer, 11 were selected for full-time internship positions, 5 for Group Research and 6 for Individual Research. Individual research projects were done by interns at three different institutions—two at SFSU, two at NASA Ames Research Center, and two at UC Merced. For the Group Research Internship program, all research projects were done at SFSU, and 23 interns were selected for the 5 research groups—two groups for Civil Engineering Group (Group A and Group B), and one group each for Computer Engineering, Electrical Engineering and Mechanical Engineering. The structure and design of the group research activities (including selection of faculty mentors) was based primarily on SFSU faculty interest and availability to participate in the summer program.

Table 2. Academic characteristics (declared major and intended term of transfer) of 2016 ASPIRES Summer Research Internship Program participants.

Characteristic	**# of Students**	**(%)**
Major		
Applied Math	1	3%
Bio Engineering	1	3%
Chemical Engineering	1	3%
Civil Engineering	5	17%
Computer Engineering	1	3%
Computer Science	1	3%
Electrical Engineering	6	21%
Engineering	2	7%
Mechanical Engineering	11	38%
Total	29	100%
Projected Term of Transfer		
Fall 2016	18	62%
Fall 2017	7	24%
Spring 2018 or later	4	14%
Total	29	100%

Table 3 shows the distribution of student majors for each of the research groups. Each of the two Civil Engineering Groups (Civil A and Civil B) had one full-time and three part-time interns. Each of the other three research groups (Computer, Electrical, and Mechanical) had one full-time and four part-time interns. Although it would have been ideal for students if they were given the opportunity to select the research project to work on, this would have led to an uneven distribution of participants in the various groups. Although students were given a short description of each of the research projects, they did not know their specific project until the first day of the program.

Table 3. Declared majors of the participants in the Group Summer Research Internship program

Student Majors	**Civil – A**	**Civil – B**	**Computer**	**Electrical**	**Mechanical**
Bio Engineering				1	
Civil Engineering	1	3			
Chemical Engineering				1	
Computer Engineering			1		
Electrical Engineering			3	2	
Mechanical Engineering	2	1		1	5
Engineering	1				
Applied Math			1		

Table 4. A summary of engineering courses completed by students in each research group. Highlighted cells in the table indicate that the course is part of the ideal preparation for interns for the corresponding research group.

Completed Courses	**Civil – A**	**Civil – B**	**Computer**	**Electrical**	**Mechanical**
Statics	75%	75%	0%	0%	40%
Dynamics	0%	75%	0%	20%	0%
Circuits	50%	50%	20%	100%	40%
Materials Science	0%	100%	0%	20%	0%
Graphics	50%	100%	20%	20%	80%
Programming in C++	25%	50%	80%	80%	20%
Matlab Programming	50%	75%	20%	20%	20%

Although the primary consideration for assigning a student to a particular research group is their declared major, student academic preparation (specifically engineering courses completed) is taken into consideration to ensure that students have the recommended background knowledge needed for the research projects. Table 4 summarizes the distribution of courses completed by students in each of the research groups. Ideally, students in the Civil Engineering research group should have completed statics, dynamics, and MATLAB. Students in the Computer Engineering research group should have completed at C++ Programming class while students in the Electrical Engineering research group should have completed the Circuits course. Ideally, students in the Mechanical Engineering group should have completed Graphics and Materials Science. As can

be seen from the highlighted cells of Table 4, the ideal minimum course requirement was satisfied only for the Electrical Engineering group. In all the other cases, many of the participating students have not completed the recommended courses. In two instances (Dynamics for Civil Group A and Materials Science for the Mechanical Group), none of the students had completed the recommended course. The pre-requisite knowledge and skills from these missing courses were acquired during the ten-week duration of the program, with supplemental assistance provided by the graduate student mentor.

3.2 Research Topics

For the six Individual Research Internship program participants, the selection of research topics and activities depended on the institution where they performed the research. For the two students selected to do their work at San Francisco State University, the research topics were selected by the participating faculty mentor (one in Electrical Engineering and one in Computer Engineering). The Electrical Engineering student designed a non-volatile spin transfer torque latch flip-flop using Magnetic Tunnel Junctions (MTJ) devices. The Computer Engineering student developed a virtual reality game using a custom made Myo armband human-machine interface. The two students selected to do research at UC Merced joined the existing research groups as part of the summer internship program administered through the UC Merced Undergraduate Research Opportunities Centers. The students selected a research group and topic of interest to them. One student worked on a computational mechanics study of pore structures of aluminum foams. The other student worked on designing a drone for detection of methane. The two students who went to NASA Ames Research Center were matched with research mentors through the Center's Summer Research Internship program. One student worked on rotorcraft aeromechanics, and the other student worked on developing methods for remotely measuring surface temperature using a four-color pyrometer. All the students participating in the Individual Research Internship program participated in a poster symposium held at the hosting institution at the end of the program. Additionally, interns at both SFSU and UC Merced did an oral presentation of their research to an audience consisting of their colleagues, professors, and graduate students at the end of the internship program.

The Group Research Internship program was held entirely at San Francisco State University. The research topics and research activities assigned to the internship program participants were decided by the SFSU faculty mentors based on students' level of preparation, existing research initiatives in the university, and the availability of graduate student mentors in these areas. Civil Engineering Group A conducted research on real-time hybrid simulation of the response of structures to seismic activity. Civil Engineering Group B worked on time synchronization of smart wearable devices for recording seismic activity. The Computer Engineering research group conducted research on developing an interface for gesture recognition using electromyographic and inertial measurement unit data. The Electrical Engineering research group worked on developing an efficient logic design using spin transfer torque memory technology and lookup tables for nonvolatile information storage. The Mechanical Engineering research group worked on developing a procedure for 3D printing of short fiber-infused photopolymer resin composites. As a final product for their research activities, each research group prepared a poster and wrote a technical paper that were presented at a culminating research symposium at San Francisco State University at the end of the program.

3.3 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 programs[25]. An adaptation of the SURE was done for two undergraduate research programs that target underrepresented students (Hispanic, in particular) at California State University, Long Beach[26]. 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 of the first day of 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 5. 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 getting good letters of recommendation. Note that the only statistically significant difference between pre- and post-program responses was observed for clarifying whether to pursue as STEM research career process [$t(1,53) = 2.20$, $p = .032$]. Also note that these results for student motivation are similar to those reported by the CSU Long Beach research programs for underrepresented students[23].

Table 5. Motivation to conduct research: Response Scale: 1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree.

Prompt: I want to do research to:	**Average Response**		
	Pre	**Post**	**Change**
Gain hands-on experience in research	4.75	4.46	-0.29
Clarify whether graduate school would be a good choice for me	4.00	4.04	0.04
Clarify whether I wanted to pursue a STEM research career	3.79	4.36	0.57*
Work more closely with a particular faculty member	3.86	3.96	0.10
Get good letters of recommendation	4.32	4.25	-0.07
Have a good intellectual challenge	4.64	4.54	-0.10

* The change is statistically significant at $p < 0.050$.

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 6. Of the 21 items in the survey, statistically significant gains are observed in eight areas: skill in interpreting results [$t(1,53) = 2.43$, $p = .018$], tolerance for obstacles faced in the research process [$t(1,53) = 2.22$, $p = .031$], understanding the research process in the field [$t(1,51) = 2.45$, $p = .018$], ability to integrate theory and practice [$t(1,52) = 2.48$, $p = .016$], understanding how scientists work on real problems [$t(1,53) = 3.39$, $p < .001$], ability to analyze data and other information [$t(1,53) = 2.53$, $p = .014$], skill in how to give an effective oral presentation [$t(1,51) = 2.06$, $p = .044$], and skill in science writing [$t(1,52) = 2.03$, $p = .047$]. The most significant gain is on understanding how scientists work on real problems.

Table 6. 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.	**Average Response**		
	Pre	**Post**	**Change**
I have a clear career path.	3.79	4.14	0.35
I have skill in interpreting results.	3.86	4.32	0.46*
I have tolerance for obstacles faced in the research process.	4.04	4.39	0.35*
I am ready for more demanding research.	3.82	4.14	0.32
I understand how knowledge is constructed.	3.86	4.21	0.35
I understand the research process in my field.	3.21	3.86	0.65*
I have the ability to integrate theory and practice.	3.61	4.07	0.46*
I understand how scientists work on real problems.	3.61	4.28	0.67**
I understand that scientific assertions require supporting evidence.	4.25	4.43	0.18
I have the ability to analyze data and other information.	3.96	4.39	0.43*
I understand science.	3.71	4.00	0.29
I have learned about ethical conduct in my field.	4.18	4.07	-0.11
I have learned laboratory techniques.	3.82	3.93	0.11
I have an ability to read and understand primary literature.	3.82	4.07	0.25
I have skill in how to give an effective oral presentation.	3.79	4.29	0.50*
I have skill in science writing.	3.43	3.89	0.46*
I have self-confidence.	4.29	4.21	-0.08
I understand how scientists think.	3.71	3.89	0.18
I have the ability to work independently.	4.25	4.25	0.00
I am part of a learning community.	4.46	4.50	0.04
I have a clear understanding of the career opportunities in science.	4.18	4.43	0.25

*The change is statistically significant at $p < 0.050$.

** The change is statistically significant at $p < 0.001$.

To compare the results of the present study with those of the previous study of the CSU Long Beach summer internship program[26], items that showed statistically significant gains from pre- to post-program surveys are summarized in Table 7. For both studies, statistically significant gains from pre to post were observed for 8 of the 21 items. However, out of the 8 items where statistically significant gains are observed in the present study, only five are the same items as those observed in the CSU Long Beach study; these five items are highlighted in Table 7. The three items the exhibited statistically significant gains in the CSU study but not in the present is study are: readiness for more demanding research, learning about ethical conduct in my field, and having self-confidence. On the other hand, three items the exhibited statistically significant gains in the present study but not in the CSU study are: tolerance for obstacles faced in the research process, ability to analyze data and other information, and skill in science writing. It should also be noted that the biggest gain observed for the CSU study is in understanding the research process in their field while the biggest gain for the ASPIRES program is in understand how scientists work on real problems. Also note that student ratings for the current study are generally higher than those of the CSU study. The pre-program survey responses for the current study (average = 4.25; range: 3.31–4.69) are significantly higher than the CSU Long Beach results (average = 3.94; range: 3.2–4.7). The post-program survey responses for the current study (average = 4.44; range: 4.06–4.81) are also higher than the corresponding post-program responses for the CSU Long Beach results (average = 4.27; range: 3.5–4.8).

Table 7. Comparison of survey results from the ASPIRES program and the California State University, Long Beach internship program[26] showing statistically significant differences in the pre- and post-program surveys.

Survey Items	**Statistically Significant (y/n)?**	
	ASPIRES	**CSU LB**
I have skill in interpreting results.	y	y
I have tolerance for obstacles faced in the research process.	y	n
I am ready for more demanding research.	n	y
I understand the research process in my field.	y	y
I have the ability to integrate theory and practice.	y	y
I understand how scientists work on real problems.	y	y
I have the ability to analyze data and other information.	y	n
I have learned about ethical conduct in my field.	n	y
I have skill in how to give an effective oral presentation.	y	y
I have skill in science writing.	y	n
I have self-confidence.	n	y

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 8 on the next page. 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 8. Results of survey of students' level of satisfaction with the summer internship program components. 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 San Francisco State University	4.44
Meetings with Graduate Student Mentor	4.67
Meetings with Faculty Adviser	4.52
Mid-Program Presentations	4.57
Final Presentations	4.65
The results of your project	4.48
Your final poster	4.36
Your final presentation	4.54
How much you learned from the program	4.50
Your group mates	4.52
Your faculty adviser	4.48
The Summer Internship Program as a whole	4.61

4. Conclusion

The pilot 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 has 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 had 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 pilot implementations of ASPIRES 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, San Francisco State University 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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