

CAHSI External Evaluation Report, 2016-17

Promoting Success for Hispanic Computing Students and Faculty

**COLORADO EVALUATION & RESEARCH CONSULTING AND
GOLDEN EVALUATION AND POLICY RESEARCH**

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Executive Summary

CAHSI is an evolving organization with a grassroots tradition seeking to expand impact in sustainable, inclusive ways. The primary goal is to support Hispanic success in computing across multiple career trajectories through an ecosystem of support. As CAHSI enters its next iteration of funding with an emphasis on regional connections and greater industry engagement, the Collective Impact¹ approach has become an ideal framework for growth. Principal Investigators active in CAHSI were asked about their impressions of the shift in method:

“The way I see it here, is the Collective Impact regional approach going to raise awareness, and get people more engaged. And when I say people, I’m talking about students and faculty. I think this is going to be key for sustaining the functionality and the mission of CAHSI.”

“Honestly, we were already seeing Collective Impact to an extent, because the emphasis of CAHSI has always been on sharing experience and an adapting perspective to the different realities and different institutions.”

“From my standpoint, in the past, we were focused more towards student engagement and was more on student-centric activities. Now I think there are opportunities to engage the other communities like community colleges and industry and K to 12 as well. I think it’s a different approach and a shift for the better.”

Regional ecosystem efforts will develop, following the lead of the three regions currently funded by the INCLUDES initiative. As CAHSI grows in new ways, the measurement of effectiveness has shifted, particularly as it relates to organizational capacity and alliance impact measurement. The new rubrics in this annual report focus on process, engagement, and capacity to serve backbone functions as CAHSI moves from recruiting new adopters to engaging new partners. This report focuses on the three common evaluation areas for Broadening Participation in Computing evaluation, and provides suggested next steps for CAHSI.

Individual Outcomes

CAHSI degree production has increased, and compares favorably in growth particularly this year, where CAHSI produced 158% of the degrees produced in 2002. The comparison departments in an IPEDS dataset have only reached 72% of the 2002 peak. CAHSI also compares favorably in terms of the production of Hispanic computing degrees when compared to all HSIs in the IPEDS database—while CAHSI departments graduate 46% Hispanic students in mainland U.S. departments, the mainland US HSIs as a whole have a much less desirable record of production with only 24% Hispanic computing degree production. CAHSI departments have become increasingly more diverse, which has lowered the proportion of degrees earned by Hispanics in recent years, a trend to address at the departmental level across CAHSI institutions. As enrollments grow CAHSI’s reach through signature practices continues to climb—PLTL reached a record number of students in 2016-17 (see individual outcomes, figure 8). Research students engaged in ARG had attended conferences (96%) and presented posters (48%) at greater rates

¹ http://c.ymcdn.com/sites/www.lano.org/resource/dynamic/blogs/20131007_093137_25993.pdf

than their REU peers from a national dataset. Finally, HENAAC was considered a positive experience with tangible student benefits—multiple students interviewed and received job offers at the conference. Those not ready for jobs learned valuable career skills with their peers at HENAAC.

Organizational Capacity

Across regions, CAHSI members and affiliates have led and planned Collective Impact-focused regional meetings with the intent of developing regional ecosystems supportive of Hispanics in computing. In these first iterations, much planning for meetings has been done collaboratively, and have engaged members from across regions through regular phone calls related to the INCLUDES subset of CAHSI participants. The events were team efforts and as observed by evaluation provided opportunity for nearly all of the elements vital to collective impact, including building trust, communication, leadership efforts to shape the direction of the collective, and opportunities for members to make important decisions related to the goals of the collective.

Alliance Impact

CAHSI regional meetings are amassing a list of practices and potential practices for dissemination more broadly. These are just becoming clarified in year 1. Multiple practices across CAHSI institutions appear viable for sharing across campuses.

A major accomplishment to date is the problem solving courses that will be piloted in the 2017-18 year at 3 campuses across CAHSI. The courses have been developed incorporating consistent, deep collaboration with Google technical staff. The first of its kind for CAHSI, the problem-solving courses are less than the typical 3 credit course, designed to fit within traditional curriculum. The intent is to instill the complementary computational thinking skills and logical reasoning needed to succeed in computer science, and make this content available across different student populations at various stages in their academic pathways. The lack of co- and/or pre-requisites create opportunities to learn across grade levels, and may create new student communities, mentorship opportunities, and social connections that support retention in college (Tinto, 1979).

CAHSI continues its strong representation across partners and institutions, and is beginning to branch into new organizations and organization types. The following organizations have CAHSI representation, meaning PIs support and promote CAHSI within these settings: teacher professional development at the state level, multiple INCLUDES pilots across the nation, American Society for Engineering Education, Computer Science Teacher's Association, Association for Computing Machinery, CRA-W, the Smithsonian Institution, Chamber of Commerce STEM Forum, California State department chairs association, and the American Association of Colleges and Universities. As networking becomes more vital the CAHSI for developing regional ecosystems of computing progress, these roles in other organizations will become more vital to success.

Next Steps

Developing regional infrastructure and expertise

The skills needed to run successful regional collectives are varied and rely on effective networks. Administrative support, constant communication, and facilitation skills are among some of the

most pressing, and time that faculty have to support these endeavors well is limited. CAHS must ensure all PIs have the resources they need, including human, financial, social, and informational resources. Coaching will be necessary for success in new regions, and effective modeling may be necessary as well to ensure new regions can build networks of change agents ready to collaborate around CAHSI's mission. Funding to support administrative burdens of leading a collective may also be needed, at national or regional levels.

Engage students who embody CAHSI's values and core purpose

The CAHSI student groups have become official organizations of the university at a few campuses. By utilizing the university student group designation, CAHSI student groups receive funding as well as additional visibility. CAHSI student groups will be developed with an eye towards giving back to the community and towards academic excellence. As student groups grow, the intention is to connect across CAHSI institutions. This has been an unfilled student need for years in the CAHSI community, as students meet one another annually yet have no formal or informal way to engage between conferences. Student engagement in a project across institutions, such as a research endeavor or online competition, may support relationship building which is vital to identity development in this field.

Provide continuous professional development for faculty

Additional funds may be needed to bolster faculty skills, knowledge, and motivation to implement best practices in undergraduate education. While the HENAAC venue would be ideal for some of this training, the packed program may need to be extended for faculty to have adequate time to learn practices such as PLTL and ARG, as well as to develop relationships with other faculty that would foster peer coaching and mentoring.

Create mechanisms to iterate and test new educational practices to share with new partners

As needs shift and audiences grow, promising practices can be shared with new partners. CAHSI may need to develop new mechanisms for distilling practices, sharing them with collaborators, and studying their effectiveness in multiple sites. While the approach need not be formal, creating norms around collaboration may facilitate greater adoption.

Evolve methods of evaluation

As the focus of CAHSI moves from student outcomes related to advancement towards multiple pathways towards success, the evaluation will need to expand measures of success to accommodate that shift. Creating mechanisms for tracking students beyond classrooms and academic pursuits will be vital to measurement in the next iteration of CAHSI.

Continue social science research

The culture of CAHSI departments were studied across three sites in a pilot study of learning environments—the pilot study indicated promise for understanding CAHSI student experiences, and with more intentional and purposeful sampling may prove a fruitful area for CAHSI research. Mixed method social science research is underway in year one of the grant and site visit analyses are available in the appendix in the form of two submitted conference papers. Additional site visits will be scheduled for year 2, and a collaborative research effort with UTEP social scientists will study the problem-solving courses implemented in 2017-18.

Introduction

This report is divided into sections that align with the common core indicators used by the external evaluation of the NSF BPC-A program. The common core indicators measure the progress of the alliance in promoting positive individual student outcomes, building organizational capacity to advance its mission, and creating impact by disseminating its practices and mission to a wider audience. The common core indicators measure CAHSI's development in these three critical areas: 1) *Individual Participation and Outcomes*, including student and faculty outcomes, 2) *Organizational Capacity* to maintain and sustain activities to support Hispanics in computing, and 3) *Alliance Impact* to create new partnerships and communities, and extend its reach beyond original members.

Common Core Indicator #1: Individual Participation and Outcomes

In the past year, graduation rates in CAHSI departments increased substantially. In part, this may be due to increased enrollments in CAHSI departments, as well the recent addition of new institutions (e.g. NEIU) and major programs. While most programs saw increases in graduates from the past year, one large institution accounted for over a third of the graduates in the 2015-16 numbers. Overall, in 2016, CAHSI increased its total number of baccalaureates by 203 students, and 15% of them were women. Forty-two CAHSI graduates in 2016 were underrepresented minorities but not Hispanic, specifically African-American or Native American.

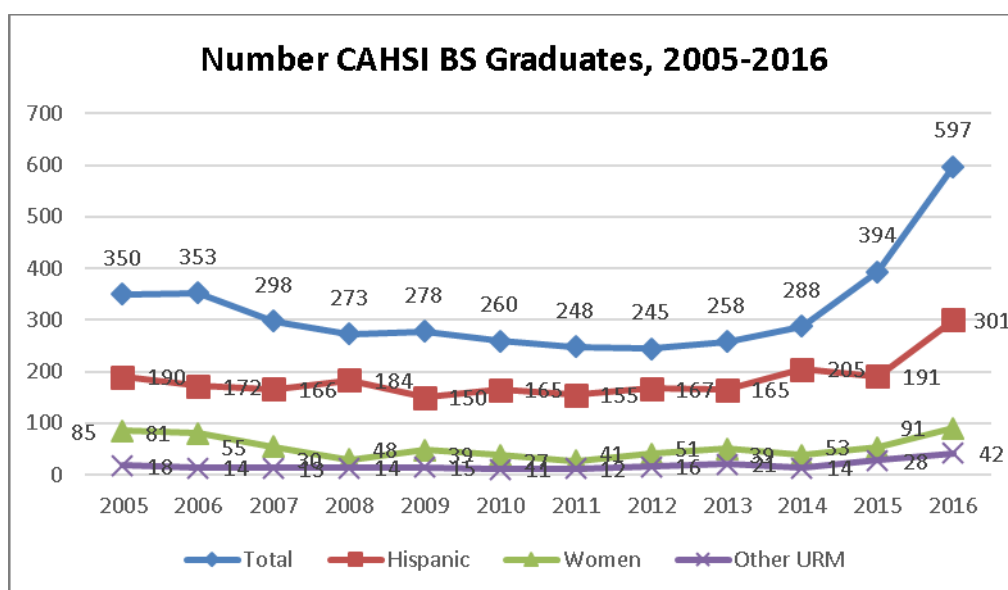


Figure 1 Number of CAHSI BS Graduates, 2005-2016

For many years of CAHSI's existence, national enrollment rates in computing plummeted, yet enrollment across the nation has increased substantially in the past several years. The nation is now producing more computing graduates and compensating for deficits in the past decade. Since its inception in 2006, CAHSI's graduation rates have consistently surpassed national trends, when comparing CAHSI against other long-standing departments that have existed since 2002. This adjustment was made—to include long-standing departments and exclude the many new departments created each year—because many colleges and universities have added

computing programs in the past decade so a more accurate comparison of peer departments can be derived from comparing CAHSI to the cohort of Computer Science and Computer Engineering departments in public and private not-for-profit institutions that have existed since the original CAHSI departments began to collaborate. Nationally, in 2016, this comparison set of departments graduated 70% of the number that they graduated in 2002, while CAHSI graduated 158% of its 2002 total. Most CAHSI departments increased their BS graduation rates in 2015-16. We caution the comparison made here as indicative of the US computing departments as a whole, as the comparison here is constrained by programs that existed in 2002—many institutions, including CAHSI schools, are innovating by developing new programs to address student and workforce needs.

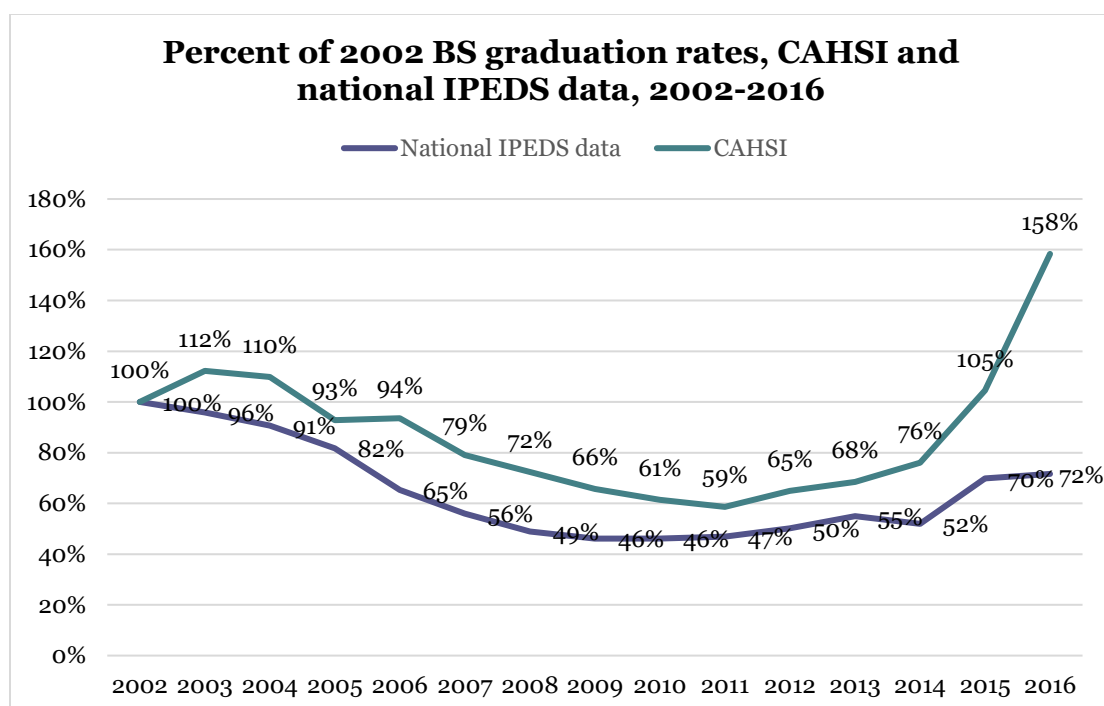


Figure 2 Percent of 2002 BS Graduate Rates, CAHSI and National IPEDS Data, 2002-2016

CAHSI graduation rates of Hispanics took a sharp fall in 2009, perhaps due to the economic recession, and have continued to decline in recent years. In part, this may be due to declining Hispanic enrollment in CAHSI institutions overall. This trend has continued in the most recent academic year that graduation data are available (2015-16) as 46% of all BS graduates in CAHSI departments were Hispanic, excluding the Hispanic students from UPRM, as per an advisory board request. Nationally, the Hispanic graduation rate in CS/CE/CIS has remained steady at about 7-8% of all graduates in those majors from our comparison departments. The decline in Hispanic graduation may also be a factor of the expanding diversity of CAHSI institutions overall - almost all CAHSI institutions are becoming more broadly diverse, including more Asian, International, and other underrepresented minority students, especially African-Americans.

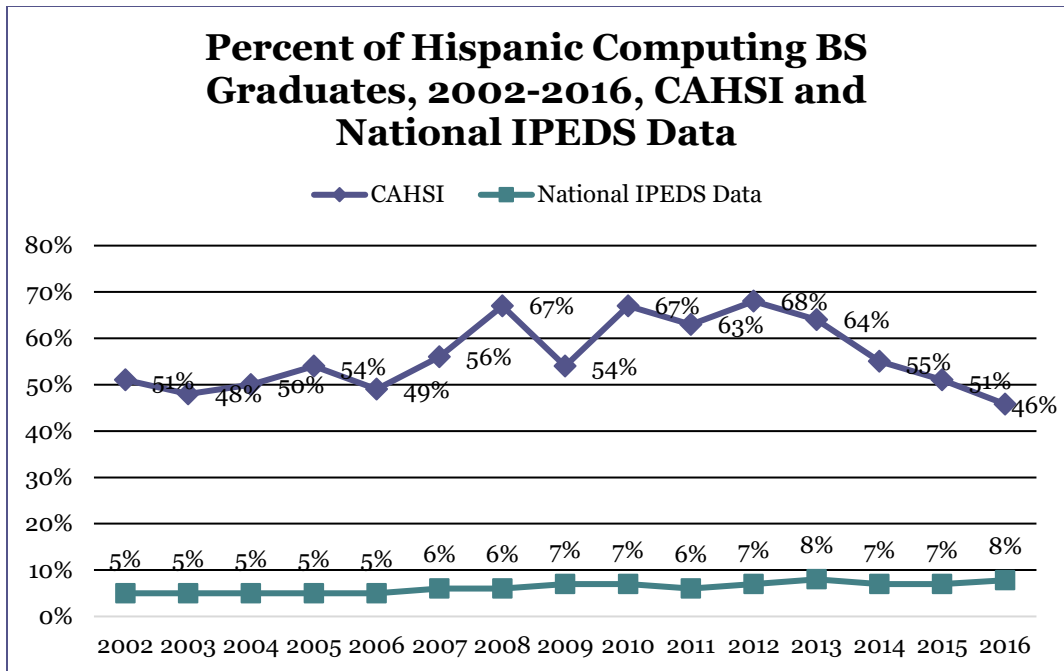


Figure 3 Percent of Hispanic Computing BS Graduates, CAHSI and National IPEDS Data, 2002-2016

When compared to all US mainland Hispanic Serving Institutions, CAHSI fares much better than average. HSIs collectively have performed more poorly in graduating Hispanic CS/CIS/CE majors than CAHSI. In 2016, only 24% of S/CE/CIS BS degrees were earned by Hispanics in HSIs across the US, while CAHSI graduated nearly double that proportion of Hispanics in its computing departments. The trendlines are worrisome, however---as HSIs as a collective are improving parity, CAHSI is slackening in that regard from peak Hispanic involvement in 2012.

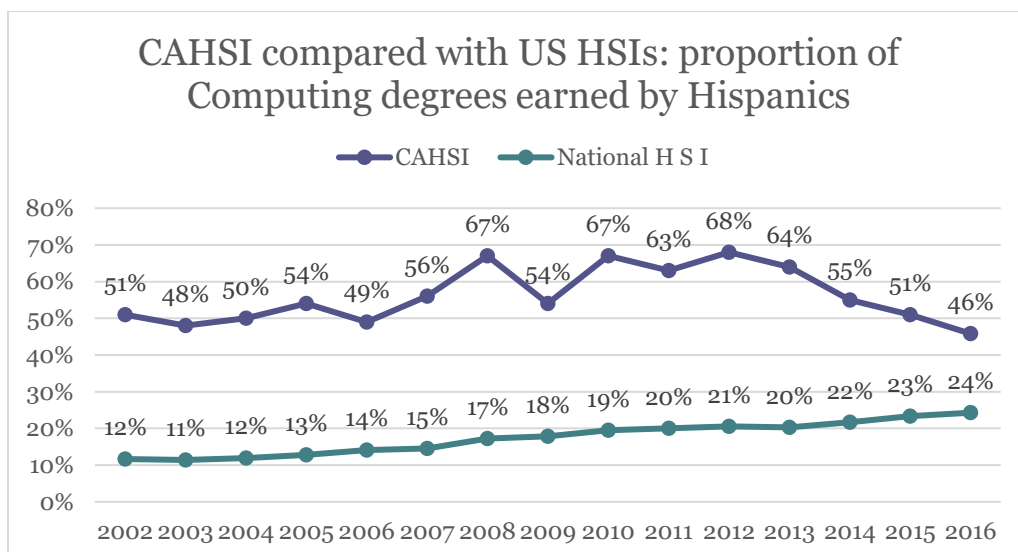


Figure 4 CAHSI compared with US HSIs

The figure below demonstrates that before the inception of CAHSI in 2006, CAHSI departments consistently graduated fewer Hispanics than their institutions overall. However, the graduation rate of Hispanics in CAHSI departments had trended upward, and in 2012, CAHSI's Hispanic graduation rate surpassed the institutional average. This past year, however, CAHSI departments' Hispanic graduation rates continued in their decline and dipped below the institutional average for the second time since 2011. The trendline is troubling—it is important to monitor the proportion of students who are of focus in CAHSI and to continue to make strides in graduation of Hispanics.

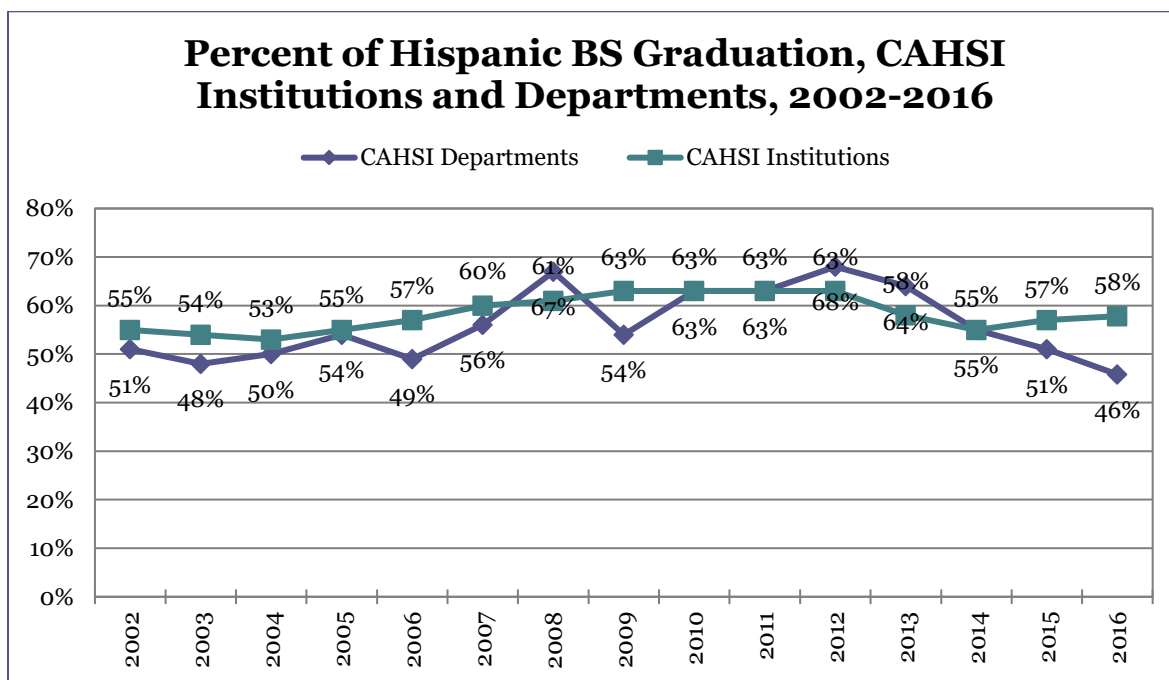


Figure 5 Percent of Hispanic BS Graduation, CAHSI Institutions and Departments, 2002-2016

BS enrollment trends

After years of decline, computer science departments across the country have seen sharp increases in enrollment in recent years. This trend has also affected CAHSI departments. Even though NEIU was added as a CAHSI member in academic year 2013-14, CAHSI enrollments in original departments have also increased substantially in the past three years. This latest increase in enrollment was much less dramatic than the past four years. At this time, it is unclear if this year is an anomaly or if enrollment is truly stabilizing again after growth. HSIs are particularly influenced by shifting enrollments, as their philosophies of open or less-selective admissions vie against competition for space in bulging classrooms.

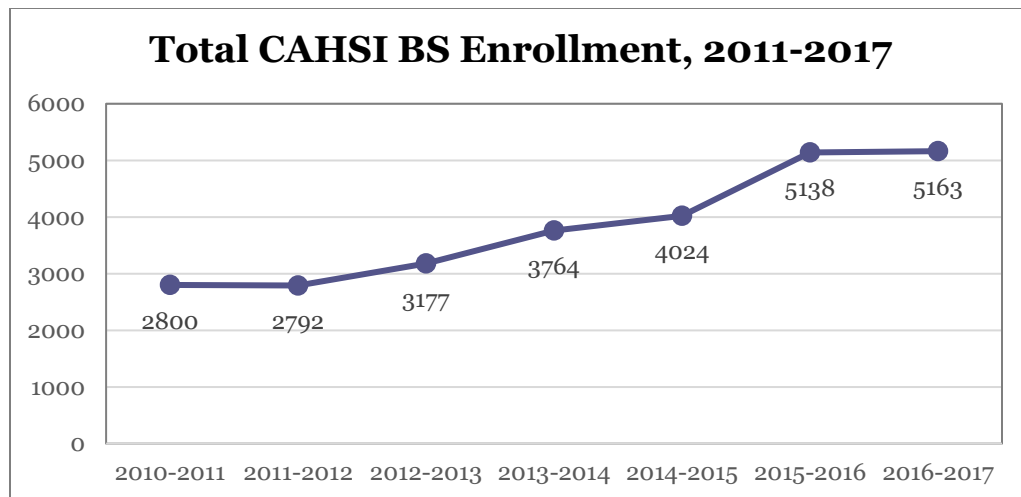


Figure 6 Total CAHSI BS Enrollment, 2011-2016

MS degrees

CAHSI has consistently graduated a high proportion of Hispanic MS degree recipients, yet this year MS degrees for Hispanics declined while other underrepresented minorities saw nine additional graduates. Women increased in number and in proportion of all graduates—rising to 31% of MS degree recipients for CAHSI. Nationally, CAHSI mainland schools graduated 24 of the 368 Hispanic MS degree recipients in CS/CE/CIS. In other words, CAHSI graduated nearly 7% of all of the Hispanic MS degrees in those fields in the mainland US. While this is a decline from past years, the upsurge for other underrepresented groups, including women, indicates CAHSI schools may be supporting inclusion in new ways.

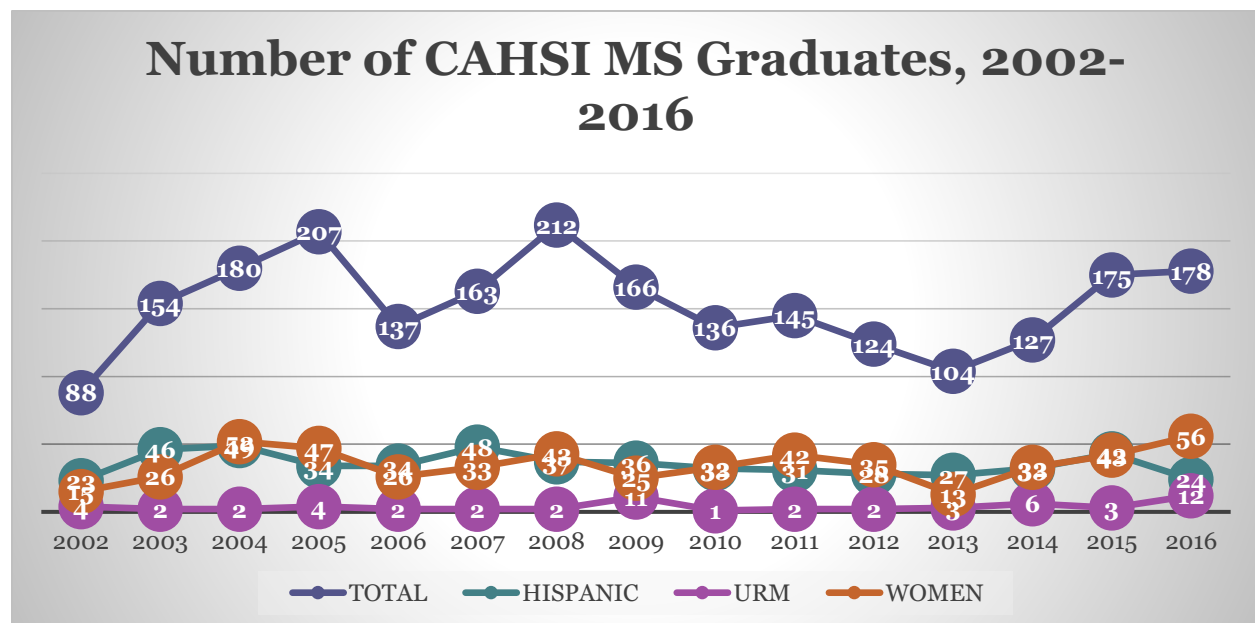


Figure 7 Number of CAHSI MS Graduates, 2002-2016

PhD degrees

PhD production for Hispanics in the computing fields remains drastically low- in 2016, only 27 Hispanics earned PhDs in the CS/CIS/CE fields. This year, while CAHSI graduated 19 PhDs, only one was Hispanic. In the list of 19, there were three women and one underrepresented minority student.

CAHSI Course Enrollment

Over the years, CAHSI has consistently provided extensive support to students throughout their degree programs. In the past year, CAHSI continued to enroll high numbers of students in CAHSI's best practice courses, although the total number of students fell slightly from academic year 2014-15. The number of CAHSI students enrolled in CS-o courses increased again in the past year, from 449 to 902 students, possibly reflecting the growth in undergraduate enrollments in CAHSI departments. In the 2016-17 academic year, CAHSI students received:²

40,590 hours of introductory computing content delivered to 902 students, more than half were Hispanic or other underrepresented minority students.

A record 34,545 hours of undergraduate-led supplemental instruction through PLTL to 2303 students, over half were Hispanic.

3,510 hours of coursework using the Affinity Research Group model provided to 78 students; over three fourths were Hispanic students.³

CAHSI's representation of women in two of its signature initiatives rises above the national average of women undergraduates in computer science. Nearly one-quarter of the participants in CAHSI initiatives were women and female participation in CS-o, PLTL surpassed the national average of 17% in CS/CIS (NCWIT, 2016).

Figure 8 CAHSI Course Enrollments, Academic Year 2015-16

Initiative	Total Students	Total Women	Percent Female	Total Hispanic	Percent Hispanic	Total Other Underrep. Minorities (URM)	Percent Other URM
CS-0	902	174	19%	414	46%	47	5%
PLTL	2303	500	22%	1278	55%	156	7%
ARG	78	9	12%	63	81%	0	0%

² Assuming a 15 week semester and a 3 hour course session per week

³ This figure is missing data from one school based on a data collection error. This report will be revised as data is available.

TOTAL	3283	683	21%	1755	53%	203	6%
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CAHSI/HENAAC Partnership Outcomes

For 2016, CAHSI formed a new partnership with HENAAC for its annual conference. The HENAAC Summit was held at the Anaheim Hilton Hotel October 5-9, 2016. It hosted several student competitions including the following:

- HENAAC College Bowl
- Research Poster Competition
- CAHSI Hackathon
- MAES Decathlon
- MAES Intern Tournament

Five hundred forty-three students took part in these competitions. The Summit also hosted over 1100 registered professionals. These professionals represented a wide variety of workforce segments, including corporate, military, academia, government, and non-profit.

Evaluation data collection

This year, 24 Summit participants completed the follow-up survey. The survey was sent out 6 weeks after the Summit to students, faculty, and professionals who had attended. The survey was not sent out immediately to participants in order to give them time to follow up with others they had met, pursue opportunities presented to them at the conference, and reflect on what they learned. Response rate was lower than last year. Of the 124 students sent the survey, 18 responded (14.5%). Faculty and professionals had a higher response rate. Of 18 faculty and professionals, 6 responded (33%). The lower response rate was likely the result of the surveys being sent out close to finals week and winter break, when all CAHSI student emails were made available to evaluators.

The CAHSI/HENAAC survey respondents represented the following ten universities:

- California state university Dominguez hills
- California State University Stanislaus
- Long Beach Community College
- New Mexico State University
- Northeastern Illinois University
- Texas A&M University, Corpus Christi
- University of Houston Downtown
- University of Puerto Rico at Arecibo
- University of Puerto Rico at Mayaguez
- University of Texas at El Paso

Thirty percent of respondents who answered the gender survey item (14 students, 6 faculty) were female while seventy percent were male. This was slightly lower than the percentage of females who attended the HENAAC conference (35%).

The majority of attendees who identified their ethnicity, according to survey results, identified themselves as Hispanic or Hispanic and another ethnicity: 40% of faculty and 93% of students,

79% overall. This falls right in line with the percentage of Hispanics that attended the HENAAC Summit (80%).

Three faculty respondents selected a non-Hispanic ethnic category to identify themselves: two answered that they were White/Caucasian and one answered Eastern Asian. Two students also identified themselves with non-Hispanic ethnicities. One selected African American/Black and the other selected White/Caucasian.

The majority of students were from Computer Science departments (79%). 14% were from Computer Engineering departments and 7% from Electrical Engineering. This represented a much different representation than the overall HENAAC conference, which in 2016 included 19% computer science/computer engineering students.

Summit mostly met, exceeded attendees' expectations

The majority of student survey respondents stated that their expectations of the HENAAC/CAHSI conference were met (46%) or exceeded (12.5%). Another 12.5% stated that their expectations were not met. For faculty, 33% stated that their expectations were met, and there were no respondents who stated that the conference exceeded their expectation. One faculty member (17%) stated that the conference did not meet their expectations.

Poster session

Of those students who responded that they participated in the poster session, 33% were very satisfied, and 50% were somewhat satisfied with their experience. One student was somewhat dissatisfied, and no students were very dissatisfied in the session. While the overall satisfaction of the poster session was high, there were a few improvements suggested. Many comments indicated that there was a bit of wait time to be judged. This wait time prevented them from being able to check out other posters and talk to other participants. Another student also stated that the poster session occurred at the same time as the career fair. This limited the student's time at the career fair.

Students and faculty enhanced their networks

The CAHSI/HENAAC Summit helped to increase student networking with faculty. A number of students (4 out of 16) contacted another student they met at the conference. Additionally, 5 students (31%) contacted a faculty member or professional they had met at the Summit.

Faculty members and professionals were also able to augment their networks. Half of the respondents (3) contacted a student they met at the CAHSI/HENAAC Summit. In addition, 33% (2) contacted another faculty member they met at the Summit. Another half contacted an industry professional they met at the Summit.

Student Academic Advancement from the HENAAC Summit

Half of the students noted that they had applied for academic scholarships, fellowships, or internships following the HENAAC conference (8 of 16). Another 25% (4 of 16) said they had not applied but planned to do so. Two of the sixteen students said they had not applied and did not plan on doing so. Another two students answered that were not eligible.

Of the 8 students who applied for academic scholarships, fellowships, or internships, 75% of them reported that they were successful. Some of the opportunities that the students reported applying for were: Google internship, Verizon internship, NEIU El Centro scholarship, Software Engineer internship at Northrup Grumman, Puerto Rico Louis Stokes Alliance for Minority Participation, and the CAHSI Mentorgrad assistantship.

When asked about taking the GRE, 25% (4 of 16) stated they had already taken it. Two more (12.5%) had not taken it yet, but planned to in the next six months. Ten students (62.5%) stated that they had not taken the GRE.

Students were also asked if they applied for graduate school or a professional degree program (law, medicine, etc). Almost 2/3 of the respondents (10 out of 16, 62.5%) responded that they had not. Three (19%) responded that they had, while another three stated that they intended to apply this year. While the percentage of students who had applied was slightly down (3%) from the previous year's Summit, the percentage of those who planned to apply went up 6% from last year.

Students were asked what they planned on doing after graduation. Of the 12 students who responded to this question, 42% of them planned to go directly into the workforce. Two of these 5 students indicated that they had already received job offers that they were accepting. The other 3 were not yet graduating, and indicated that they would look for jobs when graduating. Another 42% (5 of 12) students advised that they would pursue masters or graduate degrees. Of these 5, 3 (25%) of them indicated that they would first work, or continue to pursue post graduate degrees while working.

HENAAC Summit Influence on Students' Educational and Career Paths

Of the 14 students who responded, 4 (29%) students stated they had inquired about grad school opportunities. Another 21% (3 of 14) indicated that they planned to inquire about opportunities. An even larger number (64%, 9 out of 14) inquired about career opportunities based on their experience at the conference, while 29% (4 out of 14) planned to do so. Additionally, 46% (6 out of 13) of students inquired about internship opportunities based on their experience at the conference, and another 15% (2 of 13) planned to do so. The HENAAC summit had a more career-focused tone than the CAHSI summits tend to have, and the career fair provided opportunities to meet with employers directly.

When asked if the HENAAC/CAHSI summit provided opportunities to get career advice, 39% of respondents reported that they agreed a great deal, 17% agreed a good deal, and 33% somewhat agreed (89% total). Additionally, 94% of students reported that the Summit helped increase their knowledge of career pathways in their field. The same number (94%) of students reported that attending the conference helped increase their knowledge of computing. Half of the students responded that the Summit was somewhat (28%), a good deal (6%), or a great deal (17%) helpful in finding a mentor.

Most notably, 100% of students reported that the summit increased their dedication to their major by some degree. Broken down, 56% (10 of 16) said the summit increased their dedication a great deal, 22% (4 of 16) said it increased their dedication a good deal, and another 22% (4 of 16) said it increased their dedication somewhat. Nearly all students (89%) also felt that the Summit increased their interest in research (22% a great deal, 33% a good deal, and 33% somewhat). A

vast majority (82%) also reported that attending the Summit helped increase their interest in a particular area of computing (41% a great deal, 29% a good deal, and 12% somewhat).

Students were asked an open-ended question on how they most benefitted from the HENAAC/CAHSI summit. The most common answers included networking, both within academia as well as in the professional world, and professional opportunities. A quarter of the respondents stated that the Summit influenced their career paths. All of these students received either an internship or job offer. A smaller number specifically mentioned the hack-a-thon benefitting them. One student noted that the Summit increased their curriculum vitae, increasing their knowledge about computing and research.

"I gained experience when it came to interviews with companies, and also received an internship offer by a company."

"This conference helped me to expand my network, both within the Academia and Industry."

"I got to meet and get to know students from my university that I hadn't meet before and networking."

"It gathers the best companies with the best professionals ready to help you succeed."

CAHSI Summit provides an inclusive computing environment

Students and professionals were asked an open-ended question regarding what sets the HENAAC meetings apart from other technical/academic conferences. More than half of the responses mentioned the variety, exposure, and/or prominent presence of professionals. Another 20% mentioned the diversity of people and industry, and the comfort level it provided them. One person stated that the hack-a-thon set it apart from other conferences, while another person stated that the focus on student development set it apart.

As can be seen from the quotes below, students and professionals conveyed a level of comfort, and enjoyed that it was professional focused rather than academic.

"HENAAC was a whole different experience learning a lot of new skills that can be later used in the future."

"Almost everyone is Hispanic, therefore we could speak in Spanish and English and feel at peace."

"That it wasn't that much an academic/technical, but a professional conference."

"The exposure that students obtain with companies and professionals throughout the conference"

"How easy it is to talk to people in the conference."

Suggestions for future CAHSI Conferences

Both students and faculty were asked what they would do to improve future conferences. The most common issues are listed as follows:

- Better planning logistics – some students and faculty had issues with the hotel arrangements
- Poster session - allow more time for students to go around and talk to others about their posters. Some reported only to talking to judges. By creating a rotating system (e.g., the first hour odd numbered posters are facilitated, the second hour even number posters are facilitated) participants can better network during the poster session.
- Poster session – having the poster session at the same time as the career fair resulted in some students not exploring jobs as much as they wanted to
- Poster session – Ask professors to visit the poster session in order to provide more feedback
- Hackathon – bring along a female representative in the hackathon. Having all males intimidated some of the female participants

CAHSI Departmental Learning Environment Survey, Pilot Study

In the spring of 2017, the CAHSI department chairs were asked to distribute a student climate survey to their students. The survey was an adapted version of the “Culturally Engaging Campus Environment” instrument, and refocused on the departmental rather than institutional level. Data were collected from 3 institutions in the pilot. The figure and table below summarize data available from the climate study.

Student demographic variables: gender, ethnicity

Student academic background: presence of a STEM family member, entry status, college credit prior to entry in college

Student Socioeconomic status: parents’ educational levels; first generation status of student

Student aspirations: before attending CAHSI school, and current interest in educational advancement

Figure 9 Departmental learning environment: Climate survey scales

Scale name	Scale theme	Number of items	Sample item
Departmental Culture	the experience of the department as a learning environment (cultural congruence, comfort, belonging)	10 (5-point scale, strongly disagree to strongly agree)	“I feel like I belong in this department.”
Educational Agency	perceptions students have of their ability to make important decisions that direct	7 (5-point scale, strongly disagree to strongly agree)	“I have opportunities to make choices

	their learning within the department.		about how I learn.”
Experience of exclusion	The extent to which students have felt excluded from departmental activities or events.	7 (3-point scale, reversed to indicate <i>lack</i> of exclusion)	“I have felt excluded while attending class.”
Perceived growth in skills	Students assessed their abilities since beginning coursework in computer science.	5 (5-point scale, where 1 corresponds to “much worse” and 5 to “much better”)	“Ability to think critically”
Experience of advising	Students describe their experience with advising as it relates to academic success in computer science	6 (5-point scale, strongly disagree to strongly agree)	“Faculty take the time to assist in building a course plan that works for me.”

Student demographic information for the departmental learning environment survey across 195 responses and three institutions appear below.

Figure 10 Departmental learning environment: Student demographic information

How many hours per week do you work outside your studies?	Frequency	Percent	Self-reported student ethnicity	Frequency	Percent
0	38	19.5	African American/black	12	6.2
1-10	20	10.3	Asian, from Indian subcontinent	16	8.2
11-20	69	35.4	Asian, not from Indian subcontinent	8	4.1
21-30	31	15.9	Caucasian	32	16.4
31-40	21	10.8	Hispanic/Latino/a/Chicano	109	55.9
more than 40	16	8.2	More than one race	18	9.2
Total	195	100.0	Total	195	100.0
Respondents were 76% men, 24% women			Nearly half (49%) had a family member participating in a STEM field		

Student class standing	Frequency	Percent	Student entry status	Frequency	Percent
Freshman	12	6.2	I came directly from high school WITH college credit	47	24
Sophomore	33	16.9	I came directly from high school WITHOUT college credit	60	31
Junior	72	36.9	I transferred from a community college	63	32
Senior	66	33.8	I transferred from a different 4 year school	24	12
Graduate School	12	6.2	Total	194	100
			37% of survey participants were first generation college students		
Institution	Frequency	Percent			
School A	27	14			
School B	65	32			
School C	103	54			

Most survey participants were Hispanic (56%) and male (76%). Survey respondents were most likely juniors and seniors, though a slight proportion of respondents were lower classmen (23%). Nearly a third of students transferred from a community college (32%), while slightly fewer entered the CAHSI school directly from high school without college credit (31%), and about a fourth entered a CAHSI school with college credit via dual enrollment or AP credit (24%). Twelve percent transferred from another four-year program. Nearly half of the survey respondents had a family member engaged in STEM, according to self-report. Students were likely working more than 20 hours per week (35%), though a large number of students reported part time work (1-10 hours= 10%; 11-20 hours =35%) while 20% did not work outside of coursework.

Culture of departments, overall means by theme

Student responses hover around 4.0 for 5 point scales, which corresponds to “agree.” As the items are all positively worded, these findings indicate a general trend of agreement that the CAHSI departments in this study are generally positive learning environments for those who completed the survey. The exclusion scale was reversed such that a 3.0 would correspond to “never” feeling excluded in the on-campus and computing-related activities described.

Figure 11 Departmental learning environment: Culture of departments overall means

Overall Means		Culture Mean (5 point scale)	Agency Mean (5-point scale)	Departmental Exclusion Mean (3-point)	Perceived Growth Mean (5 point scale)	Advising Mean (5 point scale)
Total	Mean	3.9777	3.8621	2.8557	4.0697	3.8849
	N	193	195	195	195	195

Differences by school are minor, not statistically different

Mean differences across schools range from 0.04-0.37, yet none of these differences approached statistical significance in this sample. Of particular note is the uniformly high marks related to exclusion in the department- these average scores approach “3” which corresponds to “never” feeling excluded from computing within the department and in academic events off campus. The greatest differences across campuses appear in the categories of educational agency (mean difference between schools a and b is 0.37) and advising (differences between a and b is 0.25)

Figure 12 Departmental learning environment: Differences by school

Institution		Culture Mean	Agency Mean	Departmental Exclusion Mean	Perceived Growth Mean	Advising Mean
School A	Mean	3.7741	3.6580	2.8836	3.9333	3.7546
	N	27	27	27	27	27
	Std. Deviation	.69647	.81851	.22426	.80956	.94467
School B	Mean	3.9058	3.9256	2.8549	4.0738	4.0052
	N	63	65	65	65	65
	Std. Deviation	.76044	.75636	.39000	.77908	.72654
School C	Mean	4.0750	3.8754	2.8488	4.1029	3.8430
	N	103	103	103	103	103
	Std. Deviation	.68519	.75506	.34348	.69613	.84496
Total	Mean	3.9777	3.8621	2.8557	4.0697	3.8849
	N	193	195	195	195	195
	Std. Deviation	.71724	.76518	.34508	.73894	.82296

Differences for Hispanic/non-Hispanic students favors Hispanics, but not statistically different

Students with Hispanic heritage responded slightly more favorably on all but one of the scales related to a positive departmental learning environment. Hispanic students rated the culture of the department and the advising they receive slightly more favorably than their non-Hispanic peers, and were less likely to report feeling excluded from computing in their departments. They perceived slightly greater self-reported growth in skills as well. The only instance in which Hispanic students reported lower average mean scores across scale items was educational agency. While this difference was not statistically significant, it is important to monitor this pattern—if Hispanic students are less likely to feel in charge of their own educational experiences, they may be receiving messages from the department to that effect, or they may not be advocating for their learning in the same ways as other students.

Figure 13 Departmental learning environment: Differences for Hispanic/non-Hispanic students

	Hispanic/non-Hispanic	N	Mean
Culture Mean	Non-Hispanic	69	3.8493
	Hispanic	124	4.0491
Agency Mean	Non-Hispanic	71	3.9169
	Hispanic	124	3.8306
Departmental Exclusion Mean (reversed such that 3.0 refers to no feelings of exclusion)	Non-Hispanic	71	2.8209
	Hispanic	124	2.8756
Perceived Growth Mean	Non-Hispanic	71	4.0141
	Hispanic	124	4.1016
Advising Mean	Non-Hispanic	71	3.9619
	Hispanic	124	3.8408

Slightly lower scores for first generation college students, though not statistically different

The pilot study sought to understand how students who had no familial experience with college enrollment compared with their peers. First generation students earned slightly lower mean scores on 4 of the 5 scales, ranging from 0.01-0.11, however, they outperformed their peers related to perceived growth in skills (+0.12). This may reflect a slightly greater value of college learning from those who are first generation students, or may indicate differing opportunities in high school that led to greater growth in college coursework.

Figure 14 Departmental learning environment: Comparing scores for first generation college students

Scale	First Generation College Student?	N	Mean	Std. Deviation
Culture Mean	Not First Gen	122	4.0171	.69954
	First Gen	71	3.9099	.74683

Agency Mean	Not First Gen	124	3.9027	.74709
	First Gen	71	3.7911	.79618
Departmental Exclusion Mean	Not First Gen	124	2.8594	.32279
	First Gen	71	2.8491	.38324
Perceived Growth Mean	Not First Gen	124	4.0242	.77882
	First Gen	71	4.1493	.66136
Advising Mean	Not First Gen	124	3.9043	.80160
	First Gen	71	3.8509	.86375

Shifts in student aspirations within CAHSI departments

The survey employed retrospective methodology to understand how the college experience within CAHSI departments shift student aspirations towards graduate work. Students who completed the survey were more likely to aspire to graduate school than to terminate with a Bachelor's degree—in fact, 57% plan to earn a graduate degree.

Figure 15 Departmental learning environment: Student aspirations towards graduate work

Highest Degree You CURRENTLY Plan to Earn	N
Bachelor's degree	84
Master's degree	94
Ph.D.	17

For each student, the evaluators calculated a difference score based on what they reported they intended to earn when entering the department and what degree they intend to pursue now (as of spring 2017). A small portion of students decided to lower their aspirations (7%) over that time, 60% remained the same, and a third (33%) increased their aspirations during their studies in their CAHSI department. The calculated school difference score also appears in the table below—all are positive indicating an average positive shift in aspirations across CAHSI departments.

Figure 16 Departmental learning environment: Changes in aspirations

Degree Difference CURRENT minus ORIGINAL Aspiration				Degree Difference Scores by School			
		Frequency	Percent	Institution	Mean	N	Std. Deviation
Change in aspiration in which each degree level is +1	-1.00	14	7.2	School A	.2963	27	.60858
	.00	116	59.5	School B	.2308	65	.67937
	1.00	59	30.3	School C	.3301	103	.63227
	2.00	6	3.1	Total	.2923	195	.64352
	Total	195	100.0				

CAHSI Learning Environment Pilot Study: next steps

The pilot study indicates the scales may be a promising measure for understanding student experiences and room for improvement in departments, and for subgroups of the CAHSI student population. Relatively low participation rates and skewed data in which upperclassmen predominate make it clear that new sampling methods are needed to make meaningful strides in understanding CAHSI students' experiences. Future studies should involve purposeful sampling and additional departmental participation. CAHSI research and evaluation will work with the CAHSI team to create more targeted means of gathering data to increase the sample from each school and increase participation from groups underrepresented in this sample, such as freshmen and sophomores.

Affinity Research Groups: Learning through Professional Practice

There were 83 respondents to a survey for ARG student researchers in Spring 2017. Almost half of the respondents were seniors (48%, 40 people), and approximately one-quarter were juniors (26%, 22 people). The others were freshman (4%, 3 people), sophomores (12%, 10 people), Master's students (5%, 4 people), and Ph.D. students (5%, 4 people).

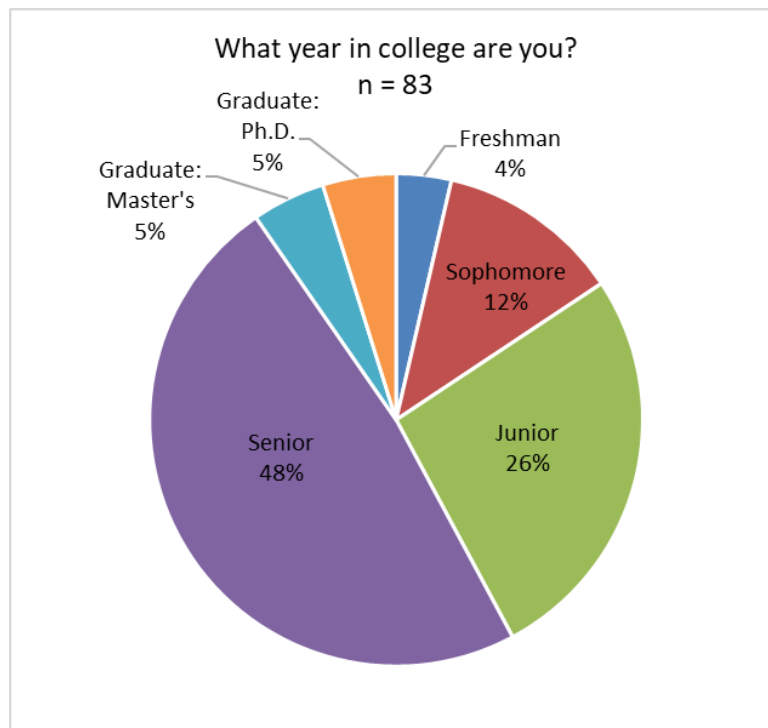


Figure 17 ARG student researchers: Year in college

Survey respondents were asked about taking the GRE and their plans for graduate school (see Figure 2). Of the 60 students who responded to a question that asked whether they had taken the GRE, 22% had taken it and 78% had not. Of the 57 students to responded to a question asked whether they planned to take the GRE, 44% planned to take the GRE while 56% did not. Students were also asked whether they had applied to graduate school, and 3% responded that they had while 97% had not (of 60 respondents). Students were also asked about their plans to apply to graduate school, and 56% reported having plans to apply to graduate school and 44% did not (of 57 respondents).

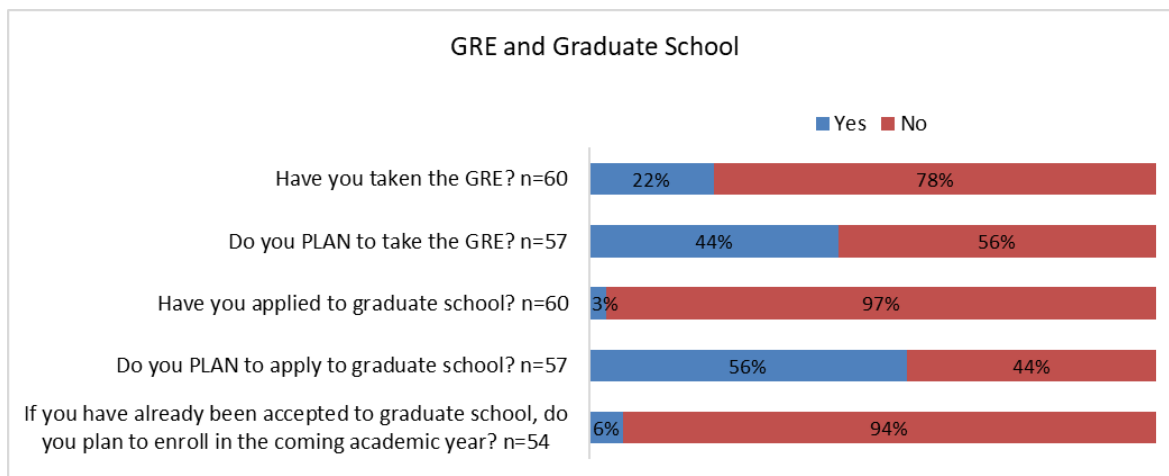


Figure 18 ARG student researchers: Taking the GRE and plans for graduate school

Students were asked about scholarships and fellowships, and 81 students responded. First, they were asked whether they had applied for a scholarship or fellowship in the past year, and 28% had applied while 72% had not. When asked whether they plan to apply, 35% said they did and 65% did not.

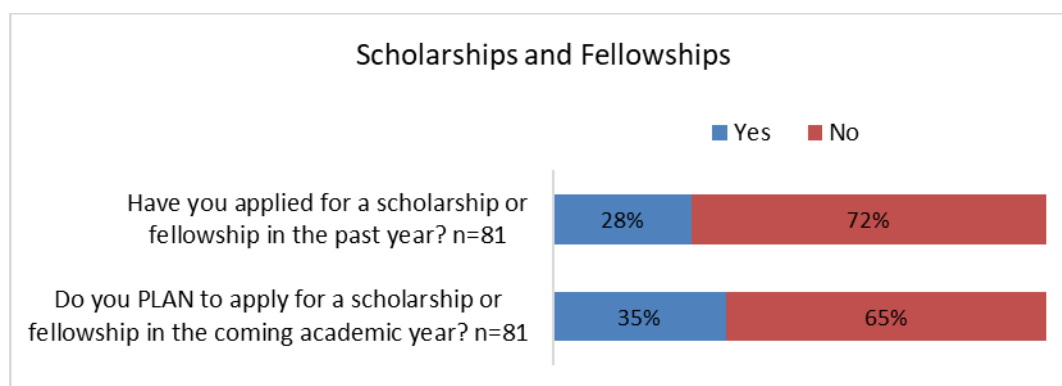


Figure 19 ARG student researchers: Scholarships and fellowships

Students were asked about their mentors and research experiences. Eighty students responded to questions about having a mentor. Approximately half the students had a mentor (49%, 39 students) while half did not (51%, 41 students). Students were asked whether they had relationship with someone who informally mentors them, and 34% said they did and 66% said they did not. Most respondents (61%, 49 students) reported having had someone advise them about graduate school or career paths in their field, and 39% (31 students) did not receive such advising. The student researchers who were graduate students were also asked whether they participated in research as an undergraduate, and 25% of them (13 people) reporting having had such experience while 75% (39 people) did not.

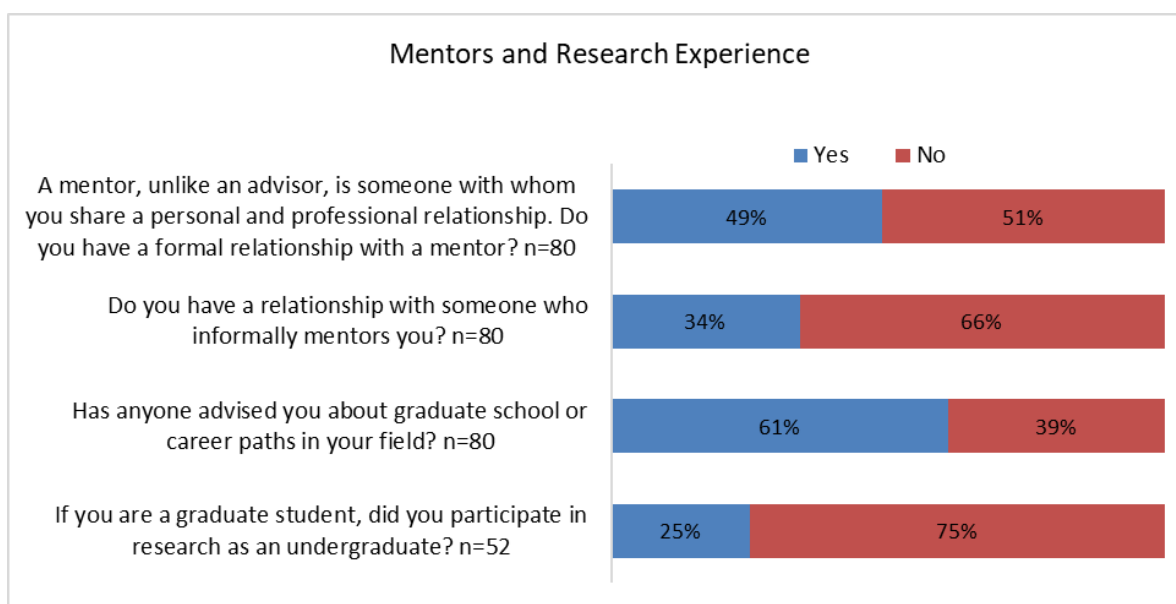


Figure 20 ARG student researchers: Mentors and research experiences

Survey respondents were asked how long they had been in their current research group (see Figure 4). Fifty-seven student researchers answered the questions, and 1-2 Semesters was the most common answer with 37 people (65% of respondents) selecting it. Another 17 people (9%) reported they had been in their current research groups for 3-4 semesters, and 3 people (1%) reported having spent 5 semesters or more with their current research groups.

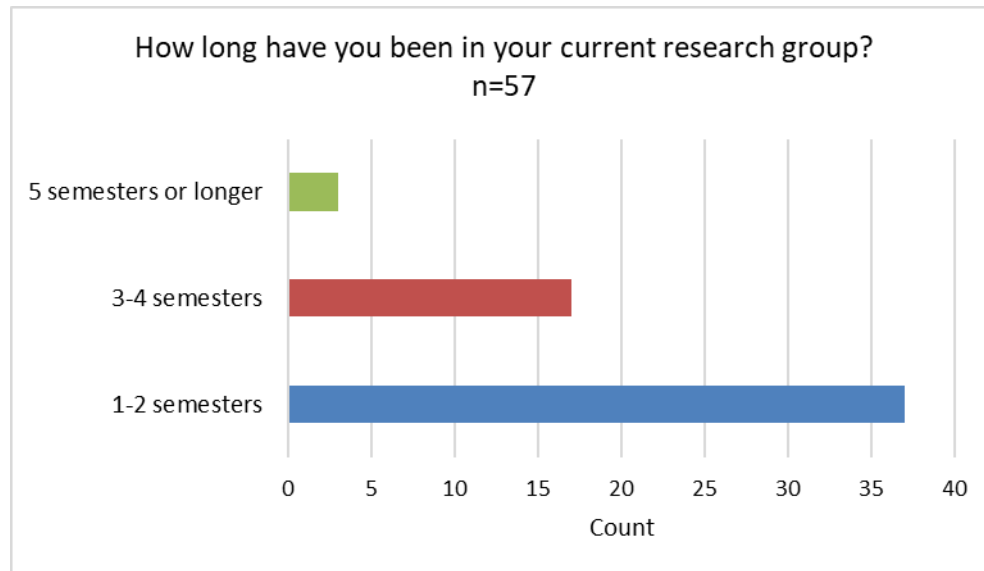


Figure 21 ARG student researchers: Semesters with current research group

The survey asked student researchers about their activities as related to dissemination of scholarly work. There were 56 who responded to the question, and activities were not mutually exclusive (see Figure 6). Almost all respondents (96%, 54 people) had attended a professional conference, meeting, or workshop. Approximately half (48%, 27 people) had prepared a poster for a conference. Some had also presented a paper at a conference (13%, 7 people) or authored or co-authored a journal paper (9%, 5 people).

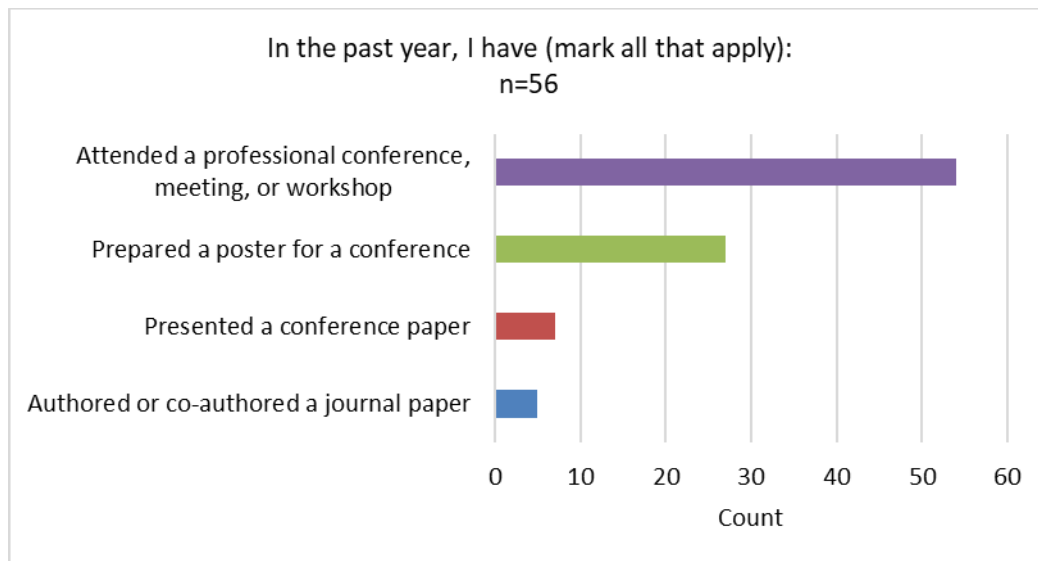


Figure 22 ARG student researchers: Dissemination activities

Student researchers were asked whether they had attended any conferences within the past year. There were 26 people who attended a total of 32 conferences, with some respondents having attended more than one conference (see Figure 7). HENACC was the most common answer with 13 respondents having attended it within the past year. Other conferences included SHPE, STARS (RESPECT Conference), SuperComputing, Richard Tapia Celebration of Diversity in Computing, and Grace Hopper. An additional 12 responses were provided by respondents who attended a conference that was not listed as a response to this question: IAP (3 people), ERN (2 people), Society of Women Engineers Annual Conference, Arduino Day, Facebook Developer Conference, IBM, Meetings and workshops of CREST, and RCIS.

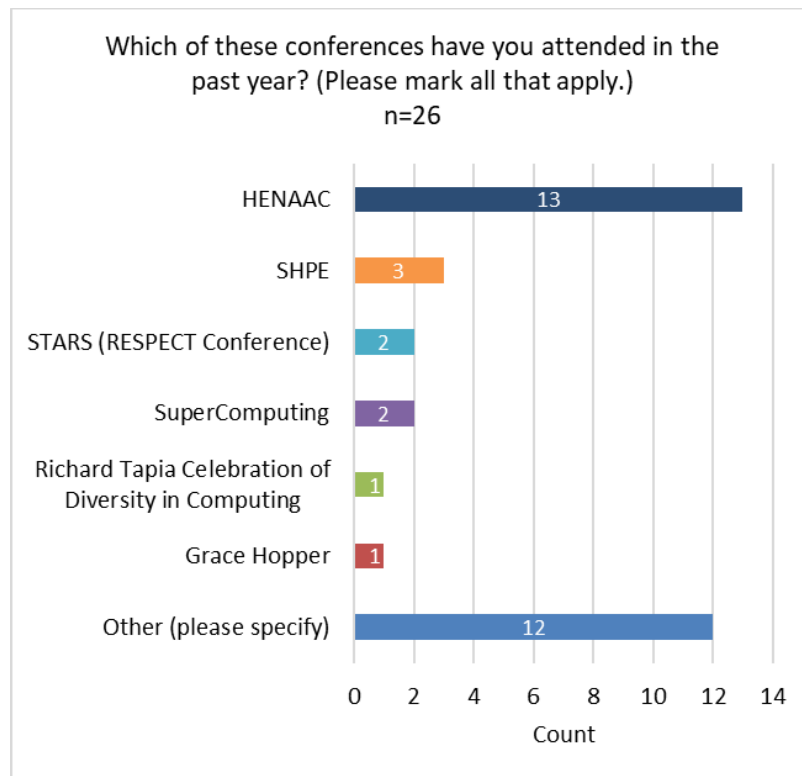


Figure 23 ARG student researchers: Conferences attended

Student researchers who are already in graduate school and those who plan to go to graduate school were asked who/what most influenced their decisions to attend graduate school. There were 81 respondents to this question (see Figure 8). Respondents cited a variety of primary influences: Research experience (28%, 23 people), undergraduate peer(s) (19%, 15 people), faculty research mentor (17%, 14 people), faculty member (14%, 11 people), parent or family member (14%, 11 people), and graduate student(s) 9%, 7 people).

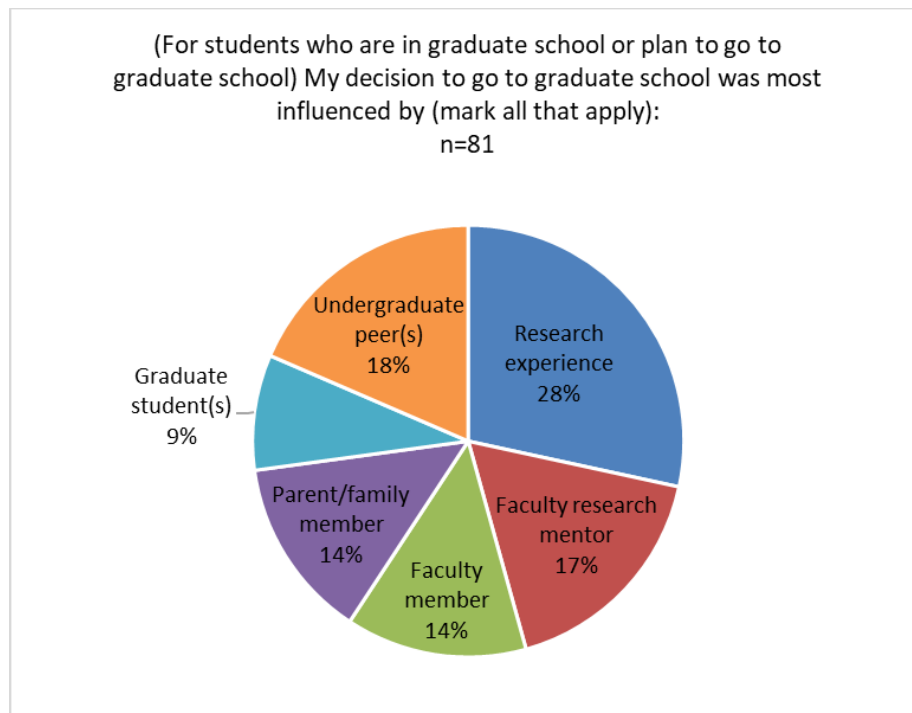


Figure 24 ARG student researchers: Largest impact on decision to attend graduate school

Seventy-one student researchers responded to a question that asked them to select the top three areas in which they had grown (see Figure 9). Research Skills and Technical Knowledge were each chosen by 46 respondents. Communication Skills and was chosen by 36 people, and Team Skills was chosen by 33 people. Thirty student researchers selected Intellectual Skills, and 29 selected Personal Growth. Finally, 25 students reported that Clarification of Intended Career Path was an area in which they had grown the most.

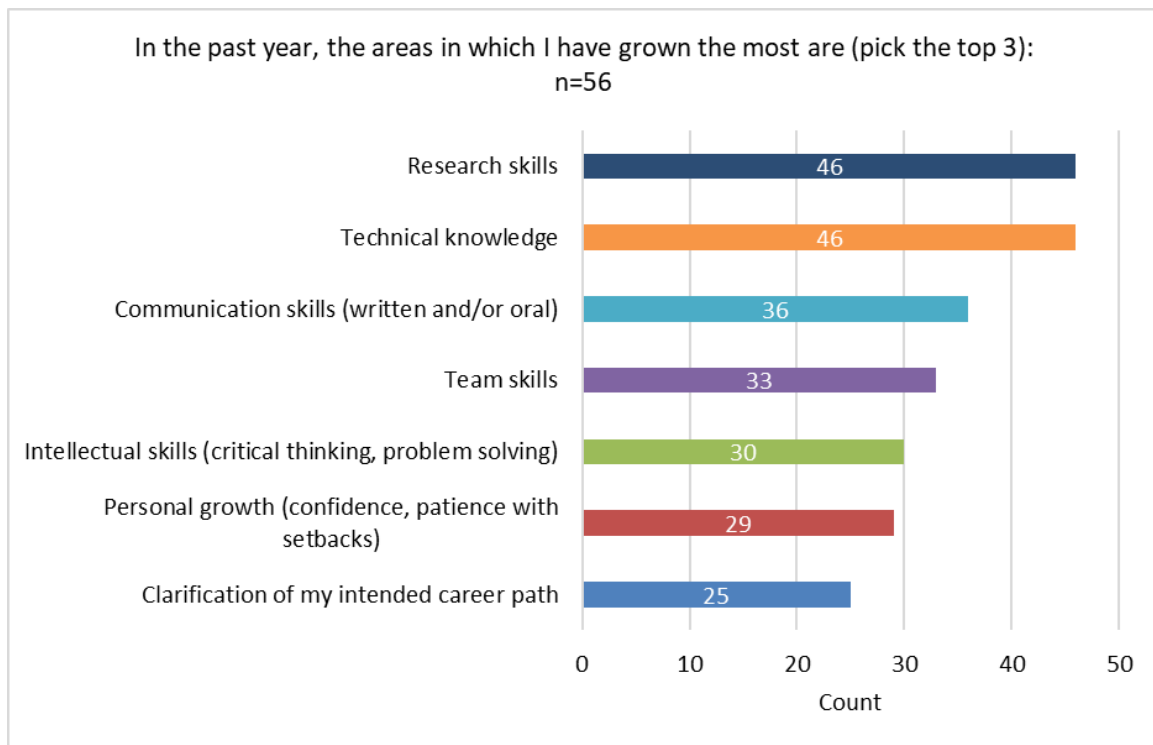


Figure 25 ARG student researchers: Areas of growth

Student researchers were asked questions specific to their affinity research groups. 88-98% of the respondents reported that they Strongly Agree or Agree with all of the statements in the area of Collaboration/Distribution of Tasks, which included statements such as, “I understand how my own tasks relate to the greater goals of the group,” and, “I feel that I contribute to decisions that impact the direction of the group” (see Figure 10).

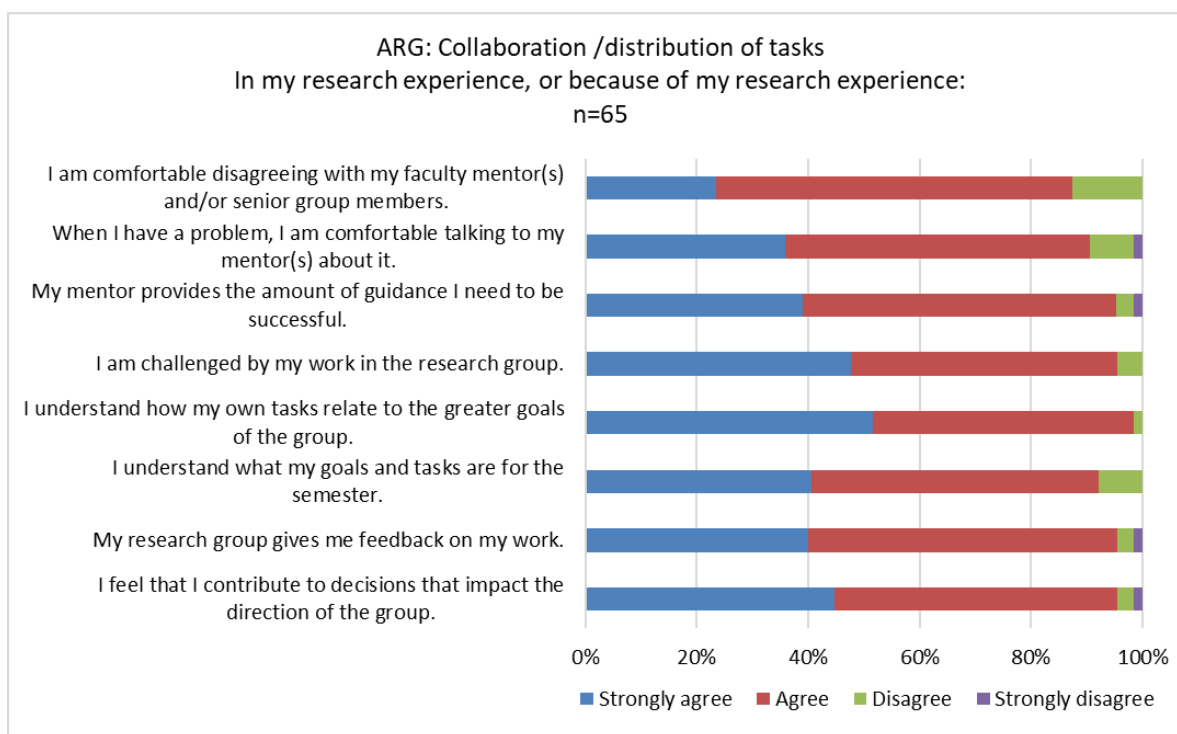


Figure 26 ARG student researchers: Collaboration/distribution of tasks

Between 91 and 97% of the respondents reported that they Strongly Agree or Agree with all of the statements in the area of Intellectual Gains/Knowledge Development, which included statements such as, “My knowledge from computing courses seems more relevant,” and, “I have gained general problem-solving skills.”

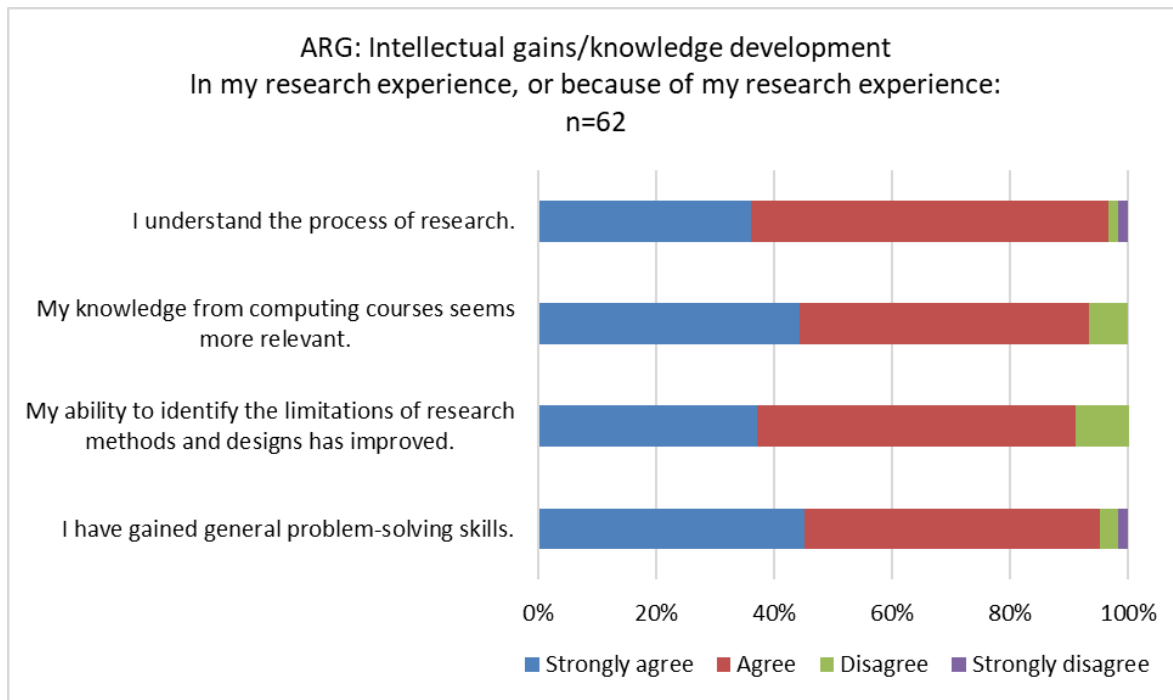


Figure 27 ARG student researchers: Intellectual gains/knowledge development

Nearly all (92-97%) of the respondents reported that they Strongly Agree or Agree with all of the statements in the area of Research Interest/Confidence, which included statements such as, “I became more interested in computing in general,” and, “I have gained confidence in my ability to contribute to the field of computing.”

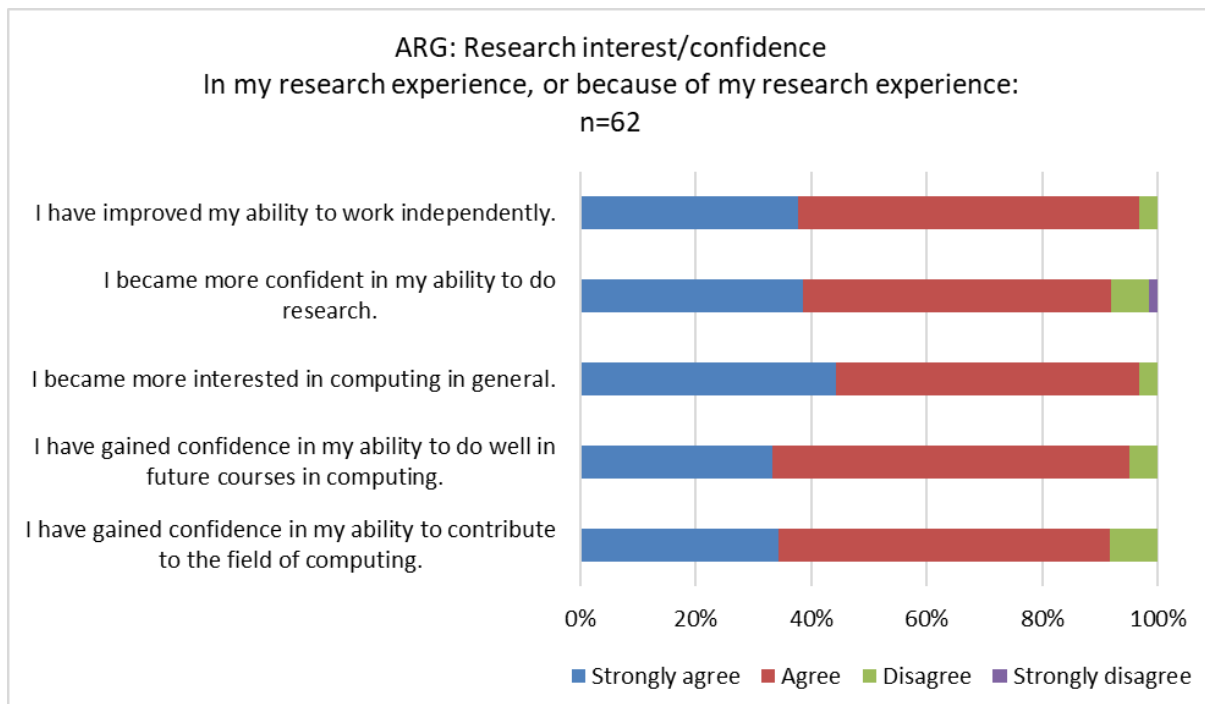


Figure 28 ARG student researchers: Research interest/confidence

The majority of the respondents reported that they Strongly Agree or Agree with all of the statements in the area of Skill Development, which included statements such as, “My time management skills have improved,” and, “My ability to understand journal articles has improved” (83-94%). Skill Development had the lowest levels of agreement with, for example, 17% of respondents selecting Disagree or Strongly Disagree for the statement, “My ability to prepare a scientific poster has improved.”

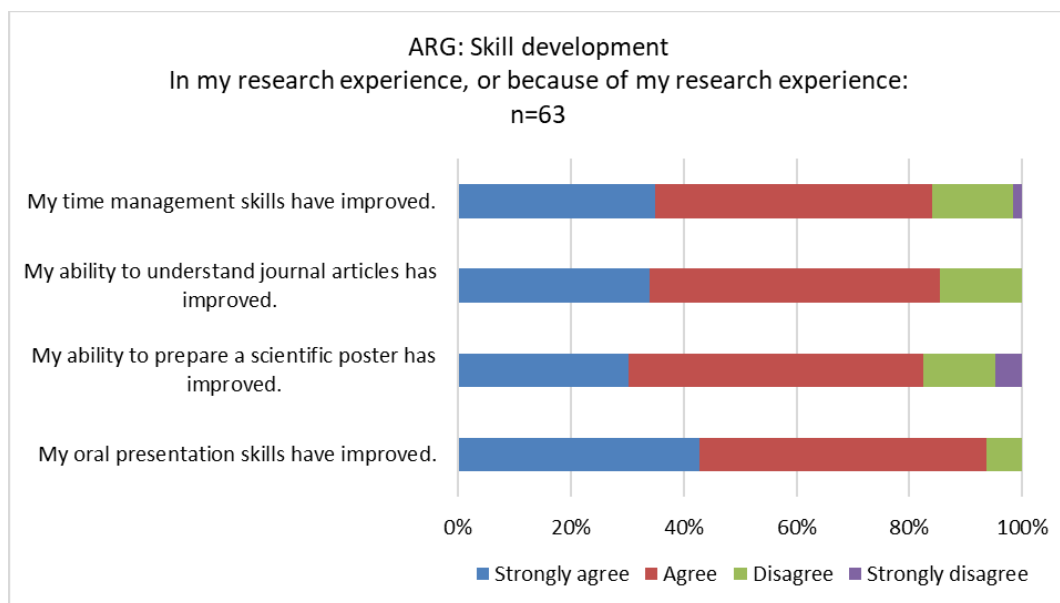


Figure 29 ARG student researchers: Skill development

In the area of Academic Program/Career Readiness, 85-92% of the respondents reported that they Strongly Agree or Agree with the statements, “I feel more prepared for advanced coursework in computing,” “I have greater knowledge of career and education options,” and “I feel more prepared for a career in computing” (see Figure 14). There were only 78% who agreed, however, and 22% who disagreed with the statement, “I feel more prepared for graduate school.”

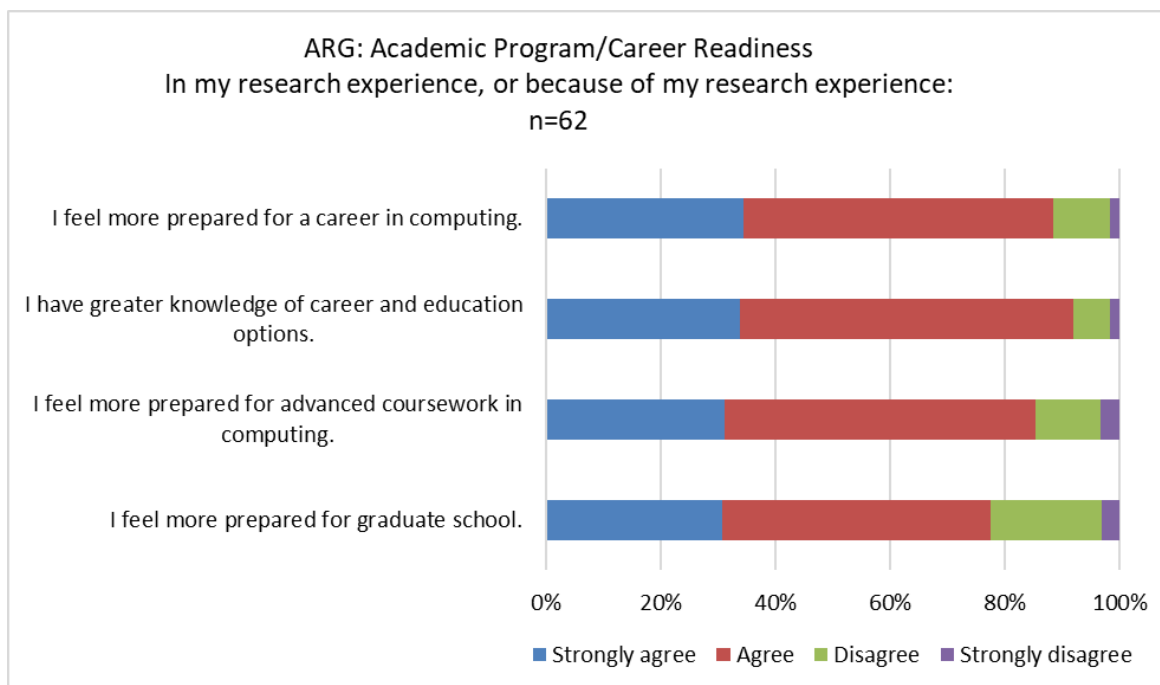


Figure 30 ARG student researchers: Academic program/career readiness

ARG Student Researchers' Demographic Information

The average GPA of student researchers who responded to the student researcher survey was 3.23. Of the 83 total survey respondents, 71 of them answered a question about their gender. The majority of the respondents were male (73%, 52 people), and a minority were female (27%, 19 people). Survey respondents were asked about their race and ethnicity. Respondents were able to select all options that applied to them, and the 71 respondents made a total of 75 selections of racial and ethnic categories. Most of the survey participants (61 people) reported being Hispanic/Latino/a. There were 5 people who reported being African American/Black, 5 who reported being Caucasian/White, and 4 who reported being Asian and not from the Indian subcontinent. Most respondents did not hold jobs outside of their research positions. Of the 68 student researchers who answered this question, 65% do not hold jobs outside of their research positions, while 35% of respondents do hold outside jobs.

Survey participants were also asked about their mother's, or closest female parental figure's or guardian's, highest level of education. Seventy-one student researchers answered this question. The answers selected were that their mother earned a 4-year degree (23 people), earned a high school diploma or G.E.D. (18 people), did not finish high school (10 people), attended some college (8 people), earned a 2-year degree (2 people), and attended some graduate school (1 person). Student researchers were then asked about their father's, or closest male parental figure's

or guardian's, highest level of education. Sixty-nine student researchers answered this question. The answers selected were that their father earned a 4-year degree (17 people), earned a high school diploma or G.E.D. (17 people), did not finish high school (11 people), attended some college (9 people), earned a 2-year degree (6 people), and attended some graduate school (2 people).

In all, 106 CAHSI students completed the Undergraduate Research Student Self-Assessment (URSSA) survey in spring, 2016. URSSA is a statistically reliable and validated survey that was developed to measure students' cognitive, personal, and professional gains from apprentice-style research experiences. Several scales on the URSSA survey were adapted for use in classroom contexts, notably the intellectual gains scale and skills scale to reflect the differences in the way the ARG model is structured within a course in contrast to an apprentice-style, hands-on research experience.

Common Core Indicator #2: CAHSI Organizational Capacity

In this section, we highlight the current organizational capacity of CAHSI and assess how CAHSI has made progress towards creating change in computing education for Hispanics within its membership and through its regional ecosystem model. As in each year since the previous grant cycle, the evaluators employ a research-based rubric of organizational capacity. CAHSI's sustainability depends on the development of capacity to support activities as well as Alliance-level abilities to continue and advance the organizations' goals. This rubric was redeveloped to measure the goals of the current grant, and focus more directly on elements of collective impact. The rubric appears first, with related text based upon each heading following, and supplementary materials provided in the appendix.

Figure 31 Common Core Indicator #2: CAHSI Organizational Capacity Rubric

Organizational Capacity Rubric- CAHSI ecosystems leveraging collective impact			
A. CAHSI regional circuit- design regional events with collective impact values	Each regional circuit event involves two PIs/professionals knowledgeable about and confident in their understanding of collective impact practices and values in the planning of the event (as reported in faculty surveys, annually)		
3	At least one PI knowledgeable and confident about CI		*goal obtained
B. CAHSI regional circuit- facilitate regional events with collective impact values	Each regional circuit event involves two PIs/professionals knowledgeable about and confident in their understanding of collective impact practices and values in the facilitation of the event (as reported in faculty surveys, annually)		
2	At least one PI/professional knowledgeable and confident about CI		*goal obtained
C. CAHSI regional circuit- regional capacity for meeting logistics/communication	Each regional circuit event involves a PI with access to staff assistance for logistics and communication- funded through the university or through the grant (i.e., there are staff who can allocate a portion of their time to communicating with attendees, arranging for technology, procuring food if needed, etc.). CAHSI PI(s) volunteer time needed to organize, communicate, etc. with little to no staff support	CAHSI national staff supports regional event in combination with PI	*goal obtained
2			

D. CAHSI regional circuit- regional events provide evidence of CI building strategies, based on observation or document review	Evidence of implementation of CI – regional events have evidence of at least 5 of the 6 elements below: • Focus on strategic actions • Focus on collaboration and trust building • Focus on emergent themes from participants (bottom up, empowerment of participants) • Leadership serves as a guide for strategy (top-down facilitation) • Leadership serves as communicating body beyond meeting • Consideration and discussion of shared measurement		
3	Less than half of the events meet the 5 of 6 requirement for collective impact	More than half (but not all) of the events meet the 5 of 6 requirements for collective impact (see appendix for direct evidence of CI elements)	*goal obtained
E. CAHSI student network- connect students who participate in individual-level CAHSI initiatives (e.g., mentor grad, ARG) regionally	Each institution has a formalized student group that has some informal or formal communication with another student group in the CAHSI network		
1	Less than half of the CAHSI institutions establish a student network, these networks are not connected	More than half of CAHSI institutions have a formalized student group network, there are few limited connections across student networks	*goal obtained
F. CAHSI expertise profiles are created across all regions and document CAHSI technical and pedagogical expertise areas	CAHSI expertise profiles are created for at least 2 faculty across all CAHSI institutions; expertise profiles include technical, educational, and service accomplishments to facilitate collaboration on multiple CAHSI-related efforts(e.g., tags might include: ARG trainer, CS-0 instructor, Cybersecurity research, interdisciplinary research, industry internship supervisor).		
1	Less than half of participating schools show participation in the expertise profiles	Either only one faculty per school participates, or less than half of schools participate	*goal obtained
G. CAHSI Summit-faculty have opportunities to gain pedagogical skill, and/or become trained in initiatives	CAHSI faculty have access to multiple professional development opportunities that relate to building inclusive classrooms or departments, specifically those that involve pedagogy. CAHSI faculty are aware of the workshops and are encouraged to attend by CAHSI stakeholders. Workshops are extensive enough, either in face to face component and/or offline coaching, to lead to adoption of initiatives/practices. (interview/survey data for HENAAC, document analysis, faculty and PI interview)		
2	Little to no professional development is available for faculty.	CAHSI faculty have uneven access to training across regions, and/or training is not adequate to implement initiatives locally.	*goal obtained
H. CAHSI Summit-CAHSI participation at the HENAAC co-located	CAHSI-affiliated institutions grow, and participate in greater numbers at the HENAAC/CAHSI conference. This results in greater numbers of faculty and students from each institution participating annually.		

event grows in CAHSI attendance			
Not available until November 2017	Fewer students and faculty participate year to year.	The same number of institutions affiliated with CAHSI participate each year, and nearly the same number of faculty and students participate from year to year.	*goal obtained

Knowledgeable, confident professionals plan and deliver all collective impact events

Across regions, CAHSI members and affiliates have led and planned Collective Impact-focused regional meetings with the intent of developing regional ecosystems supportive of Hispanics in computing. In these first iterations, much planning for meetings has been done collaboratively, and have engaged members from across regions through regular phone calls related to the INCLUDES subset of CAHSI participants. Implementation of regional events are uneven in the ways in which multiple leads and staff are involved – in the Southwest there may be up to 4 professionals well-versed in collective impact who are implementing meetings, while in the SoCal region, only one CAHSI participant is engaging in the event implementation and facilitation. *It appears important to ensure that each region has more than one PI, faculty, or staff member engaged in the larger conversations related to collective impact.*

Access to staff assistance for logistics and communication

As grants shift in focus, they clarify the needs of the collective. In the case of CAHSI, where shifts are occurring such that facilitating collaboration is a major emphasis, it is becoming clear that additional staff resources are necessary to support the CAHSI infrastructure regionally and nationally. While in interviews the majority of PIs were confident they had, or had access to, the human power needed to facilitate events, it is unclear that the same is also true for maintaining a network through communication, resource sharing, and regular support. Currently, headquarters staff have been engaged in this support for faculty across regions. Additional funding may be needed to ensure adequate backbone support at each region.

Evidence of implementation of CI

One event from each region was observed during the 2016-17 year. The goal of the collective impact measure of the organizational capacity rubric is to ensure the events follow each of the main components of the collective impact strategy, and serves some of the functions of the backbone organization. This 6 point rubric is meant to measure the extent to which the event as implemented provides opportunity for each of the elements to occur- it does not presume that the collective achieved its goals, as that will be measured through other means. The team efforts observed by evaluation were able to provide opportunity for nearly all of the elements vital to collective impact. See appendix for documentation of each element from each of three events. Maintaining high quality across regions will necessitate coaching and training to bring other PIs up to speed regarding what collective impact entails.

Formalized CAHSI student groups

The CAHSI student groups have become official organizations of the university at a few campuses. By utilizing the university student group designation, CAHSI student groups receive funding as

well as additional visibility. CAHSI student groups will be developed with an eye towards giving back to the community and towards academic excellence. As student groups grow, the intention is to connect across CAHSI institutions. This has been an unfilled student need for years in the CAHSI community, as students meet one another annually yet have no formal or informal way to engage between conferences. Student engagement in a project across institutions, such as a research endeavor or online competition, may support relationship building which is vital to identity development in this field.

CAHSI expertise profiles

This has not been a focus of the current year's efforts.

CAHSI faculty have access to multiple professional development opportunities

At this time, professional development offerings have been sporadic and not evenly accessible across CAHSI regions. Faculty professional development is vital to CAHSI growth and ecosystem development. Because of turnover in organizations that have been CAHSI members since its inception, re-training may also benefit current members as well as incoming members. As this grant does not provide funding for a great amount of faculty development, additional funds may be needed to bolster faculty skills, knowledge, and motivation to implement best practices in undergraduate education. While the HENAAC venue would be ideal for some of this training, the packed program may need to be extended for faculty to have adequate time to learn practices such as PLTL and ARG, as well as to develop relationships with other faculty that would foster peer coaching and mentoring.

CAHSI-affiliated institutions grow, and participate in greater numbers at the HENAAC/CAHSI conference

This information will not be available until November 2017.

Common Core Indicator #3: Alliance Impact

Alliance impact is measured in a new rubric, developed to incorporate the newest CAHSI plans for dissemination and growth using a collective impact framework. The rubric uses a variety of data sources (PI and faculty interviews, participant observations, document analysis, and survey data) to understand how CAHSI is reaching its goals.

Figure 32 Common Core Indicator #3: Alliance impact rubric

Communities of practice online are established and made publicly available to the computing community and the higher education community. 1	The online community of practice for CAHSI is available to outside audiences. Partners who are asked to test the community of practice find it a) useful b) useable and c) relevant to their work. Online communities are not made public, or testers overall find it less than useful/useable/relevant Communities are not easy to access, and/or results related to usefulness/usability/relevance are mixed *goal obtained
Dissemination and documented adoption/adaptation from	At least two institutions from each region adopt or adapt CAHSI initiatives. This adoption/adaptation is well documented, and data is collected commiserate to CAHSI institution data collection.

inside CAHSI to outside CAHSI (e.g., CSU Stan)			
1	One third or fewer than one third of the goal number of institutions are obtained, adaptation or adoption is concentrated in one or two regions	Half or fewer than half of the goal number are attained, or the adoption/adaptation covers half or less than half of CAHSI regions	*goal obtained
Dissemination and documented adoption/adaptation of new initiatives (e.g., regional partnerships bring in new practices, CAHSI expands practices)	At least two institutions from each region adopt or adapt new initiatives offered by CAHSI and/or CAHSI partners. This adoption/adaptation is well documented, and data is collected commiserate to CAHSI institution data collection.		
1	One third or fewer than one third of the goal number of institutions show new practices of adaptation or adoption, and/or new practices are concentrated in one or two regions	Half or fewer than half of the goal number are attained, or the adoption/adaptation covers half or less than half of CAHSI regions	*goal obtained
Faculty across regions work on a collaborative with industry that serves institutions/academics	Faculty from across CAHSI regions collaborate with their peers and industry supporters to develop academic resources (e.g., textbooks, lessons, activities, courses). Projects are added annually, such that at least one major collaboration develops per reporting cycle.	Faculty work only in isolation or with regional peers to develop modest efforts that relate to academic work (e.g., co-developed workshops for students, scholarships)	*goal obtained
3	Faculty do not collaborate with industry beyond baseline efforts		
Faculty across regions work on a collaborative project with industry that serves workforce (e.g., joint research for product development)	Faculty from across CAHSI regions collaborate with their peers and industry supporters to develop technical resources or technical advances (e.g., develop new software in faculty/student/industry collaboration). Projects are added annually, such that at least one major collaboration develops per reporting cycle.	Faculty work only in isolation or with regional peers to develop modest efforts that relate to technical work (e.g., co-ops and internships for students)	*goal obtained
1	Faculty do not collaborate with industry beyond baseline efforts		
CAHSI develops and extends its policy voice across the region and the nation.	Multiple (4 or more) CAHSI PIs served as CAHSI delegates to higher education, community based, and STEM education organizations in leadership roles in 10 or more national or regional venues across a spectrum of organization types. PIs discuss lessons learned from CAHSI rather than focusing on own institution specifically.		
3	One delegate, less than 5 organizations	Less than 3 delegates, less than 7 organizations	*goal obtained

2	CAHSI continues to seek funded opportunities to support computing education across partners.	Each (or nearly each) CAHSI institution is involved in a collaborative research grant/grant proposal that supports continued contact and scholarship among students and faculty for educational research and/or programming. Partners could include potential new CAHSI members from the regions supported or other CAHSI Three or fewer institutions are engaged in collaborative grants/proposals submitted or obtained in the academic year with an education focus Six or fewer institutions are engaged in a collaborative grant/proposals submitted or obtained in the academic year with an education focus *goal obtained
1	CAHSI continues to seek funded opportunities to support computing research across partners.	Each CAHSI institution is involved in a research grant/grant proposal that leverages CAHSI results, outcomes, and/or initiative strategies to develop new programs of technical research. Three or fewer institutions are engaged in collaborative research grants/proposals submitted or obtained in the academic year with a technical research focus Six or fewer institutions are engaged in a collaborative research grant/proposals submitted or obtained in the academic year with a technical research focus *goal obtained

Online Community of Practice

This element of CAHSI impact has yet to be addressed across universities. At this time, CAHSI faculty from the online community of practice host (UTEP) has faculty involvement—seven CAHSI department faculty have profiles on the Expertise connector (see <http://expertise.utep.edu/people>). As the Expertise Connector begins to spread to new users, the evaluation team will address satisfaction with the tool, including relevance, usefulness, and usability.

Adopt or Adapt Original Initiatives

There has been interest expressed to the evaluation team from each CAHSI region regarding implementing CAHSI practices that CAHSI institutions have yet to implement, as well as interest from newly engaged institutions in incorporating CAHSI's initial practices (e.g., CS-O, PLTL, ARG, FellowNet), yet the goals in this area have not yet been met. One formal training occurred for ARG in the NorCal region, a newly active CAHSI affiliate funded by coordinated efforts, S-STEM and CAHSI INCLUDES. One formal training was planned for PLTL in the Caribbean region, though the training was rescheduled because of an institutional strike at UPRM. HENAAC engaged faculty from across CAHSI institutions in short informational sessions related to initiatives, yet the time available at the conference was not conducive to full trainings that could lead to implementation.

Adopt or Adapt New Initiatives

CAHSI regional meetings are amassing a list of practices and potential practices for dissemination more broadly. These are just becoming clarified in year 1. Multiple practices across CAHSI institutions appear viable for sharing across campuses, yet to date, none of the new practices have

been shared in a formalized way. The following practices have potential and align with social science that drives CAHSI's current initiatives. Each potential practice is described in brief, including the social science reasoning that would support its use.

CSUDH- Student developed conference

In spring of 2017, a student group at CSUDH decided to create a conference on cybersecurity. With the chair's support and guidance, the student-led organization sought funding from the campus, recruited professional speakers, and designed a competition for participants. In an interview for CAHSI research, the student organizers described the learning process they underwent to develop the conference, and considered the conference a legacy they leave the department. Both intend to assist next year, though they will graduate before the next event. Student conference organizing has the potential to create buy-in from other students, who may not attend a faculty-developed event. In turn, it shifts responsibility for professional activity to students, which can instill confidence and a sense of belonging in the discipline. Through recruitment of professionals in the field the students improve their technical networks in the region as well.

UHD- institutionalizing professional skills training within courses

A PI at UHD learned that students were not well prepared for the job market following their BS in computer science from his institution. By partnering with the career development center on campus, he integrated professional skills such as resume writing and mock interviews into his fall senior seminar course, tying some course grades to participation in career development. These changes are institutionalized within the department within the course, and the career development center supports this effort through presentations, resume review, and mock interviews scheduled in conjunction with the class. This connection with an existing entity ensures that all students get the career assistance they may need (but may not know they need) before they enter the job market. This is a sustainable partnership that uses existing resources. By standardizing the career development across all seniors the practice normalizes middle class social capital that includes how one should prepare for the workforce for all students in the department.

UTEP- integrated student pathways and practices across 2-year and 4-year

UTEP has created multiple ways to integrate community college students into the UTEP CS department, some intentional and some through the El Paso computer science network. Two of the professionals involved in the efforts to usher community college student through computer science 4 year degrees were local community college students with connections to both institutions- thus serving as role models with similar experiences to students who are considering the transfer process. Intentional methods of smoothing transitions include incorporating PLTL as a practice across institutions, creating opportunities for students in leading PLTL at both institutions, and targeted advising by a computer science transfer student advisor.

TAMUCC-evolving CS-O as student populations change

Implementing relevant curriculum that meets students' needs is vital for departmental growth, and TAMU-CC has evolved its CS-O course to focus on student needs as the population shifts. While in past years, CS-O was focused on simple block language commands to satisfy the needs of the novice computer scientist, the department has found the need to simplify coding is less

pressing. They have turned towards new methods of teaching first level coding through MATLAB, a tool used professionally in multiple fields. By providing access to professional-grade computing tools with relevance to other discipline's needs, the course has expanded while still supporting early programming skill development.

INCLUDES (NMSU, UTEP, CSUDH)- development of one-credit problem solving courses that complement the standard CS curriculum

(described within the next rubric element related to faculty collaboration with industry)

Faculty from across CAHSI regions collaborate with their peers and industry supporters to develop academic resources

Problem solving courses will be piloted in the 2017-18 year at 3 campuses across CAHSI. The courses have been developed incorporating consistent, deep collaboration with Google technical staff. The first of its kind for CAHSI, the problem-solving courses are less than the typical 3 credit course, designed to fit within traditional curriculum. The intent is to instill the complementary computational thinking skills and logical reasoning needed to succeed in computer science, and make this content available across different student populations at various stages in their academic pathways. The lack of co- and/or pre-requisites create opportunities to learn across grade levels, and may create new student communities, mentorship opportunities, and social connections that support retention in college (Tinto, 1979). An annual project is expected for the CAHSI alliance impact rubric, and CAHSI has had some indication that Google would like to continue deep partnership in the development of academic resources.

Faculty from across CAHSI regions collaborate with their peers and industry supporters to develop technical resources or technical advances

To date, there have been no cross-institutional technical collaborations reported with industry. However, the collaboration with Great minds in STEM through the HENAAC conference co-location has created a venue for CAHSI to approach industry in new ways- five new companies have begun conversations with CAHSI leadership. It will be important to focus collaborations towards technical research with industry to ensure students are well-prepared for the world of computing work, that faculty have the resources they need to carry out high-quality research, and to develop a more varied ecosystem of support for Hispanics in computing.

Multiple (4 or more) CAHSI PIs served as CAHSI delegates

CAHSI continues its strong representation across partners and institutions, and is beginning to branch into new organizations and organization types. The following organizations have CAHSI representation, meaning PIs support and promote CAHSI within these settings: teacher professional development at the state level, multiple INCLUDES pilots across the nation, American Society for Engineering Education, Computer Science Teacher's Association, Association for Computing Machinery, CRA-W, the Smithsonian Institution, Chamber of Commerce STEM Forum, California State department chairs association, and the American Association of Colleges and Universities. As networking becomes more vital the CAHSI for developing regional ecosystems of computing progress, these roles in other organizations will become more vital to success. It will be vital to include all PIs in this effort, as well as new faculty, staff, and industry affiliates.

Each (or nearly each) CAHSI institution is involved in a collaborative research grant/grant proposal for educational aims

The CAHSI INCLUDES grant, S-STEM proposal, and S-STEM funded project have engaged participants from 3 founding CAHSI institutions and 3 affiliate institutions who are engaging in regional circuits. Many CAHSI faculty described their intended projects in PI interviews, and there were opportunities for engagement across CAHSI for these, specifically the K12 teacher professional development and additional outreach funding to K12 students.

While not directly measured in this rubric, it is clear that CAHSI institutions have had an opportunity to leverage CAHSI to garner support for outreach via Google Ignite CS—nearly all CAHSI schools were *individually* awarded support from the program. A next step in ensuring CAHSI remains engaged in Google Ignite CS could be through recognition as one of the national student groups highlighted in the application: <https://ignitecs.withgoogle.com/>.

Each CAHSI institution is involved in a research grant/grant proposal that leverages CAHSI results, outcomes, and/or initiative strategies to develop new programs of technical research.

There have not been any collaborative technical research grants sought in the past academic year.

Appendix A: Collective Impact Event Rubric

This rubric measures the ways in which activities and events are designed for the following elements of collective impact.	SoCal (Pasadena, July)	NorCal (Merced, Feb)	SW (El Paso, May)
Focus on strategic actions	MET GOAL Documentation via participant notes and observation: flash talks were a new way to bring about discussion regarding actions undertaken at partner sites—each speaker described an activity that others might collaborate or take up on their own;	MET GOAL Documentation via participant notes and observation: participants discussed their assets and how they might collaborate with one another—this activity was given substantial time in the agenda (approx. 2 hours)	MET GOAL During and following the event participants charted strategic actions in two ways—during the meeting on stick notes attached to sections of the pathway in which they were interested in working, and following through their completion of individual action and collaboration forms.
Focus on collaboration and trust-building	MET GOAL Documentation via participant notes and observation: nearly a third of time spent together was in small group discussion scaffolded by presenters—for example, presenters posed specific questions to address in small group work. Dinner was held off-site and provided opportunities to meet others and discuss topics with discussion leaders.	MET GOAL Documentation via the agenda and observation: the ARG workshop components on day 1 served 2 purposes—to assist the participants in learning affinity research group strategies and to build trust among partners within the meeting. Listening exercises and assigned roles with “get to know you” problems such as who traveled the furthest to the meeting were	NOT MET This was the shortest meeting recorded and took place with the group who had participated in the most meetings by May. However, few efforts were made to create opportunities for trust building and collaboration, as most time was devoted to large group or didactic presentation.

		designed to build trust.	
Focus on emergent themes from participants (bottom up, empowerment of participants)	MET GOAL Documentation via participant notes and observation: Dr Gates and Dr. Villa bring a vision, strategy and goals document to the group for review. The group spends approximately an hour reviewing and shifting language to better reflect their priorities. This instance indicates both leadership guidance for strategy AND focus on empowerment of participants.	MET GOAL Documentation via participant notes and observation: Assets building discussions start with participants' skills and knowledge, then build towards collaborative action.	MET GOAL Documentation via notes, participant observation: great care was taken to ensure equal footing across typically hierarchical power relationships—for example, community college faculty were elevated when positioned in a leadership role.
Serve as a guide for strategy (some top-down facilitation)	MET GOAL Documentation via participant notes and observation: Dr Gates and Dr. Villa bring a vision, strategy and goals document to the group for review. The group spends approximately an hour reviewing and shifting language to better reflect their priorities. This instance indicates both leadership guidance for strategy AND focus on empowerment of participants	MET GOAL Documentation via agenda and observation: Dr. Gates and Dr. Villa described the collective impact model in detail-offered the tentative goals for CAHSI regional collaboration, and shared resources related to collective impact	MET GOAL Documentation via agenda and observation: Dr. Gates and Andrea Tirres described the collective impact model and offered the tentative goals for CAHSI regional collaboration as well as the action items they had already identified in previous meetings.
Serve as communicating body beyond meeting	MET GOAL Documentation via email, observation: Sandra Johnson Austin (program manager, CAHSI INCLUDES) followed up on the July meeting with revised documents edited in conversations with all collaborators. Participants were encouraged to engage in the regional activities	MET GOAL Documentation via email, observation: Dr. Zatz (INCLUDES co-PI) communicated with the attendees following the Feb meeting via email. Sent contact list to all and began to schedule further meetings. The email suggested leads at each institution and requested meetings	MET GOAL Documentation via email, observation: Andrea Tirres followed up via email on two occasions, to send homework to the group and to invite the group to the connections cloud resources for the Southwest team.

		with leads in the coming weeks.	
Consideration and discussion of shared measurement	MET GOAL Documentation via agenda, participation/observation, and meeting notes: while no agreements were made regarding shared measurement, much discussion occurred in small groups and large group; an outlined plan was described and discussed related to 3 layers of measurement.	NOT MET There was little to no discussion of measurement in this meeting	MET GOAL Documentation via agenda, participation/observation: CAHSI evaluator shared common measures used, described past work as a way to brainstorm potential ideas; facilitated discussion of common measures of interest across sectors.

Appendix B: Paper accepted for presentation at the ASHE conference

“Together We Make the Department a Better Place”: Students’ Authoring Expert Computing Identities in Service of Peer Development; Hug and Thiry

Introduction

Underrepresentation of women and students of color in science, technology, engineering, and math is a national epidemic. The lack of socioeconomic, gender, and racial/ethnic diversity in computer science is particularly pronounced—only 11% of recent computing graduates were women, while Hispanics comprised only 7% of all Bachelor degree earners (AUTHORS, 2016). Ethnic minorities who are also the first in their families to attend college are less likely to graduate than their peers, especially when they experience a lack of peer support to achieve in higher education (Dennis, Phinney, & Chuateco, 2005). Co-curricular and informal learning opportunities can provide students access to expert thinking in their disciplines, and can improve retention in the sciences (Eagan, et. Al, 2013).

Given the need to understand minority student success in computer science, we explore how students on one campus took a social entrepreneurial orientation to supplement the educational offerings in their small, “less selective,” under-resourced academic computer science department. We focus on the ASHE conference theme of “Power to the People” by highlighting ways in which so-called subordinates (undergraduate students in higher education institutions) contribute to the learning opportunities students experience in higher education. The research question addressed in this paper is: *How and why do student leaders cultivate an inclusive learning environment within a computer science department?*

Conceptual framework

In this paper, we use Holland, Lachicotte, Skinner, and Cain’s (1998) concepts of identity and agency to illustrate the experiences of computer science undergraduate students in creating co-curricular learning opportunities for their less-expert peers. Participant identities are formed and re-formed through routine interactions, activities, and relationships, which are deeply tied to the norms of local and global community practice. While working within the constraints of group membership and relative status, participants within a community have opportunities to create organizational practices that enhance opportunities for expansive learning (Engstrom and Sannino, 2010). In this case, undergraduate students can exhibit agency from their positions as appointed leaders to shift the practices of their local department from the margins.

Drawing also from the work of Maldonado, Rhoades and Buenavista (2011), we consider how *student social praxis* is employed within the department to affect change in student participation in computing. We view this student-led empowerment as essential both to the student leaders’ developing trajectories as leaders within their field and to their peers’ development of social and human capital above and beyond the formal curriculum.

Methods

This study is part of a larger investigation of 8 institutions engaged in a National Science Foundation-funded alliance of computing departments across the United States. All of the

institutions are Hispanic-Serving Institutions, while 5 are also indicated as MSIs in which more than 50% of students identify as a member of an ethnic minority group. The goal of the larger study is to understand how computer science departments create (or fail to create) inclusive learning environments to support student learning. This paper focuses on one institutional case study.

Researchers engaged in participant observation (Spradley, 1980) of an annual Summit and regional circuit events, computer science courses, research group meetings, and other computer science departmental activities. Researchers also conducted focus group and individual interviews with students, faculty, and staff. Document analysis (e.g., syllabus and policy reviews) supplement interviews and observations. Thematic analysis is conducted on an ongoing basis, in which analysts use theory as well as emerging concepts from the data to develop a codebook used across all data sources. Findings can be substantiated across analysts and across data sources through inter-rater reliability metrics.

Data Sources

The qualitative analysis related to student agency and empowerment is based upon interviews with 19 students and seven faculty/instructors, as well as observational data from 13 course activities and one co-curricular workshop. Six of the students interviewed were chosen purposefully based on their roles as departmental leaders of organizations active on campus. The remaining 13 students interviewed were selected at random following their participation in computer science course work or co-curricular activity. All faculty on campus were asked to participate in interviews, and seven scheduled these interviews with researchers.

Preliminary Results

The data presented below describe the activities of student clubs in the computer science department at a “less selective” university in the western United States from the perspective of club leaders. The approach of interviewing student leaders prioritizes the student, rather than the faculty or staff, perspective on the activities developed. In addition, the interviews provide data regarding motivations for developing the learning opportunities enacted on campus. In the context of undergraduate departments, the fluidity of enrollment and the relatively short timeframe of local community membership creates opportunities to author expert identities quickly. Evidence suggests that the more expert student leaders practiced social entrepreneurialism, in which the goal of their innovation was focused on social change and the betterment of the academic department to which they belong (Mars & Rhoades, 2012).

Nurturing safe informal learning spaces

The president of the women in STEM program described what she learned about the needs of her group members at her university through participation in the club in her first year. After performing the administrative tasks needed to ensure the club was in good standing at the university, the president of the group worked to schedule regular meetings with women across departments. She described the meetings as serving a specific function for members—that of providing support and encouragement for one another.

“What I learned over time is that it wasn't as much what the club does per se or how many students attended the meetings. It was more that the time was set aside there for students who needed to attend to provide an atmosphere where we could talk about things and give the emotional support that's needed to be a minority in the STEM field, and to prepare students for when they go out into the workforce where they're still going to be a minority in the STEM field.”

Scaffolding the learning of high level material through student-led workshops

Another upperclassman who served as a president of an organization on campus (IEEE) described his efforts to bring the content knowledge gained in an upper-level course to more students on campus. The senior led day long workshops on the weekends in the student-run computer lab for students interested in cybersecurity.

“After I took my [upper level computing] class, I learned things about the computer and commands. I would do a workshop to teach students how to use Linux for the first time, then from there, how to crack a password. I did a series of workshops how to teach them tools that they could have learned if they took this class, but a lot of people don't because it's a little harder. I delivered the content in a hands-on workshop.”

Infusing the computing department with cutting edge cybersecurity knowledge

A pair of student group leaders described their work to develop a cybersecurity conference on campus to support student learning of modern cybersecurity methods. They developed a day-long conference on a weekend that attracted over 160 participants. The conference had speakers from local technical firms, a hackathon competition, and workshops for those interested in learning more about cybersecurity in parallel tracks for different learning needs.

The organizers described a few ways in which they received assistance from faculty to develop the event, for example, a faculty member with industry experience was asked to assist with the initial contact for local cybersecurity professionals via Linked In once the students selected businesses and professionals of interest, and the department chair assisted with completing paperwork related to use of the campus meeting space. Both organizers plan to graduate before the next event would be scheduled, though both expressed commitment in developing next year's conference.

Preparing students for high-status computing careers

It is after 7pm on a weeknight. Billy stands in the student computer lab near the white board. Five students sit around him, facing the white board. The workshop is an extracurricular event for students to develop skills “thinking on their feet” as needed in a computer science job interview, which often involve hands-on or paper and pencil computational thinking assignments. Billy brought the group together to prepare for interviews with industry giants like Google, expected to be at the job fair held later in the month. Billy starts the meeting, addressing the students who attended: *“We're going to work on arrays and strings. Do you need me to refresh that? Where are you in Data Structures?”* The students respond in unison *“Sorting.”* Billy considers this, and begins: *I'm going to give you a problem but I don't know the answer either. This one is called*

Zero matrix? Who knows what matrix is?" One of the students responds, describing an array. Billy asks, *"Who is weak on '2 by' arrays? I'm weak on 2 by arrays so we're here to practice."* Participants talk through the problem presented, and work together in a conversational style to address the problem in pseudocode.

Billy is another student club president in the computer science department (ACM) who develops student opportunities for learning outside of coursework. His motivation for this workshop was to prepare other students, and himself, for the types of computer science interviews that are common in elite industry interviews. The workshop is similar in focus to a workshop Billy attended at a national conference for Hispanic students in STEM, held locally the previous fall. As a senior, Billy described the need to "get serious" to be competitive in the computer science job market, and his attempt to create a learning community that prepares for intensive interviews common in the field.

Collective responsibility for student advancement

Interviews with departmental student leaders bring to light common themes of collectivism, social responsibility for the learning trajectories of others, and duty to improve and enhance opportunities for those near peers coming up in the department, and in the computing field more generally.

Adjo, a first-generation immigrant from the middle east who admits to struggles with the English language, describes how he interprets his role in the department as an upperclassman and as a student IEEE leader: *"Rather than just do your own work and stuff, you have responsibility for other people. I feel like those people in my club... Not 'my club,' but the club I'm in charge of right now, I felt like I need to make them better. It's not up to them just whatever they want to feel like I should do. Make them somehow to become better in a way, so I'm responsible."* His comment suggests he perceives his positioning within the local computer science community as "more expert" comes with more than just status, it in turn denotes a responsibility for the education of others.

Danielle, a first-generation college student and Caucasian single mother who led the women in STEM club, describes her feeling of belonging and duty to improve her academic department in context of a small, close-knit department where students have regular, collegial access to faculty: *"I enjoy the fact that with the faculty I'm kind of on a first name basis, which is really cool to be a student and have that. I feel like everybody has their place to be able to work together to make the department a better place. I think I've seen it evolve into something better as well since I've been here."* Her description of the department indicates an acceptance of the opportunity to improve the community as a student, and her tenure in the department indicates recent shifts towards inclusivity.

Brett, a Caucasian male community college transfer student, described his role as a senior who frequents the student computer science lab, which is unofficially guided by students in their third or fourth years of study. Of his participation in the lab, he states: *"If you come searching for information, we're here and readily available to give it to you. We want to give it to you. We want to get as many people involved in computer science as possible."* Brett shares a concern for the students in the department in the next years, as he and his peers graduate. *"So everybody that really knew something graduated right when I started here. At first, there was not really*

anybody who knew a whole lot. A couple of students who graduated last year, they really roped me in. But I don't feel like there was a whole lot of (student leaders) and I think that's going to happen again next year." The student leader and his co-leader, a Mexican male community college transfer student, indicated dedication to continue attending the lab as they were available following graduation to support informal learning on campus.

Discussion

In this case study, we highlight the ways in which student leaders, positioned as such by peers and faculty, develop new educational practices in their department to improve student development of human and social capital. The collectivism exhibited by the student club leaders was infused with social entrepreneurial behaviors oriented towards improving student outcomes in computer science. In future work we intend to study local (institutional and departmental) policies and practices that support student-initiated learning opportunities. We will also continue to follow student club leaders to understand how their negotiation of their roles as more expert community participants in computing shapes their peers' development of human and social capital.

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Appendix C: AERA proposed paper for the April 2018 conference

Thiry and Hug

INTRODUCTION

In the coming decade, computing careers are expected to grow at a faster than average rate (BLS, 2015), yet some minority groups (e.g., African-Americans, Hispanics, and Native Americans) are severely underrepresented in this lucrative, high-status field. For example, Hispanics are the fastest-growing ethnic group in the United States, yet only 7% of baccalaureates and less than 1% of doctorates in computer science in 2014 were granted to Hispanic US citizens (NSB, 2016). Many factors contribute to underrepresentation in computing undergraduate education, including lack of access to K-12 opportunities (Clewell & Braddock, 2000; Margolis, 2008), lack of faculty support (Gloria et al., 2005), and negative departmental and classroom climates (Margolis & Fisher, 2002). A smaller but growing body of research has highlighted the factors contributing to underrepresented minority (URM) persistence in STEM, including active learning strategies (Freeman et al., 2014, author, 2011) and undergraduate research, which introduces students to the technical and collaborative nature of STEM disciplines and increases URM graduation rates (Chang, 2008; Clewell et al., 2006; Espinosa, 2011; Jones, Barlow, & Villarejo, 2010). Identity and belonging also influence STEM persistence, especially for women of color (Carlone & Johnson, 2007; Tate & Linn, 2005). Although research has illuminated culturally-embedded reasons for disparities in scientific and technical fields and highlighted some strategies for addressing these inequities, little attention has been paid specifically to the experiences of underrepresented students in computing.

This study seeks to investigate the learning environments that contribute to the success of underrepresented students within computing disciplines. We address the following research question:

- How does a successful department structure inclusive learning opportunities for students in Computer Science (CS)?

CONCEPTUAL FRAMEWORK

We explore inclusive learning environments through the concepts of identity, agency, and structure. This framework posits that identity is formed within and through everyday interactions, activities, and relationships, such as peer interactions in or out of the classroom (Holland, Lachicotte, Skinner & Cain, 1998). Students' persistence necessitates developing a computing identity in which they not only identify as a *competent* actor within computing environments, but are also *recognized* by others as such (Carlone & Johnson, 2007). The third essential element of STEM identity is *performance*, involving the social performance of disciplinary practices and discourses (Carlone & Johnson, 2007), an aspect of identity that has been little explored in STEM higher education research. Students develop identity within institutional and other structures (e.g. historical, economic, or social contexts) which may either constrain or promote identity development (Brickhouse, Lowery & Schultz, 2000). Inclusive departmental structures hold the possibility of countering broader inequities within STEM or higher education by creating spaces where diverse students can thrive in computing.

STUDY METHODS

We present findings from a case study of a computing department at an Hispanic-Serving Institution (HSI). Case studies are ideal for understanding complex systems in a rigorous, holistic, and in-depth manner, such as investigating the interactions and practices that foster inclusive learning environments (Yin, 2003). The department was chosen because it is part of a National Science

Foundation-funded alliance to improve computer science (CS) education at HSIs. These departments have successfully raised graduation rates of women and all URM students and increased course success rates in foundational courses (Author et al., 2011, 2013, 2016). We describe results from a case study of one of these departments.

Interviews and observations were conducted during a site visit to a public, open-access HSI in California in spring, 2017. The department was selected because of its diversity, comprising large numbers of Hispanic students, but also many other URM students, low-income students, first-generation college students, and immigrants. To enhance student success, the department added a preparatory course (CS0) for students with little to no computing experience and added peer leaders to all introductory course (CS1, CS2) sections. A required capstone course was transformed to include a research component. We sought to interview both highly engaged students and more “typical” students. We individually interviewed student leaders of the five student academic clubs within the department. We interviewed the peer leaders who assist with the lab sections of introductory courses. We invited all students enrolled in the transformed courses to participate in focus groups. Focus groups typically ranged from two to four students. We invited all instructors of foundational courses to participate in an interview. We conducted in-depth, semi-structured interviews with participants (Fontana & Frey, 2005). Interviews were digitally recorded and transcribed verbatim. Interviews focused on participant’s experiences within the department and the larger field of computing. Sample interview questions include: “Where do you ‘fit’ in your department?” and “What has supported you in your pursuit of a computing degree?” Pseudonyms have been used to protect participants’ confidentiality. Each transformed course and lab section was observed using the Teaching Dimensions Observation Protocol (Hora & Ferrare, 2013). At 2-minute intervals, an analyst coded various aspects of the course, including the use of specific teaching methods (e.g., lecture with visual, small group work, etc.), student-instructor interactions, and level of student engagement. Analysts also wrote field notes of course observations to capture nuances of interactions and other social phenomenon (Spradley, 1980).

Analysis procedures followed those outlined by Spradley (1980). Codes were generated deductively, based on our conceptual framework (e.g., student-faculty interactions, peer interactions, etc.), and inductively, based on emerging issues that were salient to our participants (e.g., empowerment, upward mobility, etc.). Codes were organized into domains, which represented the larger categories of interest in our study (e.g., technical competence, performative identity, recognition, etc.). Individual codes and broader domains were explored for patterns and compared according to gender, race/ethnicity, or other characteristics.

DATA SOURCES

This paper primarily focuses on student and faculty interviews conducted during the site visit. We conducted four focus groups and seven individual interviews with 19 CS students. Eight students were Hispanic, three were African-American, four were Caucasian, three were Asian/Pacific Islander and one was multi-racial (Hispanic/African-American). Sixteen students were men and three were women. Interviewees reflect the gender and racial composition of the department. We interviewed seven faculty members who taught transformed courses. Two faculty members were full professors, three were assistant professors and two were non-tenure-track adjunct faculty; all were male. We observed seven lecture sessions, four laboratory sessions and one student club meeting.

FINDINGS

Structural barriers to computing access

Almost all student interviewees had little to no computer programming experience prior to entering college. Most students were the first in their family to attend college and had no technical professionals in their immediate families. Many of them started their studies at community college for economic reasons. Students described typing courses at their high schools but not any exposure to programming or computational thinking. Miguel, a multi-racial peer leader stated, “My barriers were academic-wise. My high school wasn’t too good or too smart so I had to learn everything in college, in community college.” Students’ early access to computing was limited, yet many students perceived this barrier as structural, rather than individual. Students focused their attention on deficiencies in their K-12 education, rather than in themselves, and this enabled them to take up the many opportunities provided by their department to address lack of exposure to computing.

Cultivating inclusive computing environments

Faculty structured the core curriculum to provide frequent opportunities for students to gain hands-on, technical experience—in short, to promote students’ technical identity and to allow them to “perform,” or display, their technical competence to faculty and peers. Most faculty believed that they could only foster students’ technical competence in an open and inclusive learning environment. Faculty fostered inclusive climates through intentional, collegial student-faculty and peer interactions. The department was small and under-resourced so faculty often compensated for the lack of financial and physical resources by promoting student-centered pedagogies and being accessible to students, as described by Alejandro.

[My professor] gives out his email, and he gives out his phone number. You send him an email, he'll answer the questions. And he doesn't give you the answer, he provides you hints, but he wants you to struggle, he wants you to learn. He never at any point gives you the answer, but he's always available to answer your questions.— Alejandro, Hispanic male CS1 student

Faculty took an anti-deficit approach to their interactions with students, asserting that structural barriers in low-income communities inhibit students’ incoming knowledge and must be deliberately addressed. A faculty member described his role as an institutional broker to help students navigate their computing pathways.

We have a diverse population of students. They come from underserved communities. They do not have much exposure [to computing]. When they come in, they sometimes get lost. So to make them successful we have to communicate with them, talk with them, and provide them a clear path, and to tell them what lies ahead and motivate them. – Assistant Professor, CS1 instructor

Providing opportunities to perform technical competency

Because faculty mostly took an anti-deficit approach to student learning, the department has woven multiple opportunities throughout the curriculum for students to develop and display technical competence. These opportunities for technical performance were situated within formal learning environments, such as required coursework, and informal settings, such as academic clubs.

Opportunities for performance were provided in formal and informal ways within courses. During the course observation, the instructor, Dr. Khadem, guided the class through a computational thinking activity. Several students in the class were clearly confused, yet Dr. Khadem did not move on until all students had demonstrated mastery. Acknowledging the confusion, he gave a short,

interactive lecture on algorithms and presented another problem. One of the first students to find the solution was a middle-aged, African-American man who had been struggling. Dr. Khadem reviewed his work, and enthusiastically called out, “Yes, that’s correct. Put the answer on the board.” The student smiled broadly as he presented the solution and explained his reasoning to the class. Thus, the opportunity to perform technical competence was not just reserved for the highest-achieving students or those traditionally most privileged in computing (e.g., white or Asian males), but was also offered to struggling students, underrepresented minorities, and non-traditional students, often intentionally so.

Another intentional opportunity for students to perform disciplinary practices was in peer-led lab sessions. These sessions provided opportunities for the peer leaders themselves to perform and be recognized for disciplinary expertise, as described below.

Hector, peer leader: The professor doesn't have time to go to every student so it helps that everyone gets time with [a peer leader] who's at a higher level to help them with projects.

Carlos, peer leader: Sometimes students have questions that are outside the scope of the class, like what they're gonna encounter in subsequent years. Stuff they tend not to ask professors. I think it helps them in that regard.

As a final step in students’ trajectories in the CS major, the department integrated a research project into the capstone course. During each class session, students presented research progress to the class, and were recognized for their growing expertise. A student reflected on the influence of the course on his own CS identity as he came to realize that he could perform equally to his peers, as he had no exposure to computers as a youth in the Philippines.

Having no experience, I guess you could call it imposter syndrome, you feel like you don't measure up to your peers... Being in this class, I've been able to successfully create the components. It informed my outlook into seeing me and the people in this room as equals now.– Rafael, Asian-American male

CONCLUSION

Everyday interactions, particularly between students and faculty, as well as intentional opportunities for performance within the curriculum cultivated inclusive learning environments and shaped students’ technical identity development. The systematic integration of performative activities into required courses was particularly salient in a department where students’ socioeconomic status shaped their early experiences with computing. In conclusion, this study demonstrates the significance of performance and displays of competence in non-dominant students’ learning experiences and identity development and highlights some of the ways in which a successful department cultivated an inclusive learning environment.

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All of the CAHSI departments reported K-12 activities that built upon CAHSI initiatives. They did so in many ways—for example, CS-0 course content was provided to younger students, peer mentoring occurred with high school students leading middle school students, high school students mentored middle school students, or collaborative undergraduate research practices were incorporated into summer camp opportunities. This is the first year that all institutions described K-12 outreach that they linked to their experience in CAHSI. Over half of the institutions (5 of 8) described innovations that occur on their campus, either by using existing CAHSI initiatives or in initiating new ways of educating youth. Some examples include: creating competitions for youth as a part of K-12 and community college outreach, developing a cohort model for ARG, and designing highly interdisciplinary courses for entering college students. With careful cultivation, these innovations could add to the body of work of CAHSI. CAHSI could capitalize on funds allotted to social science research efforts to better understand the capacity of other CAHSI institutions to take up these practices.

Funding issues remain in terms of CAHSI's long-term sustainability- in fact, not much has changed in terms of funding for initiatives through CAHSI versus other sources since last year. While course development and outreach is nearly always internally-funded, additional resources are usually needed for peer led team learning and research, as well as MentorGrad when the program exists at the

college. The new model for industry funding may create alternative funding sources for CAHSI initiatives, particularly those related to research.