Development and Implementation of an Introduction to Research Winter Internship Program for Underrepresented Community College Students

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Abstract

Despite increasingly urgent calls to broaden the participation of underrepresented minorities (URMs) in engineering, not much progress has been achieved. 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. The President's Council of Advisors on Science and Technology (PCAST) Report *Engage to Excel*: *Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics* states a critical need to dramatically increase the number of STEM graduates by addressing the retention problem in the first two years of college. One of their recommendations was to engage students in research experiences within the first two years of college. Through a grant from the Department of Education Minorities in Science and Engineering Improvement Program (MSEIP), Cañada College, a Hispanic-serving community college from Northern California developed the Accelerated STEM Pathways through Internships, Research, Engagement, and Support (ASPIRES) project, a collaborative initiative that 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. One of the main components of this project is a three-tiered internship program that that is suitable for community college students and provides multiple exposures to undergraduate research opportunities. This paper focuses on the first tier of this initiative, the development and implementation of the ASPIRES Scholars Research Program: a two-week introduction to research internship experience. Held during the winter break, the program introduces freshmen and rising sophomores to scientific research as well as a variety of topics and skills such as applying for internships; introduction to the research process; university laboratory tours; library presentation on conducting literature reviews; the university transfer process for community college students; technical presentation skills; and project-specific topics including experimental methods, instrumentation, and data acquisition and error analysis. The paper provides a detailed description of the program curriculum, results from the Winter 2016 cohort, and key findings on program outcomes relating to changes in students' engagement in their academics, confidence in applying for and obtaining further internships, transfer preparedness, teamwork ability, and sense of self-efficacy.

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 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 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 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 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 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 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, and NASA Ames Research Center.

3. Implementation of the ASPIRES Scholars Winter Internship Program

In the Winter of 2016 and 2017, the ASPIRES Scholars Internship Program was piloted. This section of the paper describes the selection of participants in the program, the program design and schedule, and the results of the implementation of the program. A total of 27 students participated in both the 2016 and 2017 ASPIRES Scholars internship programs. For both years, all program activities were held at Cañada College, with the exception of the university visit on the last day of the program to 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 starts 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 Spring 2016 and Fall 2016. In recruiting program participants, among the program benefits and incentives highlighted are the stipends ($600 for the two week intersession program), the opportunity to gain introductory research experience, and priority consideration for the 2nd level ASPIRES Summer Group Internship program upon successful completion of the Winter program. 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.

For the 2017 program, a total of 66 completed applications were received by the November 20, 2016 deadline, while a total of 69 completed applications were received by the submission deadline for the 2016 program. Applications were reviewed by two engineering faculty involved in the project. In selecting program participants, consideration was given to completion of fundamental math and physics courses, students' overall GPA, Hispanic and other underrepresented groups, and those students whose claimed major is engineering or computer science. While the program was open to all STEM students, the program activities and research areas have an engineering focus, so priority was given to students with engineering or technology-oriented majors.

Table 1 summarizes the demographics of the students who completed the 2016 and 2017 ASPIRES Scholars programs. Twenty-eight percent of the program participants were female in 2016, with thirty percent female participation in 2017. These percentages, although higher than the percentage of female students among all engineering majors, represents an underrepresentation of female students in the program compared to the college-wide percentage of female students. Among all engineering students in the college during the 2015-16 academic year, only 15% were female students while college-wide over 60% of students were female. The ethnicity distribution of the selected participants represents the program's success in recruiting underrepresented minority students, particularly Hispanic students. 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 1. Demographics of 2016 and 2017 ASPIRES Scholars Internship Program participants.

	2016		**2017**	
Demographics	**# of Students**	**(%)**	**# of Students**	**(%)**
Gender				
Male	18	72%	19	70%
Female	7	28%	8	30%
Total	25	100%	27	100%
Ethnicity				
Asian	6	24%	9	33%
Hispanic	10	40%	11	41%
White	6	24%	2	7%
Multiracial	3	12%	4	15%
Decline to state	0	0%	1	4%
Total	25	100%	27	100%

3.2 ASPIRES Scholars Program Design

The ASPIRES Scholars internship is a two-week program held at Cañada College between the Fall and Spring semesters in January. All program participants spend the first week working on developing research skills together. During the second week, participants have the option to continue research skills and work on a challenging semi-open-ended research project or can instead participate in one of two programs happening concurrent to ASPIRES Scholars at Cañada College, Math Jam or Physics Jam, which are each jumpstart accelerator programs designed to enhance academic preparedness in the discipline. Program participants who have not taken Calculus I or Physics I yet are encouraged to participate in Math or Physics Jam respectively, while participants further along in their coursework are grouped into research groups for a second project in week two.

The primary goal of the ASPIRES Scholars Program is to serve as a stepping stone introduction to the research process and to help develop students' abilities as STEM researchers. Since some of the participants would not be joining the research program for week two, key activities were selected for week one to help all participants develop fundamental research skills. Table 2 shows the schedule for week one of the 2017 program. The first week contains topics and activities in conducting and presenting research including measurements and uncertainty, statistical analysis tools, literature review and data visualization, and developing and delivering technical presentations. Additionally there is a session dedicated to the university transfer process and what makes a successful student. This session is led by both the faculty instructor and graduate student assistants, who each gave accounts of their own educational pathways including transfer shock experienced transitioning from community college to university.

Table 2. Week 1 of the 2017 ASPIRES Scholars Program.

<table>
<tr><th></th><th>January 2, 2017</th><th>January 3, 2017</th><th>January 4, 2017</th><th>January 5, 2017</th><th>January 6, 2017</th></tr>
<tr><th>Time</th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>9:00-9:30 AM</td><td rowspan="15">Holiday</td><td>Welcome to the Program</td><td rowspan="2">Research for Presentations</td><td rowspan="2">Data Analysis and Visualization</td><td rowspan="2">Univ Transfer Process and what makes a successful student</td></tr>
<tr><td>9:30-10:00 AM</td><td>Ice Breaker + Pre-program Survey</td></tr>
<tr><td>10:00-10:30 AM</td><td>Intro to Research Process</td><td>Analyzing a Presentation</td><td>Delivering Technical Presentations</td><td>Work on Presentations</td></tr>
<tr><td>10:30-11:00 AM</td><td rowspan="2">Scientific Papers</td><td>Developing Technical Presentations</td><td rowspan="3">Work on Research Presentations</td><td rowspan="3">Finalize/Practice Presentations</td></tr>
<tr><td>11:00-11:30 AM</td><td rowspan="2">Literature Review and Conducting Research</td><td rowspan="2">Work on Research Presentations</td></tr>
<tr><td>11:30-12:00 N</td></tr>
<tr><td>12:00-12:30 PM</td><td>Lunch</td><td>Lunch</td><td>Lunch</td><td>Lunch</td></tr>
<tr><td>12:30-1:00 PM</td><td rowspan="4">Applying for Internships</td><td rowspan="4">Measurements and Uncertainty</td><td rowspan="4">Work on Research Presentations</td><td rowspan="4">Give Research Presentations</td></tr>
<tr><td>1:00-1:30 PM</td></tr>
<tr><td>1:30-2:00 PM</td></tr>
<tr><td>2:00-2:30 PM</td><td rowspan="2">Select Internships</td><td rowspan="2">Taking Measurements</td></tr>
<tr><td>2:30-3:00 PM</td></tr>
</table>

Students that stay to continue research during the second week of the program engage in the activities listed week two of the program, shown below in Table 3. The activities in this week help students develop skills in electronics, microcontroller programming, sensors and signal conditioning, data acquisition, and supplemental topics including MATLAB programming and LTSpice circuit simulation. The students are given a semi open-ended project to design and calibrate an electronic measurement system and then design and conduct an experiment using their newly developed measurement system. Student groups were assigned either an Infrared (IR) distance sensor or a dual-axis accelerometer to build a measurement system with. Groups using the IR sensor developed experiments to measure the velocity of moving objects, or measure the period of simple harmonic motion in a mass spring damper system. Groups using the dual-axis accelerometer developed experiments to measure simple harmonic motion in of a pendulum, or the impulse delivered to a block in a ballistic impact. On hand physics lab equipment at Cañada College used to facilitate the construction of the students' experimental apparatus. Students present their independent experimentation projects at the end on the second to last day of the program.

On the last day of the program, all ASPIRES Scholars participants gather at SFSU for a tour of the research labs in the School of Engineering. Students visit a variety of labs where an SFSU university graduate student presents their current research project. ASPIRES participants hear about research in seismic structural engineering, bio-electronics, and intelligent computing and embedded systems. The program concludes with administration of the post-program survey, along with a brief wrap-up meeting.

Table 3. Week 2 of the 2017 ASPIRES Scholars Program.

<table>
<tr><th></th><th>January 9, 2017</th><th>January 10, 2017</th><th>January 11, 2017</th><th>January 12, 2017</th><th>January 13, 2017</th></tr>
<tr><th>Time</th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>9:00-9:30 AM</td><td>Intro to Basic Electricity</td><td>Introduction to Sensors</td><td rowspan="4">Work on Projects</td><td rowspan="2">LTSpice</td><td>Travel to campus</td></tr>
<tr><td>9:30-10:00 AM</td><td rowspan="2">Electronics Activity</td><td>Sensors Activity</td><td>Welcome to SFSU</td></tr>
<tr><td>10:00-10:30 AM</td><td>How to Read a Data Sheet + Sensor Calibration</td><td>Work on Presentations</td><td rowspan="5">SFSU School of Engineering Research Lab Tours</td></tr>
<tr><td>10:30-11:00 AM</td><td>Intro to Arduino</td><td>Signal Conditioning</td><td rowspan="3">Finalize/Practice Presentations</td></tr>
<tr><td>11:00-11:30 AM</td><td rowspan="2">Arduino Activity</td><td rowspan="2">Data Acquisition with the Arduino</td><td rowspan="2">Using Timers for time-based measurements</td></tr>
<tr><td>11:30-12:00 N</td></tr>
<tr><td>12:00-12:30 PM</td><td rowspan="2">Lunch</td><td rowspan="2">Lunch</td><td rowspan="2">Lunch</td><td rowspan="2">Lunch</td></tr>
<tr><td>12:30-1:00 PM</td></tr>
<tr><td>1:00-1:30 PM</td><td rowspan="4">MATLAB</td><td rowspan="4">Introduce Final Projects</td><td rowspan="2">Work on Projects</td><td rowspan="4">Final Presentations</td><td>Lunch</td></tr>
<tr><td>1:30-2:00 PM</td><td>Exit Survey</td></tr>
<tr><td>2:00-2:30 PM</td><td rowspan="2">Start Presentations</td><td rowspan="2">Research Lab Tours</td></tr>
<tr><td>2:30-3:00 PM</td></tr>
</table>

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 Scholars 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 self-efficacy for the 2017 program are summarized in Table 4. During the course of the ASPIRES Scholars Program, students' STEM self-efficacy increased the most in areas related to knowledge of how to get an internship and how to conduct and understand scientific research.

Table 4. Results of survey of student self-efficacy for the 2017 program. (*n = 27*)
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	**Pre**	**Post**	**Change**
Math is hard.	2.41	2.36	-0.05
Physics is hard.	3.18	3.32	0.14
I know how to work as part of a team.	4.05	4.46	0.41
I know how to conduct scientific research.	2.96	4.05	1.09*
I know I will be able to complete all the requirements for transfer.	4.41	4.64	0.23
I'm confident I will get a BA/BS in engineering, computer science, biology or another STEM field.	4.50	4.73	0.23
Math can be fun.	4.55	4.64	0.09
Physics can be fun.	4.09	4.36	0.27
I am confident I will have a career in a STEM field.	4.50	4.59	0.09
I am confident that having a career in a STEM field will be interesting.	4.55	4.73	0.18
I have friends who are interested in STEM.	4.46	4.50	0.04

At Cañada College, I feel I'm part of a STEM community.	4.09	4.41	0.32
I know other students I can form a study group with for my STEM classes.	4.14	4.59	0.45
I like to study with other students instead of on my own.	3.18	3.68	0.5
I understand the research process in my field.	3.23	4.18	0.95**
I understand that having research experience can help me get an internship and transfer.	4.46	4.68	0.22
I know what I need to do to get a STEM internship.	3.23	4.55	1.32*
I am committed to passing all the classes required for transfer.	4.73	4.91	0.18
I feel confident about my academic skills.	4.09	4.46	0.37
I have a clear understanding of career opportunities in engineering/computer science/ other STEM fields relevant to my interest.	3.82	4.36	0.54***

* The change is statistically significant at $p < 0.001$.
** The change is statistically significant at $p < 0.002$.
*** The change is statistically significant at $p < 0.050$.

In a pre-ASPIRES survey students were asked about their participation during the Fall semester in a range of extra-curricular and enrichment activities related to STEM, including academic engagement and planning, engaging in STEM projects and professional activities, and getting involved in the STEM community on campus. At the end of ASPIRES, they were asked about their plans to engage in the same range of activities during the Spring semester. Table 5 shows the results of student engagement before and after the 2017 program. A large increase between actual (Fall) and expected (Spring) participation was observed in terms of the number of students who planned to apply for internships—although the timing for applications may have influenced these responses (up from 10 students to 24 students); the number of students who planned to join a STEM club (up from 8 to 21); ask a professor if they have a project the student can work on (up from 5 to 15); join a professional network such as LinkedIn (up from 6 to 15); read about engineering/STEM programs at four year colleges (up from 12 to 20); volunteer on a STEM related project (up from 8 to 15); and visit an engineering program at a four year college (up from 7 to 14). Students also noted that the program helped them become aware of the importance of team work, interested in and more confident about pursuing research opportunities, and committed to using office hours and developing relationships with their teachers.

Table 5. Results of survey of student engagement in the 2017 program. (*n = 27*)

Question: Check which activities you plan to participate in during the coming semester	**Pre**	**Post**	**Change**
Attended class	100%	100%	0%
Complete homework assignments	100%	95%	-5%
Go to office hours at least once a month	68%	86%	18%

Develop a semester-by-semester education plan	86%	86%	0%
Visit a STEM program at a four year college that I'm considering for transfer	45%	77%	32%
Read about STEM programs at four year colleges	64%	95%	31%
Read at least one paper or journal article about a topic that is of interest to me	59%	91%	32%
Participate in one or more Canada College STEM Center activities	86%	100%	14%
Mentor/tutor other STEM students	36%	86%	50%
Volunteer on a STEM related project	23%	82%	59%
Join a STEM club	68%	100%	32%
Apply for internships (in addition to the ASPIRES Scholars Program)	50%	95%	45%
Join LinkedIn or other online professional network	50%	86%	36%
Ask a professor if s/he had a project I can work on	27%	68%	41%

In evaluating student perception of the program, students were asked to rate how useful they found each of the program activities to be in terms of helping them develop skills, confidence, and interest in conducting research. Table 6 gives the results of the student evaluation of the 2017 program. Note that the highest item rated as most useful activity was working in groups, followed by giving technical presentations, and delivering a presentation.

Table 6. Results of survey of student program evaluation in the 2017 program. (*n = 27*)
Response Scale: 1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree.

Question: Rate how useful you found each of the following activities to be in terms of helping you develop skills, confidence, and interest in conducting research	Average
Intro to research process	4.41
How to read a data sheet	4.45
Sensors	4.42
Data acquisition with the Arduino	4.35
Measurements and uncertainty	4.45
Literature review and conducting research	4.59
Giving technical presentations	4.77
Data analysis	4.59
Prepare for presentation	4.55
Deliver presentation	4.68
Working in groups	4.82
Working on the research presentation (week 1)	4.55
Analyzing a scientific paper	4.41
Data visualization (graphing examples handout)	4.52
Resume workshop	4.10
The design project (week 2)	4.50
Using Arduino timers for time-based measurements	4.29

4. Conclusion

Implementation of the ASPIRES Scholars Internship program has been successful in increasing participants' skills and confidence in their ability to understand and participate in scientific research and in pursuing STEM internships. Students also increased their knowledge of what it means to be a student actively engaged in STEM, particularly in terms of their participation in extra-curricular activities. Many students left feeling excited and motivated about engineering, especially about hands-on projects and applications that showed them what it means to be an engineer. The program has been successful in recruiting students from underrepresented minority groups as evidenced by the higher participation rate among Hispanic students compared to the overall engineering enrollments.

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.

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.

Acknowledgements

This project was supported by the US Department of Education through the through the Minority Science and Engineering Improvement Program (MSEIP, Award No. P120A150014); and through the Hispanic-Serving Institution Science, Technology, Engineering, and Mathematics (HSI STEM) Program, Award No. P031C110159.

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