NATIONAL SCIENCE FOUNDATION
BROADENING PARTICIPATION IN COMPUTING

CAHSI ANNUAL REPORT

RECRUITING, RETAINING, AND ADVANCING HISPANICS IN COMPUTING

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EXECUTIVE SUMMARY

The Computing Alliance of Hispanic-Serving Institutions (CAHSI) is a partnership of ten higher education institutions with the mission of increasing the number of Hispanics pursuing bachelors and advanced degrees in computing.[1] To achieve these goals, the alliance has implemented multiple interventions across three critical educational transitions: high school to college; undergraduate to graduate study; and graduate study to the professoriate. CAHSI institutions are producing high numbers of computing bachelor degree earners, still above the number of graduates from 2002, a peak year in the nation. While Taulbee data (a record of computing degree production across 150 universities and colleges across the nation) shows a decline to 48% the number of 2002 degree completions, CAHSI continues to produce more computing degrees than they did in 2002. CAHSI schools continue to produce a large number of Master's degree recipients, particularly Hispanic Master's degree earners. In fact, in the first full years of CAHSI, seven CAHSI schools served the equivalent of 15% of the Hispanic MS computer science earners from the entire Taulbee database of 150 schools. Future reporting will focus on those students who graduate from undergraduate programs in CAHSI schools and later enroll elsewhere, so that we can gain information about the advancement of all Hispanic computing professionals engaged in CAHSI.

PEER-LED TEAM LEARNING (PLTL) ENHANCES COMPLETION RATES IN CHALLENGING COURSES IN THE MAJOR

PLTL courses are designed to provide academic and social support to students enrolled in critical, "gate-keeper" courses in the major that are required to advance to a computing degree. PLTL implementation in CAHSI departments focuses on cooperative and active learning as structured methods to support student learning in a positive classroom environment. Statistical analysis of institutional records of students' course completion rates prior to and after the implementation of PLTL indicate that PLTL has significantly increased students' retention in these courses. Prior to PLTL, 77% of students in CAHSI departments completed the course, while 87% of students completed the course after the implementation of PLTL. This ten percent increase in course completion translates to an added 89 students finishing critical courses in the major over what would be expected before PLTL courses were implemented. Likewise, Hispanic students showed significant increases in course completion after PLTL was implemented—a six percent increase in course completion translates to an added 31 Hispanic students completing PLTL courses. Finally, course completion rates for women increased by 13% (from 74% of women to 87% of women completing key courses in the major).

Enhanced course completion rates in PLTL courses most likely result from the collaborative work environment, active learning opportunities, and peer mentoring afforded in the courses. PLTL students completed a survey based on the Social Cognitive Career Theory (SCCT) constructs developed by Lent, et al. (2005). Between eighty and ninety percent of students surveyed showed gains/positive values across all of the survey constructs, including increased self efficacy (or sense of proficiency in computing); ability to cope with a difficult major; greater commitment to educational goals; enhanced career outcome expectations that computing is a rewarding and valuable career; greater access to social support; and increase in interest in computing.

Peer leaders gain 21st century career skills and competencies

Over the years, the CAHSI evaluation has collected data from 89 PLTL leaders across six institutions. Peer leaders are students who have previously excelled in the course and lead supplemental active, cooperative learning to support student learning. Peer leaders have reported that they gained many skills and competencies from their peer leading experience that are sought in the 21st century computing workforce. According to the Accreditation Board for Engineering and Technology (ABET), academic programs focused on engineering and technical fields must provide opportunities for students to develop group work skills and the ability to communicate effectively (ABET, 2009). Peer leaders at CAHSI institutions indicate the program facilitated their development of so-called "soft" skills vital in a team-based, design-oriented industry like computing.

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[1] While ten institutions are now members of CAHSI, this grant supports the original seven, and so data will reflect the seven original institutions. See SACI for data on the newest members of CAHSI.

The majority of peer leaders (60-83%) reported that leading PLTL sessions enhanced their teaching skills, leadership and communication skills, and deepened their computing content knowledge.

CS-0 COURSES DO NOT ENHANCE ADVANCEMENT TO CS1 COURSES, BUT DO INCREASE STUDENTS' POSITIVE REGARD FOR COMPUTING CAREERS

CS-0 courses are meant to introduce students to computer science and possibly interest students in continuing on into the computer science major. CS-0 analyses are two-fold—evaluators ran analyses of student level completion for CS-0 courses and the next course in the sequence, CS-1. In addition, evaluators received survey data from CS-0 students regarding their interest and impressions of computing following the CS-0 course. Surveys were based on the same SCCT constructs as the survey administered to PLTL students.

At all institutions, 86% of students finished CS0 courses. Individual institutions ranged from 63% to 91% in their completion rates. Eight percent of students passed CS-0 and then passed CS1. Thirty-five (35) out of 1519 (or 2%) entered CS1 but did not pass. Of those students entering CS1 from CS-0, 78% finished CS1, which is slightly higher than the 75% for the general CS1 population. Women had slightly higher rates of completion in CS1 courses than men (76%, 75% respectively), although this difference was statistically and practically non-significant. Hispanics who had taken CS-0 completed CS1 at higher rates than Hispanics who had not taken CS-0 (79%, 76% respectively). The difference is not statistically significant. The lack of impact of CS-0 on students' course advancement in CS/CE majors may be due to the different populations served by the CS-0 course across CAHSI. Some CS-0 courses are designed for majors without a strong programming background, while other courses are designed for non-majors or for other general student populations. Qualitative survey data also indicate that most students who enroll in CS-0 without an intention to major in CS enjoy the course but do not change their major intentions.

However, students' interest in computing and positive regard for computing career increased from participating in CS-0. Over three-quarters of students reported increases on the interest scale from their experience in CS-0 and close to 90% of students reported higher regard for careers in computing. Although the CS-0 course is not recruiting students into the major as originally expected, the course appears to spark student interest in computation and computing careers.

AFFINITY RESEARCH GROUPS (ARGS) SOCIALIZE STUDENTS INTO THE COMPUTER SCIENCE RESEARCH PROFESSION

Affinity Research Groups (ARG) emphasize the deliberate and intentional development of the technical, intellectual, communication and professional skills and knowledge required for research (Gates et al, 1999; Kephart, Villa, Gates, & Roach, 2008). In the Affinity Research Group, undergraduate researchers are exposed to increasing levels of independence, responsibility, and technical sophistication. Affinity research group students completed a modified version of the Undergraduate Research Student Self-Assessment (URSSA), assessing their growth and development in research, communication, collaboration, and career skills. Student means on the research gains scales have changed little from year to year—they typically range from 3.2 to 3.4 on a 4.0 point scale. Students rated their gains in "personal growth"—or increased in confidence and interest—and "collaboration/teamwork" as their strongest gains from participating in ARGs. While participation in Affinity Research Groups clearly benefited all students, Hispanics consistently reported higher gains than their peers. Though not statistically significant, Hispanics reported higher gains than non-Hispanics in four out of five areas (personal growth, collaboration/teamwork, intellectual gains, and career preparation). On the other hand, men reported stronger gains than women on all survey scales.

Participating in ARGS also influenced students' educational aspirations: 79% of students reported that they are more interested in graduate school after their ARG experience. Students are also more prepared to enter graduate school. ARG students have authored or co-authored journal articles at twice the rate (13%) of a large, diverse national sample of REU students, and presented a paper or poster at a national conference at three times the national rate (51%). Note that these differences are statistically significant at the 0.05 level, indicating that ARG students are becoming well-prepared for graduate school. To determine actual graduate school enrollment rates of CAHSI students, the evaluation team has begun to work with the National Student Clearinghouse to track students' enrollment in other academic institutions after they have graduated from CAHSI institutions.

Though ARG students are interested in graduate school, few students seem to be taking steps to achieve this goal. ARG students who identified themselves as junior or senior undergraduates were asked to complete an extra set of survey items about their intentions and actions to pursue graduate school. Students clearly had strong *intentions* to take the GRE and apply to graduate school (74% and 80% of students, respectively), yet only three students had actually applied to graduate school. Nearly three-quarters of ARG students reported that someone had provided guidance and advice to them about the path to graduate school. Therefore, most students seem to have adequate access to guidance and advice about career and educational planning, yet they do not appear to be turning their intentions into concrete actions.

CAHSI ANNUAL MEETING EXPANDED PARTICIPANT'S NETWORKS IN A SUPPORTIVE ENVIRONMENT

One of CAHSI's key initiatives is their annual meeting with the goals of: fostering cross institution collaborations, providing opportunities for students and faculty networking, serving as a forum for advanced discussion of computing and computing careers, and disseminating CAHSI's interventions to an outside audience. Annual meetings attendees completed a follow-up electronic survey several weeks after the meeting to assess the impact of the meeting on participants' knowledge, networks, and career behaviors. Student survey participants reported similar rates of post-conference networking activities to students in previous years—46% of students had followed up with another student and 39% of students had contacted a faculty member after the conference. CAHSI students also advanced their academic careers across the academic computing pipeline following their participation in the annual meeting, which focuses much student content on the values and goals of MentorGrad- the CAHSI initiative charged with supporting student advancement to graduate school. Students near the beginning of the career path applied for scholarships (29%), inquired about graduate school opportunities (49%), and submitted applications for graduate school (26%) following the annual meeting. These responses indicate possible increase in action towards graduate school following the annual meeting, as students who replied to ARG surveys approximately six weeks earlier had completed fewer related tasks. When asked what sets the CAHSI annual meeting apart from other conferences, participants mentioned that CAHSI focuses more on diversity, offers more opportunities for networking, and creates a more personal, supportive atmosphere than is typically found at professional conferences.

FACULTY PERCEIVE POSITIVE CHANGES IN DEPARTMENTAL CLIMATE FROM CAHSI

Another BPC goal is to support positive climate or cultural change. Until now, the evaluator's focus on departmental culture has been on students' perceptions of a positive environment to work and learn, yet as CAHSI expands and sustainability and replicability become more prominent issues, we have shifted focus to those who impact culture more directly—faculty. For CAHSI to be sustained, the effort must permeate departments, leading to lasting change. Thus, 40 faculty members at CAHSI institutions completed a survey about faculty participation in CAHSI initiatives, and the impact of those initiatives on departmental climate and student-faculty interactions. Trends in CAHSI faculty awareness data show a critical mass of survey respondents engaged in CAHSI early in its development (fall 2005), and a gradual increase in CAHSI participation can be seen over time, from 13 faculty and staff to 28 across seven institutions. Faculty reported that they are involved with CAHSI through mentoring students, teaching CS-0 or PLTL courses, and developing curriculum. Mentoring a research student was the most common activity. Over three-quarters of faculty who were aware of CAHSI perceived a positive change in departmental climate since the inception of CAHSI. Additionally, nearly half (45%) of faculty reported that they have more frequent interactions with students since CAHSI began.

CAHSI HAS DEVELOPED, OR IS DEVELOPING, ORGANIZATIONAL CAPACITY TO SUSTAIN THE CAHSI COMMUNITY AND ITS MISSION

The *CAHSI organizational capacity rubric* measures the extent to which CAHSI departments have developed resources, infrastructure, and human capital to support and sustain their efforts. In most areas, CAHSI has begun to develop the infrastructure and organizational capacity needed to achieve their goals in the coming years. CAHSI institutions have been able to train faculty through widespread hosting and leading of training for faculty and students at member institutions and joining institutions, and CAHSI's reach towards undergraduates has been strong- with each university able to provide research experiences to students and nearly all providing individualized training to a large number of undergraduates regarding graduate school application.

CAHSI IS PREPARED FOR SUSTAINABILITY AND GROWTH IN SOME AREAS

The *CAHSI alliance rubric* illustrates the elements of funding, dissemination, and extended collaboration internally and externally, that CAHSI needs to prepare for sustainability and growth beyond the years of the grant, with emphasis on cultivating dispersed leadership, extended linkages among partners, maintain resources, and further development of organizational knowledge and expertise. In several areas, CAHSI is still developing its capacity to disseminate its materials and expand its reach. Areas in which CAHSI is still developing impact include website dissemination and cross-institutional research collaborations and grant proposals. Areas in which CAHSI has been determined to have "exemplary" impact are cross-institutional funding for education/service, departmental-level funding contributions, organization-wide resources, and faculty dissemination of CAHSI activities or achievements.

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DEVELOPING COMPUTING PROFESSIONALS: CAHSI INSTITUTIONS IN CONTEXT

CAHSI INSTITUTION DEGREES

Institutional data from CAHSI schools were compared to national data sets of undergraduate completion rates in computing fields, in particular the Computing Research Association Taulbee survey (Vegso, 2009). CAHSI degree production is maintained above the 2002 peak for the nation- in fact, while Taulbee scores fell to 48% of the 2002 high for national Bachelor degree production in computer science, CAHSI schools remain above the 2002 figure, even with a slight decline in the last two years. See figure below.

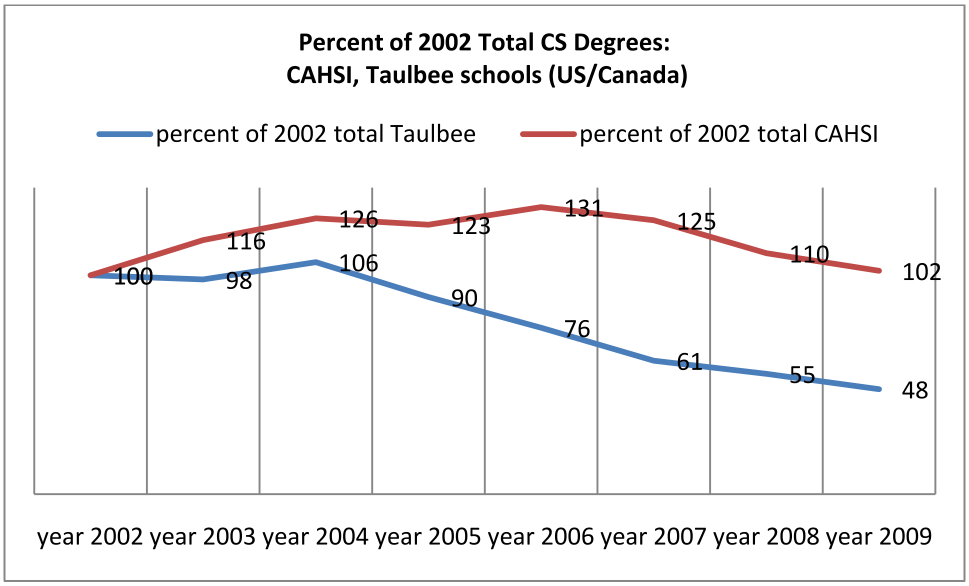

Figure 1: CAHSI schools in context: Comparisons with Taulbee computer science BS degree data

Enrollment data has been requested for each school as well, and will be reported in a supplement to this annual report when al data is available. Taulbee data does suggest a rebound across the country in computer science enrollment, and this trend will be measured against CAHSI enrollment information.

CAHSI schools are producing a relatively large proportion of Hispanic graduate students in MS programs—from 8 to 11 times the national (Taulbee) rate in computer science and from 16 to 28 times the national (Taulbee) rate in computer engineering. Taulbee schools average a steady 2% Hispanic graduation, while CAHSI schools are stable at 1 in 5 MS computer science students, and between 1 in 3 and 1 in 2 computer engineering students are Hispanic, according to IPEDS data for CAHSI institutions.

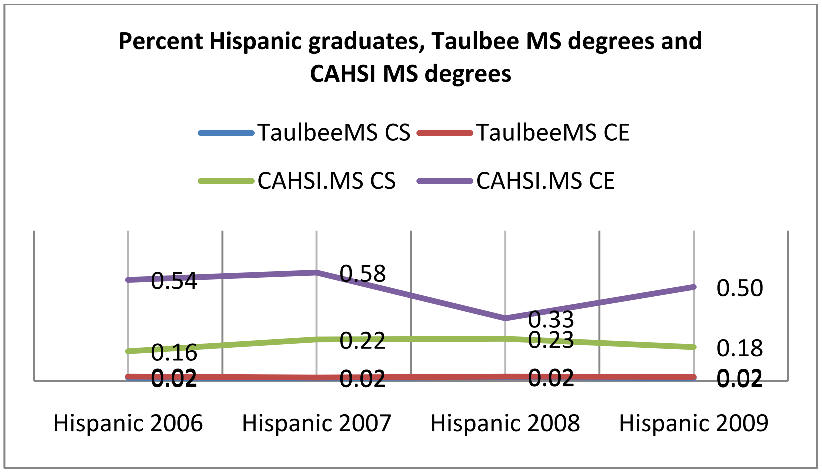

Figure 2: CAHSI schools in context: comparison with Taulbee in percent Hispanic graduates

Comparing raw numbers of graduates, we see that during four CAHSI years for which graduation data is available, member institutions produced an equivalent of 15% of Hispanic MS computer science graduates from Taulbee schools, which report on an average of 150 departments in the United States. Comparisons with Computer Engineering are strong as well, though the number of departments being compared is less striking—CAHSI schools graduated the equivalent of 68% of the Taulbee reported CE Master's degrees earned by Hispanics. Note, we describe these as comparisons and not true proportions of the total number of Hispanics graduating from US departments in the Taulbee data because not all CAHSI schools are part of the Taulbee data set of 150 departments.

Table 1: CAHSI institutions in context: MS production for CAHSI schools in comparison with Taulbee schools

Number of departments in sample	Sample		Total MS produced, 2006-2009	Total Hispanic MS produced, 2006-2009
147-156 CS depts; 10-12 CE depts	Taulbee totals with ethnicity information	MS CS	25332	441
		MS CE	3010	70
5-6 CS depts; 3 CE depts	CAHSI totals	MS CS	344	67
		MS CE	100	48

CAHSI STUDENT PROGRESS

The above data shows progress made in graduating Hispanic students within the CAHSI institutions. The data does not show, however, whether and how undergraduate degree earners at each institution engage in post baccalaureate study. Evaluators for CAHSI are partnering with Institutional Research Offices at CAHSI schools to discover when and if CAHSI graduates enter graduate school following their BS. The National Student Clearinghouse retrieves data on individual students from 3,300 United States colleges, which serve 92% of undergraduate student populations on the US mainland.

Requests were made for each institution to create a list of undergraduate computing degree earners over the 2002-2010 school years. These names were provided to the National Student Clearinghouse, and the non-profit organization is in the process of reporting to evaluators whether the students on the list later enrolled in a college or university. The goals of this analysis are to compare the pre-CAHSI rates of graduate school enrollment and completion to post-CAHSI rates of graduate school enrollment and completion. Effects of time since degree are accounted for in our analyses by comparing overall enrollment rates as well as "two years from graduation" enrollment rates for pre-CAHSI and post-CAHSI comparisons for graduates in years 2002-2008. These data are expected for a January 2011 supplemental report.

PLTL: ENHANCED COURSE COMPLETION, REGARD FOR COMPUTING, AND LEADERSHIP DEVELOPMENT THROUGH COLLABORATION

PLTL IN CAHSI

The CAHSI academic computing departments have adopted a novel approach to the peer-led team learning workshops first developed by City College of New York in the mid-nineties (Roach & Villa, 2007). PLTL implementation in CAHSI departments focuses on cooperative learning as a structured method to support student learning in a positive classroom environment focused on active-learning strategies. The PLTL model as implemented throughout CAHSI hinges on the components found in cooperative learning: positive interdependence, individual and group accountability, group processing, social skills, and face-to-face promotive interaction (Johnson, Johnson & Smith, 1991; Sperry & Tedford, 2008). During the PLTL sessions, students create a learning environment that is far different from the traditional classroom. In this non-traditional setting, cooperation and participation are encouraged over competition and individualism.

IMPROVED COURSE COMPLETION

Because of PLTL efforts, student retention rates have increased in critical, gate-keeper courses in the computing major. Institutional data of course completion rates were compared to examine the effects of PLTL on retention in these gate-keeper courses. Institutional data for student course completion was collected prior to and after the implementation of PLTL so we could analyze whether PLTL impacted the rate of course completion. We used two types of statistical analyses: the Chi-square statistic ($\chi 2$) tests if the percentage of students in certain categories are significantly different from each other (e.g., do PLTL and non-PLTL students in the same course differ from each other in rates of course completion), and logistic regression models test whether participating in PLTL predicts course completion when other variables are held constant.

The use of PLTL in computing courses significantly impacted students' course completion rates. Comparison of all students at CAHSI institutions using chi-square analysis shows a significant effect favoring PLTL, $\chi 2(1, N=5195)=53.07$, $p<.01$. In other words, students were significantly more likely to pass and complete the PLTL version of the course than the non-PLTL version of the course. Additionally, logistic regression at all schools showed a positive effect for PLTL participation on course completion even when other variables were held constant. Logistic regression at all schools also showed significant effects for Hispanic ethnicity, indicating that PLTL was particularly effective in increasing the retention rate of Hispanic students.

Our study indicated implementing PLTL significantly impacted students' course completion rates in "gate-keeper" courses that are necessary to advance in the major. Prior to PLTL, 77% of students in CAHSI departments completed these courses. In contrast, 87% of students completed these courses after the implementation of PLTL. This 10% increase in course completion translates to an added *89 students* finishing critical "gate-keeper" courses in the major over what would be expected before PLTL courses were implemented. Although a 10% increase in course completion rates may seem modest, it can be viewed as a significant achievement given the challenges to academic advancement faced by many CAHSI students (e.g., non-native English speakers, under-preparation in mathematics, financial struggles, etc.).

Moreover, participating in PLTL appears to have benefited the course completion rates of all students, regardless of ethnicity. However, the percentage of women and Hispanics completing PLTL courses rose at a greater rate than that of men and non-Hispanics. Hispanic students showed significant increases in course completion after PLTL was implemented, $\chi 2(1, N=2716)=17.4$, $p<.01$. The table below displays the percentages of course completers before and after PLTL disaggregated by gender and ethnicity.

Table 2: Completion rates for all schools before and after PLTL

		PLTL		
		BEFORE PLTL	AFTER PLTL	Difference (After PLTL – Before)
		Percentage of course completers		
GENDER	FEMALE	74%	87%	13%
	MALE	78%	87%	9%
HISPANIC	NON-HISPANIC	80%	84%	4%
	HISPANIC	86%	92%	6%

In conclusion, CAHSI initiatives seem to have increased students' retention rates in the major at a time of national decline in CS/CE degree production. Additionally, PLTL increased students' course completion rates in challenging, gate-keeper courses (Sperry & Tedford, 2008).

BENEFITS FOR LEADERS

Over the years, CAHSI evaluation has collected data from 89 PLTL leaders across six institutions. In this annual report, we detail the benefits gained from those who mentor less experienced computing students. We note three main gains garnered from leading PLTL sessions: teaching skills, leadership and communication skills, and enhance content knowledge.

Data were collected at the end of each semester from 89 peer leaders over five college semesters and six institutions using an electronic survey system. Peer leader coordinators and faculty from each school sent the survey to all leaders, ranging from two to 10 leaders per institution each semester. Each survey administration measured a semester of work as a Peer Leader—items asked participants to respond based on their leader experience that semester. The majority of items used the following scale: 1= strongly disagree, 2=disagree, 3= agree, 4=strongly agree, 5= I don't know/Not applicable. The rating of ―5 was described as "missing" in the statistical software program, so as not to inflate means with irrelevant responses.

Developing teaching skills in PLTL

Seven items from the Science Teaching Efficacy Belief Instrument (STEBI) (Riggs & Knochs, 1990) were modified for use with Peer leaders to examine growth in teaching skill. While most computing scientists do not intend to pursue teaching careers, the skill of conveying computational ideas to others is certainly useful in many professional roles. Table 3 shows the frequency and proportion of individuals who agreed or disagreed with the seven statements, and the mean score for each item. The table also shows the composite scores for individuals averaged across the seven items. The Cronbach's α=0.85, suggesting strong internal consistency, a measure of reliability across the items. This value indicates the scale is robust.

Table 3: Peer Leaders' Teaching Skill development Peer Leader's Teaching Skill Development

Table 1:Peer Leaders' Teaching Skill development Peer Leader's Teaching Skill Development			
Item (N=88)	Percent Agree	Percent Disagree	Mean Score (4 point scale)
Leading PLTL has improved my teaching skills	80%	20%	3.20
I am confident in my ability to help students understand computing concepts	83%	17%	3.17
I generally facilitate PLTL sessions effectively	79%	21%	3.02
I am confident in my ability to motivate students	75%	25%	3.01
I often think of better ways to facilitate PLTL sessions	79%	21%	3.01
*I am uncomfortable addressing students' questions	69%**	31%**	2.93
(**percentage agree is reversed, shows comfort addressing questions)*[2]			
*When I put more effort into my PLTL lessons, I see little change in students' achievement	60%**	40%**	2.61
TOTAL = COMPOSITE VARIABLE	80%	20%	3.00

Results show that most students (60-83%) view PLTL as an experience that supports teaching skill development, particularly when teaching skill is defined in terms of active learning, where teachers are guiding students rather than simply presenting information. Negatively worded items "I am uncomfortable addressing students' questions" and "When I put more effort into my PLTL lessons, I see little change in students' achievement" show the lowest scores in this construct, and had more "I don't know" and "Not applicable" responses than any other items, a possible indication of confusion based on item wording. ANOVA analyses indicate that returning leaders rated their development of teaching skill slightly higher than beginning peer leaders ($F=4.804$, $\alpha=0.03$)

In open-ended survey items, leaders described what was difficult about their role in the computer science curriculum. One survey response indicated an understanding of teaching as a difficult skill to master, given students' varied levels of understanding and multiple preferred learning styles.

"The main challenge is trying to come up with effective sessions. Every student has a different type of learning style and also learn on different levels. So trying to keep the sessions so everyone is learning is sometimes hard."

Another leader described her effort to be an enthusiastic, group-work oriented, responsive facilitator.

"Strategies I use as a peer leader are to go into each session enthusiastically, talk to the students, put them into small groups, and walk around to make sure the students are working together."

Leadership and Communication Skill Development

According to the Accreditation Board for Engineering and Technology (ABET), academic programs focused on engineering and technical fields must provide opportunities for students to develop group work skills and the ability to communicate effectively (ABET, 2009). Peer leaders at CAHSI institutions indicate the program facilitated their development of so-called "soft" skills vital in a team-based, design-oriented industry like computing. Five items were developed based on informal data collected from staff, leaders, and project coordinators during the first semesters of CAHSI's implementation of PLTL. Cronbach's alpha (0.93) indicates strong relationships among responses to these ―soft skill‖ items. See table below.

Table 4: Peer Leaders' Leadership and Communication Skill Peer Leaders' Leadership and Communication Skill development

Peer Leaders' Leadership and Communication Skill Peer Leaders' Leadership and Communication Skill development			
Item (N=89)	**Percent Agree**	**Percent Disagree**	**Mean Score (4 pt scale)**
Leading PLTL has improved my oral communication skills	**81%**	**19%**	**3.21**
Leading PLTL has improved my leadership skills	**79%**	**21%**	**3.06**
I know the steps necessary to effectively communicate computing skills	**81%**	**19%**	**3.05**
Leading PLTL has improved my interpersonal skills (in other words, my ability to cooperate with others)	**77%**	**23%**	**3.05**
****Leading PLTL has improved my decision-making skills3**	**76%**	**24%**	**2.91**
TOTAL = COMPOSITE VARIABLE	**82%**	**18%**	**3.03**

According to survey data, the majority of students who lead computing PLTL workshops improve in communicative abilities vital to success in engineering professions. Between 76-82% of leaders indicated growth in soft skills related to communicating concepts, leading a team, and making decisions.

One student who gained communication skills as a peer leader described the greatest challenge of leading the workshops:

"I think the greatest challenge for me was actually getting up there in front of everyone and talking to them."

Content Knowledge Development

Perhaps the greatest benefit for leaders is that of increased content knowledge. As leaders consider problems to pose to their students, they must solve them as well as develop strategies for guiding their peers towards deeper understanding. This differs in some ways from teaching assistant roles, in which giving hints or perhaps providing correct answers is sometimes the norm. In PLTL, leaders attempt to *guide* students to the necessary concept or problem solving strategy. The PLTL leader survey included FIVE items related to the peer leader's content knowledge, two of the items explicitly reflecting leaders' change in content knowledge attributed to leading peers. Cronbach's alpha (0.79) suggests a moderate to strong relationship among items, and indication of a reliable "content knowledge" construct.

Table 5: Peer Leaders' Content Knowledge Development Peer Leaders' Content knowledge development

Peer Leaders' Content Knowledge Development Peer Leaders' Content knowledge development			
Item (N=89)	**Percent Agree**	**Percent Disagree**	**Mean Score (4 point scale)**
I understand computing concepts well enough to be an effective peer leader	**82%**	**18%**	**3.18**
I am typically able to answer students' computing questions	**83%**	**17%**	**3.17**
***I question whether I have the necessary skills to facilitate peer-led team learning**	**82%**	**28%**	**3.13**
(*percentage agree is reversed, shows respondent does have necessary skills)*			
Leading PLTL has increased my computing knowledge	**71%**	**29%**	**2.94**
Leading PLTL has improved my study skills	**56%**	**44%**	**2.62**
TOTAL = COMPOSITE VARIABLE	**82%**	**18%**	**3.04**

Items in this section refer to students' confidence in having content knowledge in general, as well as the impact of leading PLTL on their study skills and computing knowledge. Results show that peer leaders are largely confident regarding their content knowledge following a semester of peer leading (82-83%). A majority of leaders also state the experience increased their content knowledge (71%) and a smaller fraction said it improved their study skills (56%). Anecdotal evidence from conversations with leaders indicates being a peer leader takes time, and that this additional work time may detract from time to study. Comparison across groups indicate returning students develop greater content knowledge based on their peer leading experience ($F=4.774$, $\alpha=0.032$).

One student described the influence of the program on his interest and knowledge of computing:

"*(Being a peer leader) has sparked my interest in computing even more… my foundations of computer science have been fortified by being a peer leader, I feel more confident about the material, not to mention that I have also learned from the students."*

Another student said:

"(Since becoming a leader) I like teaching, I got more involved, and I feel more comfortable and secure now with my knowledge."

Overall Peer Leader Results

Results from 89 peer leaders over five college semesters and six institutions signify that leading sessions designed to engage peers in understanding concepts of computer science has clear benefits for the majority of leaders. In particular, peer leaders develop teaching skills, communicative abilities, and content knowledge in their discipline. While current results are based on self-report, future studies will incorporate faculty assessment, retention rates in the major, and GPA to see if peer leaders' academic data show similar positive impact from the experience. The results of our study indicate that academic departments could benefit students by providing peer-leading opportunities.

This work suggests further study into retention in computing for those who lead workshops for their peers. The strong confidence in ability and content knowledge of leaders following their experience as leaders, and development of relevant skills and abilities that support computing professionals suggest leading workshops, as well as attending workshops, may improve retention. In the words of one leader:

"As a peer leader, I realized I'm capable of much more, and learned to love Computer Science!"

PLTL STUDENT OUTCOMES

Students enrolled in PLTL courses (courses receiving one hour per week of undergraduate student-led activities/instruction) were asked to take a survey during the final days of the semester. This interim report focuses on 187 student responses obtained in December 2009 and April 2010. The majority of students were Hispanic (74%, or 128 of those reporting ethnicity), most were computer science/computer engineering majors (73% or 128 of those reporting major) or math majors (14% or 24 of those reporting major). The vast majority of PLTL students were male (70% or 121 of those reporting gender), though this proportion of males is less than expected given current female graduation rates in computing disciplines. Eighty percent of students responding to the survey attended most PLTL sessions (76-100% of the sessions). Participants were fairly well experienced with mathematics courses needed to succeed in computing- 70% state they have taken 3 or more math courses at the time of the survey. Students were fairly new to computing coursework, however, as 43% had never taken a computing course before their PLTL course, and 25% had taken only one other computing course.

Surveys were adapted from Lent's 2008 Social Cognitive Career Theory instrument, which measures student self efficacy, student coping efficacy, student interest in the field, student educational goals, student outcome expectations of the major, and student perception of social supports and barriers. The instrument was obtained from Dr. Robert Lent of the University of Maryland, and was modified to indicate change based on PLTL course experience. Overall student averages for each of the sub scales are reported in the table below. All items were adjusted to indicate positive values, where 10= strongly agree/very likely/greatly increased intention. Note that a neutral response would occur at 5.5, and all mean values are between 7.04 and 8.04, indicating the PLTL course positively impacted students.

Between eighty and ninety percent of students surveyed showed gains/positive values across all of the Social Cognitive Career Theory constructs, including self efficacy, coping with a difficult major, strongly held educational goals and educational outcome expectations for themselves, access to social support, and increase in interest in computing. No significant differences were detected in subscale mean scores when comparing men and women, Hispanic students with non-Hispanic students. Computer science and engineering majors had higher average scores across all categories, and this difference was statistically significant for each construct. The sections below describe a few key findings and provide qualitative data that further explains the quantitative findings. See appendix A for a list of all constructs and their definitions.

Table 6: PLTL Student Average Scores on Social Cognitive Career Theory Constructs (Lent, et. al., 2008)

PLTL Student Average Scores on Social Cognitive Career Theory Constructs (Lent, et. al., 2008)					
SCCT constructs (Scale of 1-10)	**Number of students**	**Percent reporting increase/ positive ratings (5.50 or better average)**	**Number of students reporting increase/ positive ratings (5.50 or better average)**	**Mean**	**Std. Deviation**
Computing Self Efficacy	**186**	**89%**	**165**	**7.73**	**1.87**
Coping Self Efficacy	**182**	**86%**	**157**	**7.23**	**1.8200**
Educational Goals	**187**	**90%**	**169**	**8.04**	**2.32**
Outcome Expectations	**179**	**89%**	**160**	**7.99**	**1.9956**
Social Supports/Barriers	**175**	**90%**	**157**	**7.04**	**1.45**
Computing Interest	**169**	**80%**	**135**	**7.36**	**2.397**

Self Efficacy[2]

> *Self Efficacy- A student's judgment of his or her capability to perform effectively as a computing/engineering major*
>
> *"Excel in your discipline over the next two semesters"*

In open-ended comments, students described the influence of PLTL on their sense of self-efficacy in their major. One student described the way a Peer leader served as a role model of confidence in computing.

"My peer leader's unwavering confidence rubbed off on me greatly… (peer leader)has put inside me the confidence to take on multiple CS classes at once next semester, and I know I can do it because I am so confident."

Another student was intimidated by the course, but found it was less difficult than he first imagined it would be.

"I found that I could do the work. I thought the courses might be crazy rigorous, but they turned out not to be bad at all."

Data show that students who were not in the computing major but were expected to take CS1 were frustrated with the course, found that they had to learn outside of lecture, and did not see how the course applied to the major. These responses were entered in the "self efficacy comment" box, indicating these issues may have influenced their confidence in their technical abilities. At UTEP, this problem is being addressed by allowing mathematics majors to substitute CS-0 for CS1 courses. Data from CS-0 mathematics majors are more positive, indicating less frustration with the content and with the (typically less lecture-based) classroom activity.

Coping Self-efficacy

> *Coping Self Efficacy- A student's judgment of his or her capability to cope with a variety of barriers inherent to a computing/engineering major*
>
> *"Find ways to overcome communication problems with professors or teaching assistants in your discipline"*

All mean values across populations and items are positive, mid-range responses. Coping efficacy items focused on students' abilities to communicate well with professors and TAs, while the PLTL model introduces a new set of mentors, undergraduate students. It is conceivable that while PLTL did not directly influence students' abilities to talk with professors, the initiative added a new human resource for students. Additionally, we note that our survey asked students to describe a change in coping self efficacy based on the PLTL course, and so student responses may be sufficiently different from a more general notion of an individuals' ability to cope with departmental issues and culture without an intervention. Most statements provided in response to the "coping efficacy" comment section dealt with difficulties students had with communicating with their instructors and professors.

"I realized that every class is different and you just need to adjust."

" I'm trying to find time away from working, to develop better study habits...it's hard."

"Having a good professor strongly affects my grades."

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[2] Definitions from Akbulut & Looney, Communications of the ACM, 2007, and (Lent, et.al. 2008)

"I must have a good supportive and understanding relationship with my professors and upperclassmen. Without it, I feel lost."

In contrast, students described the benefits of communicating about content with peer leaders. A theme in responses was the availability of peer leaders, their accessible language and friendly, helpful manner. In some cases, these descriptions were in contrast to an instructor's demeanor and language use.

"Peer-Led Team Learning helped me because the Peer Leader even though only a year ahead of us was very relatable, and knowledgeable in the course that I was taking. They did a good of balancing working us along and making us work to find the solution to a problem."

"Yes, peer leaders explain and go more into detail in the stuff that professors touch or go over."

CONCLUSION: PLTL SUPPORTS STUDENT LEARNING, CONFIDENCE, AND ACHIEVEMENT IN COMPUTER SCIENCE

Peer-Led Team Learning (PLTL) has provided 17,580 contact hours of student-centered, collaborative instruction in critical gate-keeper courses. Students are passing these computing courses at greater rates since CAHSI's PLTL initiative began, leading to shorter time-to-graduation and increased retention in the major. Institutional data of student course completion rates show a statistically significant effect indicating that students were more likely to complete the course after the implementation of PLTL. Peer leaders also benefit significantly from their work in the collaborative learning environment—the majority of the 98 leader experiences documented via PLTL leader surveys show increases in content knowledge, leadership and communication skill, as well as teaching ability. Students who engage in PLTL courses indicate increased self efficacy, feeling of support in the major, as well as an ability to cope with difficulties associated with studying in the sciences. These positive results were strongest for computing majors, according to statistical analyses of differences between groups.

CS-0 INCREASING POSITIVE REGARD FOR COMPUTING CAREERS

CS-0 analyses are two-fold—evaluators ran student level completion for CS-0 courses and the next course in the sequence, CS-1. In addition, evaluators received survey data from CS-0 students regarding their interest and impressions of computing following the CS-0 course. Two short case studies provide additional information about CS-0 as it pertains to two universities receiving additional NSF funding for their course implementation, TAMUCC and UTEP.

CS-0 AND COURSEWORK

This section describes student course level data analysis as well as survey data regarding Computer Science Zero (CS-0) at CAHSI institutions. A case study of institution-specific data analysis is also presented. Overall, CS-0 students enjoy their introduction to computer programming through visually appealing lessons in ALICE and Python languages, and see the value of the computing field as a career option. Course level data analysis, however, does not indicate CS-0 is effectively recruiting current college students into the major. Faculty, students, and case studies of analyses conducted at individual institutions provide some information regarding

Course level student analysis

This analysis examined course completion rates and grades for students taking CS0 courses at five institutions. CS0 courses are meant to introduce students to computer science and possibly interest students in continuing on into the computer science major. General questions for this effort include:

- What proportion of students finish CS0 courses and continue on to CS1 courses?
- Did students who previously took CS0 courses have comparable grades with students who did not?
- Did completion rates and grades vary by gender? Did female or male students previously completing CSO courses have comparable completion rates and grades with students who did not previously take CS0 courses?
- Did completion rates and grades vary by Hispanic ethnicity? Did Hispanic or non-Hispanic students previously completing CSO courses have comparable completion rates and grades with students who did not previously take CS0 courses?

Comparisons used simple Chi-square tests to examine expected versus observed frequencies for students completing courses. Statistically significant results at less than $\alpha = .05$ indicated greater than expected frequencies and percentages for specific groups of interest. Analysis of Variance (ANOVA) tests were used for comparisons with multiple factors such as gender, ethnicity and students either taking/not taking CS0 previously.[3]

At all institutions, 86% finished (1519 of 1752) CS0 courses. Individual institutions ranged from 63% to 91% in their completion rates. Note that completion and non-completion for CS-0 did not always hinge on failing a course, but could refer to withdrawals based on interest, discovering the level of the course was not appropriate for the student, and other similar reasons. Grades in CS-0 were relatively high, and the nature of the course in most schools is that of an elective, not a required course as is the case for CS-1.

Table 7: Completion rates in CS0 for all students, and at each institution.

	CS0			
	Did not pass course		Passed Course	
	N	%	N	%
All Institutions	233	13.3%	1519	86.7%
CSUDH	29	24.0%	92	76.0%
NMSU	43	19.4%	179	80.6%
TAMU	17	37.0%	29	63.0%
UHD	93	9.0%	945	91.0%
UTEP	51	15.7%	274	84.3%

At all institutions, 75% finished CS1 courses (2709 of 3588). Individual institutions ranged from 74% to 82%.

Table 8: Completion rates for CS1 for all students, and at each institution.

	CS1			
	Did not pass course		Passed Course	
	N	%	N	%
All Institutions	879	25%	2709	75%
CSUDH	75	26.4%	209	73.6%
NMSU	29	17.9%	133	82.1%
TAMU	290	25.4%	853	74.6%
UHD	210	25.7%	607	74.3%
UTEP	275	23.3%	907	76.7%

Eight percent (or 123 out of 1519) passed CS0 and then passed CS1. Thirty-five (35) out of 1519 (or 2%) entered CS1 but did not pass. Of those students entering CS1 from CS0, 78% finished CS1, which is slightly higher than the 75% for the general CS1 population. This difference translates to four added students above what would expected in the general student population. The difference in completion rates was not statistically significant with $\chi 2$ of 0.45, $p = .56$.

[3] Grade comparisons were based on a four-point grade scale with an F = .5 and an A = 4.5.

Grades were placed on a five-point scale. Grades were very similar between groups; students previously taking CS0 had an average of 3.32, students who did not take CS0 previously had an average of 3.34. This difference was statistically (and practically) non-significant. Males finished CS0 courses at lower rates than females, (84% males, 88% females); the difference was statistically significant with $\chi 2$ of 8.2, $p = .004$.

In CS1 courses, males and females finished at almost identical rates with 74.9% for men and 75.8% for women. This difference was statistically and practically non-significant. When completion rates for CS1 courses were examined comparing males and females who either took or did not take CS0, an interaction was evident that showed lower completion rates for females taking CS0 previously (65% v. 75%), and higher rates for males (82% v. 75%). This interaction was statistically significant with an F-statistic for the interaction $F = 4.3$, $p = .038$.

Hispanic students who had taken CS-0 had slightly better outcomes than non-Hispanic students or Hispanics students who did not take CS-0. However, Hispanic students in general had a slightly lower rate of completion in CS1 than non-Hispanic students (74%, 76% respectively). This difference was not statistically significant. However, Hispanic students who had taken CS-0 finished at higher rates than Hispanic students who had not taken CS-0 (79%, 76% respectively) and all non-Hispanic students (79%, 76% respectively). However, these differences were not statistically significant.

The analyses do not show a statistically significant improvement in students' completion of CS1, and in fact, an interaction of gender shows that women who first take CS0 are less likely to complete CS1 than are men with the same course-taking pattern. Some unanswered questions in this data set involve CS-0 as a recruitment tool—major identifiers at multiple schools made it difficult to ascertain whether students changed majors following CS-0. For example, students who are most likely to take CS-0 are those not yet ready for calculus. At the same time, those who intend to major in CS cannot declare this major until they have passed calculus, and remain "pre-engineering", "pre-science", or "undeclared". Qualitative survey data, however, indicate that most students who enroll in CS-0 without an intention to major in CS enjoy the course but do not change their aspirations. Another question unanswered here is "how would ill-prepared CS-0 students have fared in CS-1 if they had not enrolled in the CS-0 course?" while CS-1 passing rates serve as a comparison, they are based on past years of data as well as students who self-selected into CS-1 over CS-0, students who were potentially more prepared at course entry.

CS-0 SPARKS INTEREST IN COMPUTATION

Computer Science Zero is a course designed to introduce computing concepts to students who are A) majors ill-prepared for computer science 1 courses or B) non-majors engaged in an elective or summer bridge course. CS-0 students took the same SCCT survey regarding computing careers that the PLTL students (nearly all computing majors) took at the end of their semester of CS-0.

Student descriptions of CS-0

Surveys asked students to list what activities and projects made them the most proud of their accomplishments. This list generated freely by students

At TAMUCC, instructors received additional CCLI funds to develop and teach their CS-0 course, and so completed independent data analyses on their student level data. Phyllis Tedford and John Fernandez asked the following questions: 1. Does a student's CS-0 completion lead to completion of CS1 at greater rates than nonCS-0 students? 2. Does a student's CS-0 completion lead to completion of CS3 at greater rates than non CS0 students? 3. Do these completion rates differ by underrepresentation status?

They found a statistically significant difference in persistence for those CS-0 students who continued on through CS3- they completed the upper level computing with much greater success than their non-CS-0 counterparts (36% compared with 18%, chi-square =5.73, p-value=0.01) . This difference was observed for underrepresented groups as well as their majority peers, though numbers are at this time too small for statistical comparisons by race/ethnicity or gender.

This study suggests CS-0 may influence students further along the pipeline than first thought, though another possibility is that computing majors are more likely to elect to take CS-0 before taking CS1.

spoke to the sheer diversity of CS-0 experiences on CAHSI campuses: changing the color of an image, drawing representations of physical behaviors through programming, installing and running Linux, developing video games and films, attending career expositions, modeling problem solving techniques, and building computers by hand. In open-ended survey items, CS-0 students who were new to computing express how their introduction to computer science is eased through their participation in CS-0.

"I think (I was most proud of) just becoming familiar with the language and understanding the syntax errors later in the year. It felt like I was now understanding the program."

"I was completely new to (JES programming) and it opened up my eyes to how complex a system can be and how they can follow simple orders."

"I was most proud of my first project (because of) the fact that I understood and incorporated things I learned in the class to develop a brief animation. I never really thought of animating before— it was interesting."

"Getting a hands-on class with different computer programs helped me familiarize myself more with how computers work."

This data complements the quantitative survey results, described above, by adding nuance and student voice to the CS-0 experiences on CAHSI campuses.

Students represented five schools in the fall 2009/spring 2010 data set, and 20 different majors, with slightly more than half majoring or intending to major in computing (52%). Of the 159 completed responses, over two thirds of the survey respondents were male (72%) and 60% were Hispanic, while 20% were Caucasian/white and 10% African American or black. indicated a GPA of 3.0 and above. A quarter of student's maternal figures did not complete high school (25%), while a third had attained at least a 2-year degree, and 10% completed at least some graduate education. Paternal figures in students' lives were slightly more educated, with 19% not completing high school, 37% achieving a two year degree or higher, and 11% gaining some graduate school education. Students were primarily first year students (57%), a large portion of them did not work outside of school (43%) while one third (33%) worked 10-20 hours per week, 11% worked 20-30 hours outside of their responsibilities as students, and 13% were employed full time as they attended school.

As CS-0 students are not all majors, we would expect that they would ***gain interest in computing fields***, but may not exhibit the same levels of self-efficacy in computer-related academics. Because CS-0 courses often introduce computing career information we might expect that the CS-0 students report ***positive outcome expectations for computing careers***. The collaborative, collegial nature of computer science zero courses may similarly enhance majors' attitudes regarding ***social support in the computing field.***

Table 9: CS-0 Student Average Scores on Social Cognitive Career Theory Constructs (Lent, Et. al. 2008)

CS-0 Student Average Scores on Social Cognitive Career Theory Constructs (Lent, Et. al. 2008)				
SCCT constructs (Scale of 1-10)	**Number of all students (number of computing students)**	**Percent all students reporting increase/ positive ratings (5.50 or better average)**	**Overal l Mean**	**Std. Dev.**
Outcome Expectations (11 items)	159	88%	7.44	2.16
Social Supports/ Barriers (majors only) (8 items)	87	84%	6.6	1.39
Computing Interest (5 items)	158	76%	6.59	2.10

From the data presented above, we find that students' average ratings over multiple survey items for the three key elements in computing career choice are consistently positive. For each category, between 76% and 88% of respondents averaged over 5.5 on a 1-10 point scale, indicating most individuals reacted positively to computing following the CS-0 course across categories, with computer science majors indicating higher scores in all categories.

Following our hypotheses, overall averages show CS-0 students stated their interest increased in computing activities (such as solving problems with computers) and expressed positive educational outcomes (such as improving lives and receiving high salaries in computing careers) for computing degrees. Computer majors perceived supportive academic communities within computer science departments. We note that majors who complete PLTL surveys in later coursework measuring the same constructs have more positive views of their academic departments, and describe their departments as lacking barriers to their success.

MPCT is a project developed by Eric Freudenthal and Kay Roy at the University of Texas at El Paso. This version of CS-0 uses the free educational version of python, called Jython or JES. Students in this course program algebraic equations and concepts using physics examples to give depth and visualization to their assignments. An express goal of MPCT CS-0 is to support pre-calculus students with the mathematical and physics-related content they need to complete computing prerequisites.

Studies led by a CAHSI evaluator for the separate CCLI grant have found student gains in student perceptions of mathematics: 83% of spring 2010 MPCT students said the course increased their confidence in math ability, and 77% state they are better able to apply mathematics concepts to real-life problems following MPCT.

MPCT may improve students' physics understanding as well. Forty students from MPCT in spring 2010 completed 6 conceptually based physics items in the first week of the course and during the last week of the course as part of a voluntary survey. Students' scores increased by 0.55 points overall.

MPCT is beginning to include a few weeks of Java instruction near the end of the semester to ease the transition into more difficult programming languages. Initial qualitative results indicate some students find the transition to be easy- in fact, for some Java was easier to learn than Jython was, because they had Jython experience as a basis for understanding computing concepts. According to one student:

"We were first taught the Jython language, and coming to the end of the semester we were introduced to Java. The transition was very easy to grasp."

Evaluators found through pre-post measures of CS-0 in past semesters that students enter the course with high (perhaps inflated) perceived interest in computing, that remained relatively flat or unchanged during the course. We submit that youth have a great deal of peripheral, positive experience with using the computer as a tool. This experience may shape entering interests in computing activities, which is then modified with experience in the CS-0 course, as they begin to understand the complexities of computer use and computer programming. Because of this pattern, we began asking students to rate how their experience of the CS-0 course influenced their current impressions of computing.

As computing becomes more amorphous, blending with multiple disciplines and serving research and practice areas from art, biology, physics, medicine, law, and business, to name a few, it becomes increasingly important that those in fields outside of computing have some knowledge of computational thinking and logic, as well as some programming skill. While CS-0 is not recruiting new majors from freshman classes as first expected, it does seem to increase interest, confidence, and positive regard for the field as a whole, no matter the discipline of the entering student.

ADVANCING UNDERGRADUATE STUDENTS THROUGH AFFINITY RESEARCH GROUPS

Affinity Research Groups (ARG) emphasize the deliberate and intentional development of the technical, intellectual, communication and professional skills and knowledge required for research (Gates et al, 1999; Kephart, Villa, Gates, & Roach, 2008). In the Affinity Research Group, undergraduate researchers are exposed to increasing levels of independence, responsibility, and technical sophistication. The ARG model operates in a non-hierarchical manner, emphasizing shared leadership and decision-making among faculty and students engaged on a research project. All ARG participants receive the ARG survey, distributed online via CAHSI PIs and research leaders. Affinity Research Group students completed a survey about their research experience, adapted from the Undergraduate Student Self-Assessment (URSSA) instrument (author, 2009). The instrument was initially piloted and validated on multiple campuses through "think-aloud" interviews with preliminary statistical tests of validity and reliability. Next, the survey was administered to a diverse group of nearly 600 students on numerous campuses for further statistical refinement. The survey quantitatively and qualitatively assesses the development of students' computational/scientific thinking and research skills, personal and professional growth, career intentions, and their understanding of professional practice in a research community. Items were rated on a 4-point likert scale (1=no gain at all, 4=great gain).

DEMOGRAPHIC CHARACTERISTICS OF ARG SURVEY RESPONDENTS

Overall, 60 Affinity Research Group (ARG) students completed the Undergraduate Research Student Self-Assessment (URSSA) survey during spring 2010. Survey responses were received from UTEP (37% of student participants), TAMU-CC (12%), UHD (10%), CSU-DH (20%), NMSU (10%), and UPRM (12%). Two of the students (both from UPRM) were members of FemProf.

As has been the case in previous years, ARG students were primarily undergraduates (71% of respondents). Undergraduate students tended to be upperclassmen: only one ARG student was a 1st year student, 10% were 2nd year students, 27% were 3rd year students, and 32% were fourth year students. In addition, 19% were master's students, and 10% were Ph.D. students. More master's students completed the ARG survey this spring than in previous years where the percentage has typically been 10%. Five of the graduate students noted that they had participated in an ARG as an undergraduate, suggesting that the ARG model may be successful in advancing students to graduate school.

Nearly half of ARG students were relatively inexperienced researchers. Forty-eight percent of students had only completed 1-2 semesters of research. Almost one-third (30%) of students had completed 3-4 semesters or summers of research, and the remainder had completed 5 or more semesters or summers of research.

ARG students were predominantly Hispanic (59%), though the representation of Hispanic students is slightly less than in previous years where the proportion of Hispanic students was a little more than two-thirds. The remainder of ARG students was Caucasian (23%), Asian (22%), or African-American (7%). The proportions do not total 100% because students were allowed to select multiple race/ethnicity categories.

ARG students were also predominantly male (77% of students), though there was a slightly greater representation of women in ARGs than in previous years. The gender representation of ARG students is consistent with the national average: in 2005, 22% of bachelor's degrees in computer science were awarded to women (NSF, 2006).

ARG STUDENTS UNDERSTOOD THEIR RESEARCH TASKS AND GOALS

Students answered a series of questions about the clarity of their project goals, its fit with the work of the research group, and their sense of ownership of their research tasks. The overall mean for these items was quite high—though slightly lower than previous years—(3.32 out of 4.0),[4] indicating that most students had a solid understanding of the tasks at hand and how they related to the work of the larger group. A sense of ownership over the project and clarity about the project's goals are essential for achieving the greatest gains from an apprenticeship experience in research (Thiry, Hunter & Laursen, 2009).

STUDENTS' TOP GAINS WERE TECHNICAL KNOWLEDGE AND RESEARCH SKILLS

Students were asked to pick their top three gains from their research experience. Students' top three gains differed somewhat from previous years. For instance, last year, students cited their top three gains as: technical knowledge, research skills, and personal growth, respectively. In contrast, this year, students cited personal growth, technical knowledge, and communication/intellectual skills, respectively. Students' top three gains in 2010 the percentage of students selecting each gain are outlined in the figure below.

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[4] All gains items were rated on a 4.0 point scale with 1=strongly disagree, 2=disagree, 3=agree, and 4= strongly agree.

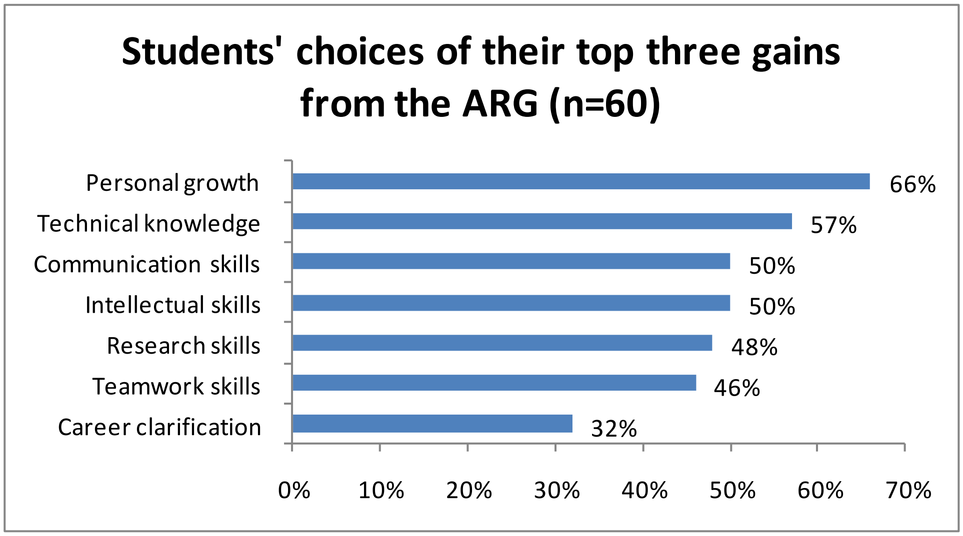


Figure 3: ARG Students' choices of their top three gains from research

RESEARCH GAIN SCALES

Students evaluated their growth and development in several areas:

- *Career clarification/preparation:* Clarification and/or confirmation of students' career and educational goals; feeling prepared for graduate school or a computing career.
- *Personal growth*: Growth in confidence, interest in computer science, independence and responsibility.
- *Collaboration/teamwork*: Increases in teamwork skills, and the extent to which students worked collaboratively with their research groups and contributed to the work of the larger group.
- *Skills*: Increases in communication skills, problem-solving, and organizational skills.
- *Intellectual gains*: Increases in students' understanding of the research process in computer science, increases in critical thinking skills, and appreciation of the relevance of research to coursework.

Students made roughly equal gains in all of the above categories. In fact, student means on the research gains scales have changed little from year to year—they typically range from 3.2 to 3.4 on a 4.0 point scale. Students rated their gains in "personal growth"—or increased in confidence and interest—and "collaboration/teamwork" as their strongest gains from participating in ARGs. The overall means for all students for these scales are outlined in the figure below.

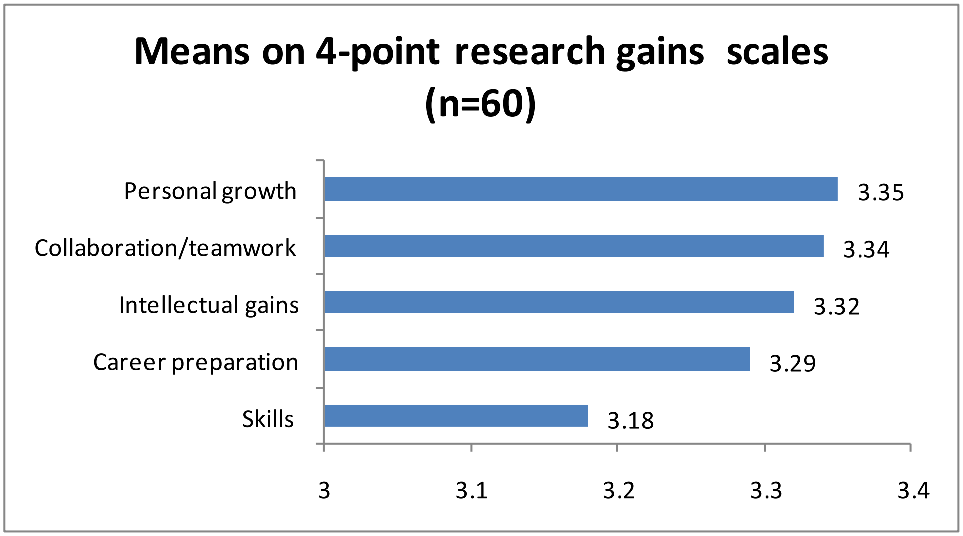


Figure 4: Student mean rating scores along five research gain scales

HISPANICS MAKE STRONGER GAINS THAN NON-HISPANICS

While participation in Affinity Research Groups clearly benefited all students, Hispanics consistently reported higher gains than their peers. Though not statistically significant, Hispanics reported higher gains in all areas than non-Hispanics, with the exception of "skills." As in previous years, the most striking differences occurred on the intellectual gains and career preparation scales. These gains are particularly important for Hispanic students as they may enter the research experience with less confidence and background knowledge than their majority peers. The figure below highlights the differences between Hispanics and non-Hispanics on research gains scales.

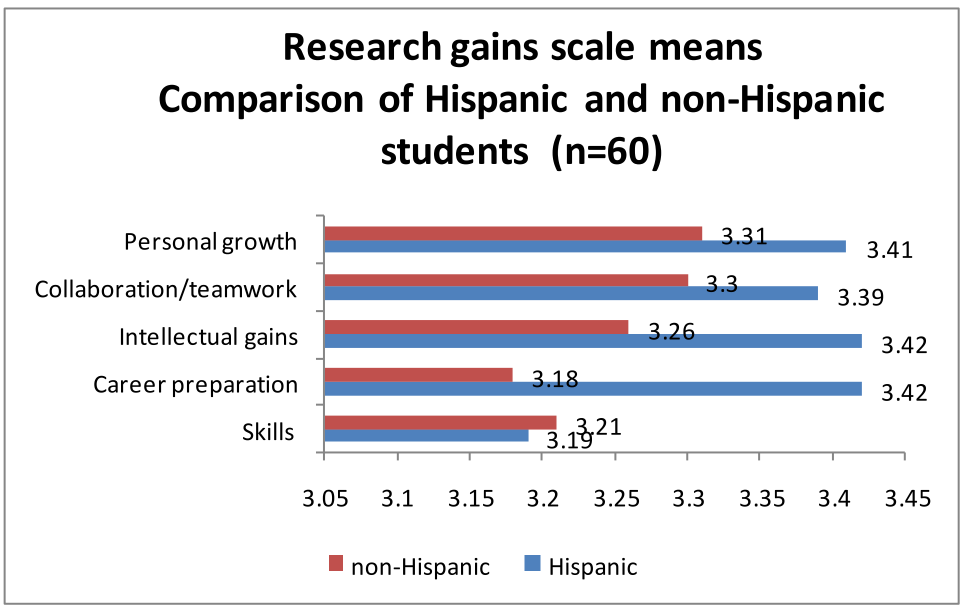


Figure 5: Students' research gains scale mean scores for Hispanic and non-Hispanic students

MEN MAKE STRONGER GAINS THAN WOMEN

Men made stronger gains than women on all research gains scales. Though the small sample size of women did not allow for tests of statistical significance, men reported higher gains than women in many critical areas, such as skills, intellectual gains and personal growth. In fact, women's ratings of their personal growth (gains in confidence and interest) lagged far behind those of men. This is particularly concerning given that women often enter STEM fields with lower confidence and interest than men. Though we cannot necessarily make generalizations given the small sample size for this survey, ARG mentors and faculty members should be aware that women are reporting fewer gains than men from research and take steps to enhance the gains achieved by women.

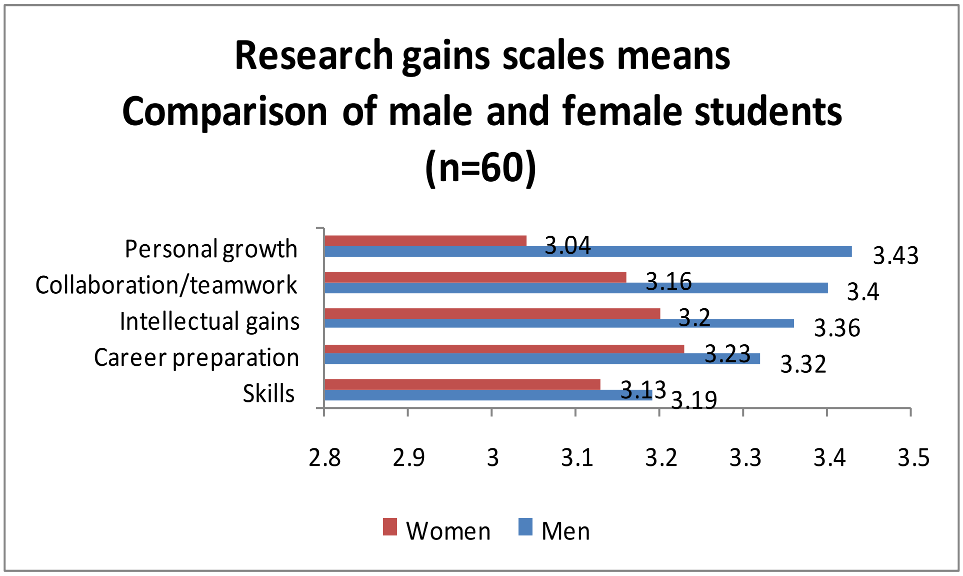


Figure 6: Students' research gains scale mean scores for women and men

IMPACT OF ARG: STUDENTS BECAME MORE INTERESTED IN GRADUATE SCHOOL

Participating in ARGs influenced students' future career and educational goals and helped them to feel prepared for graduate school and/or computing careers. Clarifying career and educational goals as well as gaining knowledge about future options are particularly important outcomes for students from underrepresented groups who may not have the same awareness of career and educational options as their majority peers (Dryburgh, 1999; Mulkey & Ellis, 1990). Minority students, in particular, receive important professional socialization benefits from participating in undergraduate research, particularly in learning about professional practice from working closely with faculty and graduate students in a shared research endeavor (Thiry & Hunter, 2008; Thiry & Laursen, in review).

Fully 79% of ARG students felt that their research experience had increased the likelihood that they would pursue graduate study—slightly higher numbers than in previous years. Students had the opportunity to expand on their answer in an open-ended comment. The most common response was that the ARG had influenced students' graduate school aspirations because they gained confidence from their research experience that they could succeed in graduate school. Students also knew to expect in graduate school from working closely with graduate students in the ARG.

"I have always been considering graduate school but after my research experiences I've been feeling more confident about myself and motivated to keep researching."

"I did not feel like I would get accepted until I talked to one of my co-workers in the research group. After the talk, I feel that I should apply and leave the decision up to the school."

Some students were more motivated to attend graduate school because they began to realize how many problems still needed to be solved in computer science. Students wanted to go to graduate school so that they could learn more about computer science and contribute to the field.

"I feel that with time I can develop techniques and methodologies to optimize the solving of complex problems, and I am certain that if I attend graduate school I will have more opportunities to do so."

"(Research) has shown me that there are many more complicated things to learn in my field, so I should learn about them."

No students reported that they had been negatively influenced about graduate school from their research experience. Indeed, poor research experiences can give students negative impressions of graduate study and "turn them off" from graduate school (Thiry, Laursen, & Hunter, 2010). Therefore, it is encouraging that students only reported positive impressions of graduate study from their experiences in ARGs.

Participating in ARGS increased students' motivations to pursue graduate school and helped them to define their career and educational goals. Students benefited from observing graduate students at work and learning about the roles and responsibilities of graduate students. Likewise, several previous studies have documented the educational and career gains from participation in research for minority students, including increased interest in science careers (Nagda, Gregerman, Jonides, von Hippel & Lerner, 1998) and an increased likelihood that students will pursue graduate school (Alexander, Foertsch, & Daffinrud, 1998; Barlow & Villarejo, 2004; Hathaway, Nagda, & Gregerman, 2002).

ADVANCING TO GRADUATE SCHOOL

ARG students who identified themselves as junior or senior undergraduates were asked to complete an extra set of survey items about their intentions and actions to pursue graduate school. Thirty-five students responded to these items. Students clearly had strong *intentions* to take the GRE and apply to graduate school (74% and 80% of students, respectively), yet very few had actually done so. Only one student had actually taken the GRE and only three had applied to graduate school. Nearly three-quarters of ARG students reported that someone had provided guidance and advice to them about the path to graduate school. Most of these students reported that a professor or graduate student in their department had helped them with advice and graduate school planning; a few students mentioned the CAHSI annual meeting as an important source of information. Therefore, most students seem to have adequate access to guidance and advice about career and educational planning, yet they do not appear to be turning their intentions into concrete actions.

Table 10: Graduate school activity taken by CAHSI ARG/Mentorgrad students

Survey item	Number of students responding "yes" (n=35)	Percentage
Have you taken the GRE?	**1**	**3%**
Do you plan to take the GRE?	**26**	**74%**
Have you applied to graduate school?	**3**	**9%**
Do you plan to apply to graduate school?	**28**	**80%**
Have you applied for a scholarship and/or fellowship in the past year?	**3**	**9%**
Has someone advised you about the path to graduate school?	**26**	**74%**

IMPACT OF MENTOR GRAD: PARTICIPATION IN RESEARCH HAD SOME INFLUENCE ON STUDENTS' ASPIRATIONS TO BE A PROFESSOR

In contrast to previous years where few students were influenced to pursue the professoriate from participating in an ARG, a little over half of ARG students in 2010 (52%) reported that they were more interested in becoming a professor. Many of these students stated that participating in the ARG had confirmed or reinforced their career goal of becoming a professor. The current "MentorGrad" initiative, in which students learn about academic pathways, may have some influence on these student aspirations.

"The research experiences have definitely reinforced my desire to become a professor. I have also learned a lot about careers in the academia thanks to my mentors and other faculty at my university."

"My research experience has helped me understand the importance of extending the knowledge I've gained; and a great way to do so is to pass on that knowledge to others who may be in a better position to further develop it. What better way to do that than becoming a professor?"

Participating in an ARG also gave students confidence that they could become a professor and helped them to learn what the work of a professor entails.

"This research experience allows me to feel confident in my path to becoming a professor in Computer Science in the future, as it gives me insight into what a professor does aside from their teaching. It also inspires me to continue on research and interest students into getting involved with a research experience that will better benefit them."

STUDENTS PARTICIPATED IN PROFESSIONAL COMPUTER SCIENCE RESEARCH COMMUNITIES

Most ARG students had the opportunity to disseminate their research results in a professional forum of peers and experts. The number of ARG students participating in conferences and scholarship was slightly lower than in previous years; this is most likely due to the timing of the survey. The survey was sent just prior to the CAHSI annual meeting so many students did not count their participation in the annual meeting or poster session as scholarly activities. Nevertheless, nearly half of ARG students attended a professional conference within the past year. Less often, students had the opportunity to present or publish their results; however, our prior research on UR has shown that these accomplishments are rare for undergraduates (Hunter et al., 2007; Seymour et al., 2004). Even without the CAHSI annual meeting, many ARG students seemed to have had opportunities to engage in authentic research that led to publishable results. Access to "real-world" research is essential for socializing students into the profession and producing the intellectual and professional growth necessary to enter the STEM professions (Thiry et al., 2009).

Table 11: ARG students' professional activities performed in 2009-2010

Professional activity undertaken in the past year (n=53)	Number of students	Percentage of students
Attended a professional conference	27	45%
Authored or co-authored a journal paper	8	13%
Presented a conference paper	6	10%
Presented a poster at a professional conference	11	18%

OVERALL IMPACT OF AFFINITY RESEARH GROUPS ON ADVANCING STUDENTS

Participating in research has numerous benefits for CAHSI students and the Affinity Research Group model has helped to develop students' intellectual, research, collaborative, and communication skills. The majority of ARG participants were Hispanic, suggesting that CAHSI is effectively reaching underrepresented groups of students, particularly their target group of Hispanics. Hispanics also reported stronger gains from research than non-Hispanics, indicating that participating in ARGs is a valuable experience for minority students. Participation of women in ARGs is slightly higher than the national average, yet women have reported weaker gains than men. ARG mentors and faculty should be aware of this discrepancy and take action to try to mitigate this disparity in the future. Another discrepancy is the difference in students' intentions to pursue graduate school and their behaviors to actually pursue that goal. Hispanics face numerous obstacles on the path to graduate school and ARG data suggest that most students have a mentor who has provided guidance and support on the path to graduate school; however, this does not appear to be enough to encourage concrete behaviors such as taking the GRE or applying to graduate school. Despite these discrepancies, CAHSI students clearly benefited from participating in ARGs. Students gained invaluable teamwork, communication, and research skills, and increased their interest in advancing to graduate study.

CREATING A COMMUNITY OF ADVANCEMENT IN COMPUTING- PROFESSIONAL DEVELOPMENT WORKSHOPS SUPPORT MENTORGRAD GOALS, ADVANCEMENT OF STUDENTS

OVERVIEW OF THE CAHSI ANNUAL MEETING

One of CAHSI's key initiatives is their annual meeting with the goals of: fostering cross institution collaborations, providing opportunities for students and faculty networking, serving as a forum for advanced discussion of computing and computing careers, and disseminating CAHSI's interventions to an outside audience. In addition, CAHSI annual meetings provide much of the Mentor Grad content that students receive throughout the year.

Data collection for evaluation

Attendees received surveys after each of six workshops during the annual meeting. Surveys were collected and analyzed by workshop. A month after the CAHSI event, attendees received an invitation to take an online follow-up survey, to address their attitudes and opinions about the CAHSI event as well as to ascertain how the meetings influenced subsequent attendees' networking, professional, and career-related behaviors. Surveys were sent via email invitation, with 2 email reminders occurring over the following weeks. The delayed response was employed to avoid the "halo effect", in which participants tend to mark experiences as highly enjoyable when they have little time to reflect upon the experience.

Demographics of attendees

This year, fifty-seven annual meeting participants completed the follow-up survey. Seventy-two percent of survey respondents were students and 28% were faculty or industry professionals. CAHSI annual meeting attendees represented the following twelve universities:

- California State University- Dominguez Hills
- Florida International University
- Miami Dade College
- New Mexico State University
- Polytechnic University of Puerto Rico
- Texas A&M University-Corpus Christi
- Texas State University
- University of Houston - Downtown
- University of Puerto Rico – Arecibo
- University of Puerto Rico – Mayaguez
- University of Puerto Rico - Rio Piedras
- University of Texas at El Paso
- University of Texas – Pan American
- University of Turabo
- Youngstown State University

Demographics of survey respondents

Fifty-seven individuals responded to the post survey, sent nearly month after the event at the Microsoft headquarters in Seattle in April of 2010. This number represents 53% of those who registered for the conference. One-third of survey respondents were women, indicating that the CAHSI annual meeting attracted a slightly greater proportion of women than is traditionally found in computing professions.

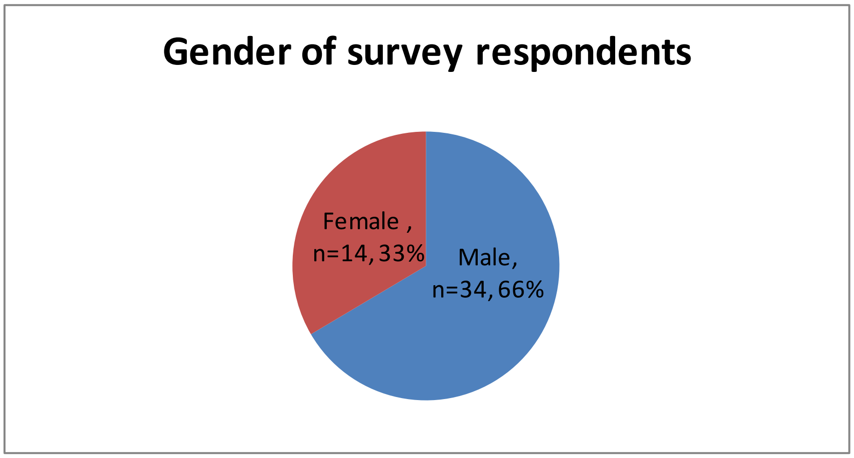


Figure 7: Gender of CAHSI Event Survey Respondents

The vast majority of attendees, according to survey results, identified themselves as Hispanic; specifically, 94% of students and 85% of computing professionals stated they were Hispanic, or 91% overall. Six percent of respondents uniquely identified themselves as Caucasian. One respondent was from the Indian subcontinent. The small numbers of non-Hispanic survey respondents make statistical comparisons impractical.

OVERALL SATISFACTION WITH THE CAHSI MEETINGS

Meeting met, exceeded attendees' expectations

The majority of survey respondents state that their expectations of the CAHSI annual meeting were met (55% or 31 respondents) or exceeded (18%, or 10 respondents)—rates similar to last year. In contrast to last year when 11 students and professionals reported that they did not know what to expect from the conference, only three attendees in 2010 responded this way. Seven students and three professionals felt the conference somewhat met their expectations. Only two attendees—both students—reported that the conference did not meet their expectations. Participants' ratings did not differ significantly by gender, although women rated their experiences slightly higher than men (means of 4.1 and 3.8 respectively, on 5-point scale).

Majority expect to attend the 2011 annual meeting

Most students planned to attend the next annual CAHSI meeting (68%, 27 students), at similar rates reported by last year's student attendees. Financial support seems to be crucial to student attendance at the annual meeting; fully 37% of students felt that their future participation will depend on the availability of scholarships or travel stipends. Only one student did not plan to attend again; in contrast to last year when seven students felt they would not attend a future CAHSI conference.

Computing professionals were more likely than students to state they planned to return to the CAHSI conference in 2011 (81%, 16 professionals). No professionals reported that a scholarship would influence their decision to attend future annual meetings. No professionals marked that they would not attend future CAHSI conferences.

CAHSI attendees recommend the conference to peers

Students and faculty were both highly likely to recommend the CAHSI annual meeting to peers: 90% of students and 75% of professionals agreed or strongly agreed that they would recommend the conference. One student and two professionals indicated that they would not recommend the meeting to peers.

Attendees were mostly satisfied with meeting site

Participants were satisfied with the location of Microsoft for the annual meeting. The vast majority of attendees were very satisfied (54%, 30 attendees) or somewhat satisfied (34%, 19 attendees) with the location of the meeting. Attendees indicated in their written responses that they felt the Microsoft campus was beautiful and a nice location for the meeting. A substantial minority of attendees wrote that they desired more involvement and a greater presence from Microsoft during the meeting. A few attendees disliked having to be escorted to the bathrooms, though such practices have been in place at each corporate meeting site thus far.

SUGGESTIONS FOR FUTURE CAHSI CONFERENCES

Survey respondents were asked to provide suggestions for future CAHSI events, based on their experiences at the 2010 event. Some responses were similar to prior years (e.g., need for more interactive workshops, logistical concerns, and more social/networking activities for students) while some responses were new and many of these concerned Microsoft as a venue (e.g., do not hold future events at the corporate site, more participation and support from corporate partner, etc.) Attendees mentioned the following suggestions for improvement in future years:

- Need for more interactive, hands-on presentations; more activities and discussion during workshops/presentations (6 participants)
- More organization and structure to the conference (5)
- Hold a job fair during the conference to highlight internships/job openings at the industrial site and/or nearby companies (3)
- Include social activities or ice-breaker activities for students to meet each other and network (3)
- Hold the conference at a nearby hotel, rather than at the corporate site. Include a tour of the industry site but do not hold the meeting itself at the industrial site (3)
- More participation from the corporate sponsor (3)
- Hold an opening and closing ceremony (2)
- Hold more workshops or discussion about industry careers (2)

Keynote was attendees' favorite part of the conference

Survey respondents overwhelmingly identified Cecilia Aragon's keynote speech as their favorite part of the CAHSI annual meeting. Most participants felt that the keynote was inspirational and motivational. Participants also cited the Affinity Research Group model workshop and the female panel of industry and academic researchers as their favorite parts of the conference. The following activities were cited by attendees as the "best part" of the meeting:

- Cecilia Aragon's keynote speech (23 participants)
- Affinity Research Group workshop (5)
- Female panel of researchers (3)
- Cognitive radio presentation (3)
- Juan Vargas presentation (2)
- Creating a research plan presentation (2)
- Making yourself marketable panel (2)
- Poster session (1)
- Everything was great! (1)

CAHSI ANNUAL MEETING PROVIDES A SUPPORTIVE, PERSONAL ENVIRONMENT

When asked what sets the CAHSI annual meeting apart from other conferences, participants mentioned that CAHSI focuses more on diversity, offers more opportunities for networking, and creates a more personal, supportive atmosphere than is typically found at professional conferences. Participants mentioned the following aspects of the CAHSI annual meeting as different from other professional conferences:

- More personal, supportive environment (7 participants)
- Emphasis on diversity and Hispanics (6)
- Student-centered, focus on involving students (4)
- Don't know (3)
- Opportunities for networking (2)
- Emphasis on professional development (2)
- Held at corporate headquarters, offers insight into industry (2)

EXPANDING THE CAHSI COMMUNITY: ACTIONS OF STUDENTS FOLLOWING THE CONFERENCE

Students enhanced their networks

Student survey participants reported similar rates of post-conference networking activities to students in previous years. As in previous years, students were more likely to contact other students following their participation in the CAHSI annual meeting, although they reported contacting faculty this year at a slightly higher rate than last year (39%, 27% respectively). To a lesser degree, students contacted industry professionals. Additionally, 12 students volunteered to become CAHSI advocates at their schools.

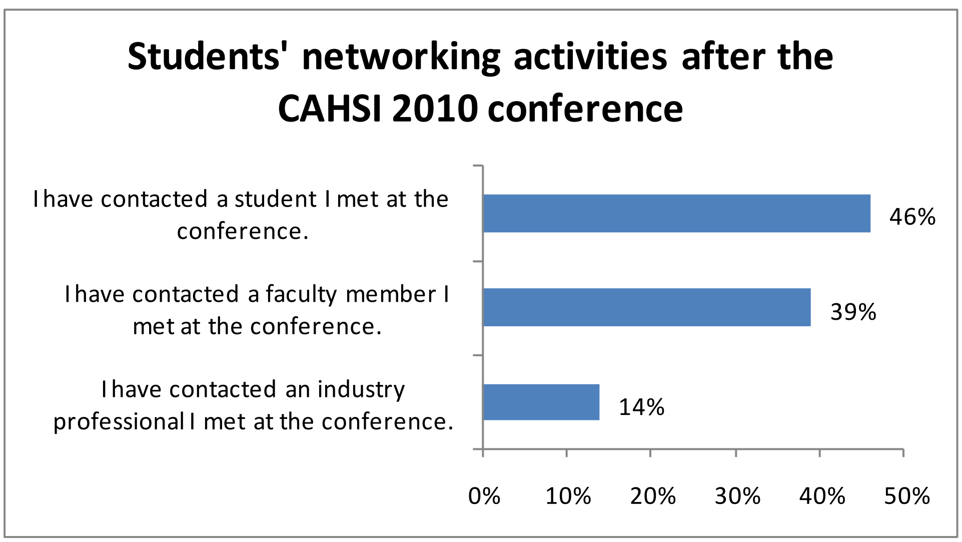


Figure 8: Students' Reported Networking Activities Following CAHSI Event

Students searched and read materials written by CAHSI presenters

Over one third of students continued learning about computing following the conference; 16 of the student respondents said they searched for additional research articles or materials written by CAHSI speakers (43%), and nearly all had also read those materials (35%, 12 students).

Academic advancement through mentor grad

CAHSI students advanced their academic careers across the academic computing pipeline following their participation in the annual meeting, which focuses much student content on the values and goals of MentorGrad- the CAHSI initiative charged with supporting student advancement to graduate school. The pattern of student effort towards career development was similar to previous years. Students near the beginning of the career path applied for scholarships (29%, 11 students), inquired about graduate school opportunities (49%, 16 students), and submitted applications for graduate school (26%, 8 students). The rate of graduate school application rose from 12% in 2009 to 26% in 2010. Also, advanced students sought academic positions following their time at the CAHSI conference (32%, 11). They also sought industry employment (35%, 12), and searched for corporate careers (26%, 8). Student rates of applying for academic employment increased from 14% in 2009 to 32% in 2010. Percentages are reported in comparison to all student respondents, though it is important to note that none of the students would be in a position to complete all listed activities.

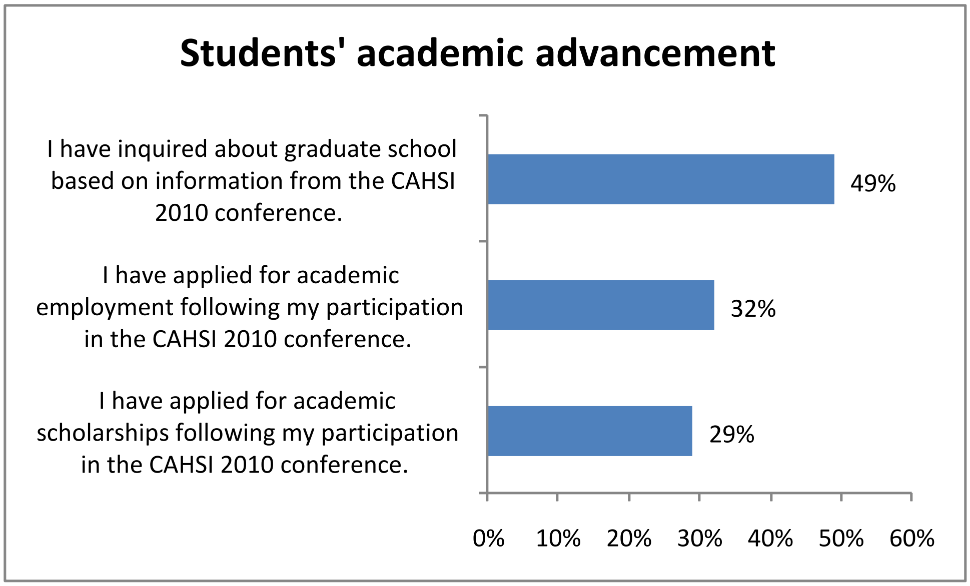


Figure 9: Students' Reported Activities Following CAHSI Event—Academic Advancement

Industry Advancement

Students also engaged in career development behaviors following the 2010 CAHSI annual meeting. Over one-quarter of students who responded to the survey have since searched for corporate careers following the CAHSI meetings based on information received at the conference (26%, 8 students). Also based on information from CAHSI, students applied for industrial employment (21%, 12 students). These rates were similar to those from last year.

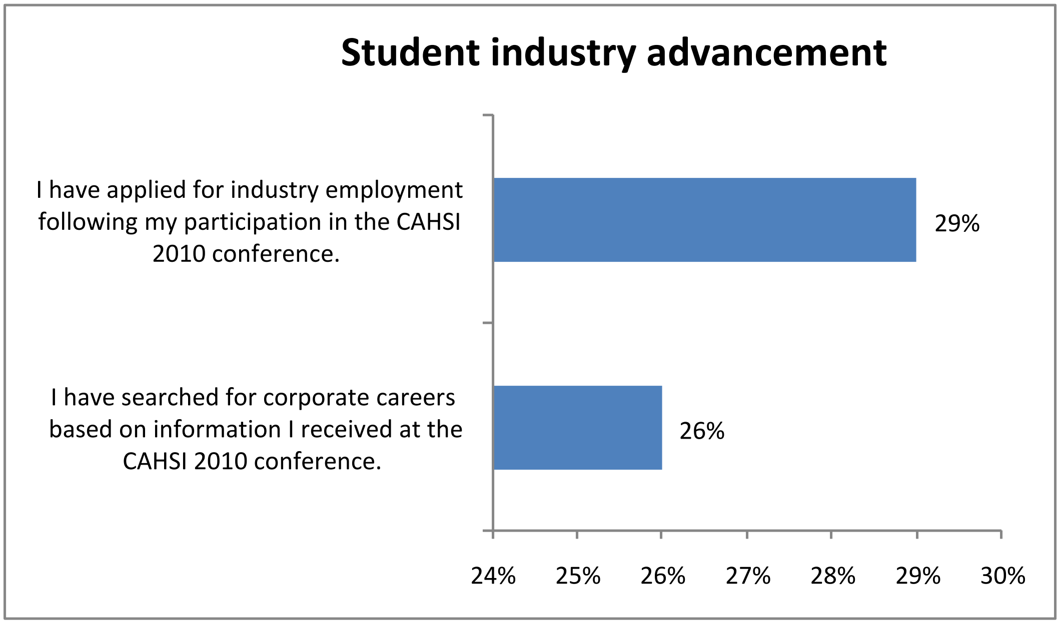


Figure 10: Students' Reported Activities Following CAHSI Event—Industry Advancement

EXPANDING THE CAHSI COMMUNITY: ACTIONS OF FACULTY/PROFESSIONALS FOLLOWING THE CONFERENCE

Faculty and professionals extended their participation in CAHSI

Computing professionals were asked to describe their networking and other professional follow-up activities in the month following the 2010 CAHSI annual meeting. According to participants, most of this activity occurred at their home institutions—81% of responding faculty and industry professional—as opposed to a little over 50% last year—stated that they had contacted peers in their own departments about CAHSI interventions described at the meeting. A slightly smaller percentage of computing professionals contacted faculty at other CAHSI institutions (63%, as opposed to 39% last year). In both cases, about 20% of respondents indicated this item was "not applicable", because they were not affiliated with a university or were already involved at CAHSI institutions. Two individuals (13%)—as opposed to 11 last year--volunteered to become a CAHSI advocate at their institutions. Therefore, rates of peer networking about CAHSI interventions were much higher than in previous years but fewer faculty volunteered to be CAHSI faculty advocates.

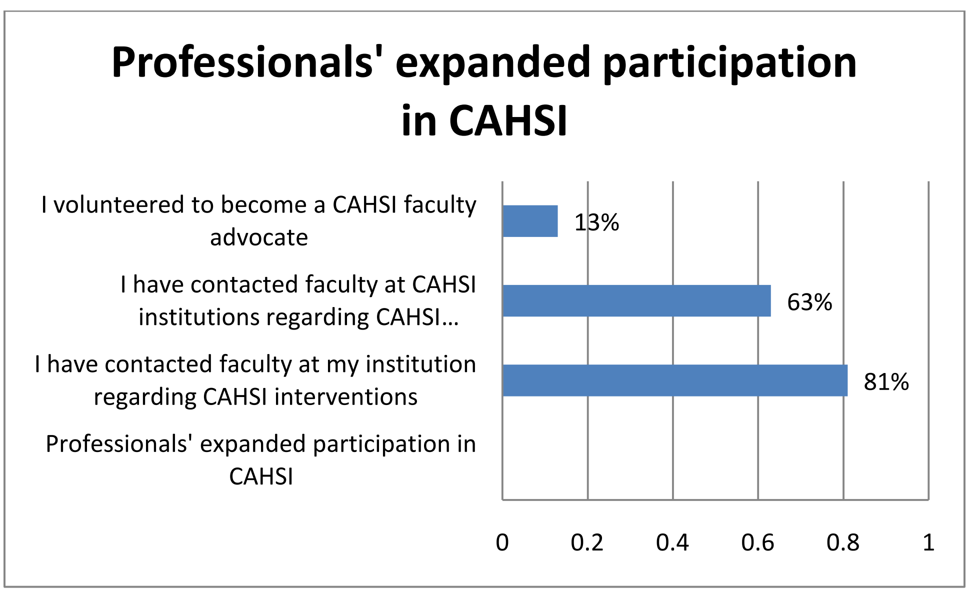


Figure 11: Professionals' Reported Activities Following CAHSI Event—Expanded CAHSI Participation

One of CAHSI's goals is to develop formal and informal networks of computing professionals, particularly for Hispanics. Following the CAHSI annual meeting in April, two-thirds of the professionals responding to this survey stated they had made contact with a faculty member they first met at the CAHSI meetings (69%, 11 professionals). A smaller proportion contacted an industry representative following participation in CAHSI (31%, 5 professionals). These rates were almost exactly the same as reported by faculty and industry respondents to the 2009 annual meeting survey. About 20% of professionals marked "n/a" to these items.

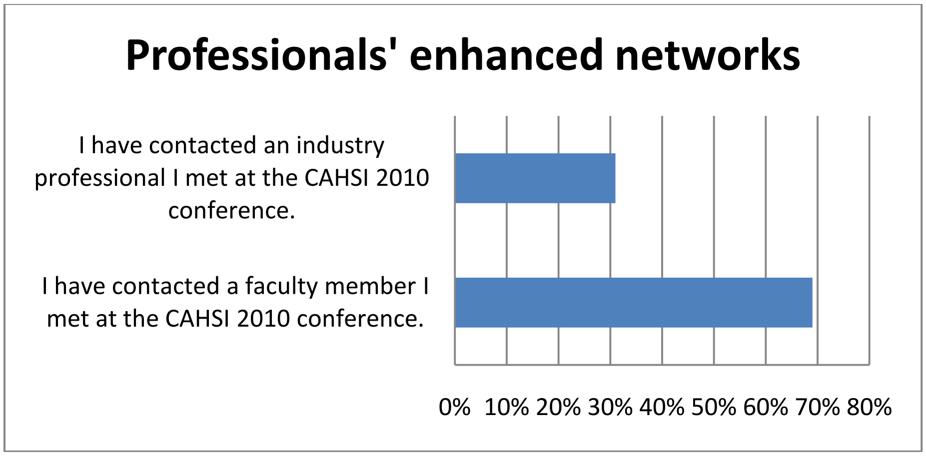


Figure 12: Professionals' Reported Activities Following CAHSI Event—Communication

Professional Development

CAHSI aims to promote the development and refinement of professional knowledge in the computing fields, during and after participants' time at the annual meeting. Many computing professionals who attended the CAHSI annual meeting later continued to learn more about speakers' computational areas of expertise by searching for (75%, 12 professionals) and reading (75%, 19 professionals) research articles and materials written by CAHSI presenters. These rates were higher than those reported by faculty and industry participants of the 2009 annual meeting. Last year, closer to 50% of professional searched for and read research materials written by CAHSI presenters.

Facilitation of Student Advancement

To a lesser degree, professionals facilitated student advancement following the 2010 CAHSI annual meeting. Industry professionals and faculty members contacted students more often for general reasons (56%, 9 professionals), though some professionals contacted students about research or internship opportunities (31%, 5 professionals). These rates almost exactly matched those from last year's annual meeting.

Non-student participants were asked to rate their satisfaction with the peer review process- the six who participated stated the process was somewhat (2) or very (4) satisfying. A participant mentioned spreading the responsibility for programming across multiple institutions would improve the meeting.

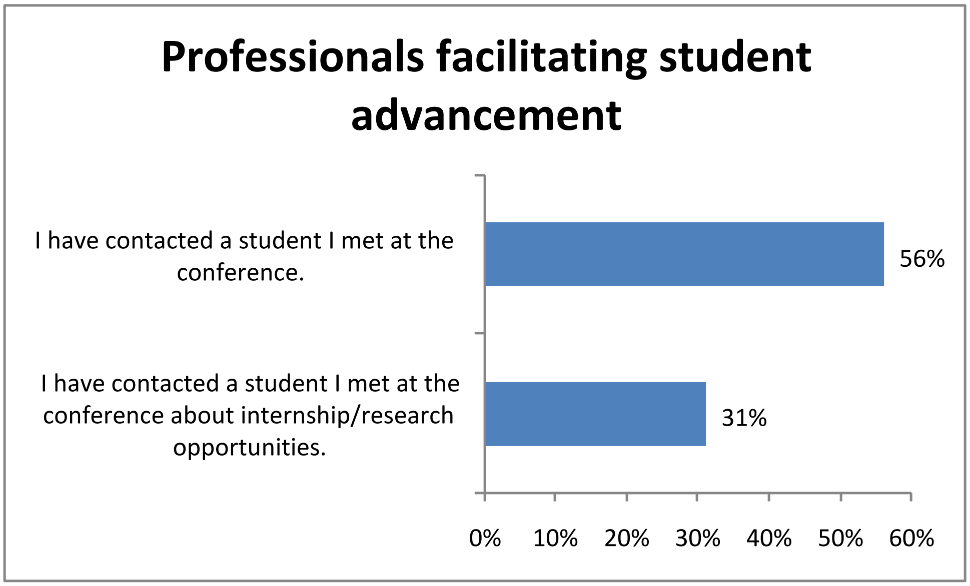


Figure 13: Professionals' Reported Activities Following CAHSI Event—Facilitation of Student Development

DISCUSSION

The CAHSI annual meeting provided many opportunities for participants to network in a more supportive and personal environment than is typically found at a professional conference. Attendees appreciated hearing the inspirational and motivating stories of the keynote speaker and the student and professional panels. Participants also extended the life of the conference by maintaining their networks after the conference and sharing information about CAHSI interventions with colleagues within and beyond their departments. Students also reported applying for scholarships and graduate school at higher rates than reported by last year's participants. Most attendees, particularly faculty and industry professionals, built upon their learning from the conference by searching for and reading materials written by CAHSI speakers. Survey data suggest that the CAHSI annual meeting facilitated student and faculty professional development and enhanced participants' professional networks.

BPC GOAL 2: SUPPORTING A POSITIVE CULTURE OR CLIMATE

The focus of CAHSI evaluation in the area of positive culture or climate has shifted throughout the project. Until now, the focus on departmental culture has been on students' perceptions of a positive environment to work and learn—demonstrated each year the evaluators have been engaged with CAHSI. As CAHSI grows and moves toward sustainability, we shifted focus to those who impact culture more directly—faculty. For CAHSI to be sustained, the effort must permeate departments, leading to lasting change where change is needed, or lasting positive support for students where department environments may have been positive at the start of CAHSI. .This section of the report details results from faculty and Principal Investigator surveys with CAHSI affiliation. The purpose of the survey was to ascertain the following:

- The level of faculty and instructor ***awareness*** and ***participation*** in the CAHSI initiative within departments
- Faculty members' impressions of their ***campus community*** before and after the adoption of CAHSI initiatives
- Faculty members' impressions of their departments' ***visibility*** before and after the adoption of CAHSI initiatives.

This report section summarizes data collected to date from 40 faculty members at CAHSI institutions, and is supplemented with data from PIs regarding CAHSI participation, as a validation check regarding faculty responses, and as a way to measure faculty participation in the survey with respect to PI's reports of faculty participation in the CAHSI initiatives. This evaluation data serves to document the ways in which CAHSI is developing with sustaining a positive culture in mind.

SURVEY PARTICIPATION

Faculty names were culled independent from CAHSI PIs, through a department search via all seven institution websites. To ensure all currently teaching undergraduate faculty and instructors were contacted, evaluators compared these lists with current academic course offerings in required undergraduate courses, adding any names that were missing from the initial department faculty listings. In all, 143 requests were made. Three messages were marked undeliverable, leaving 140 potential respondents from seven schools. Respondents were reminded with three additional requests for information following the initial request, only if the respondent had not yet replied to the survey. This total figure differs from the numbers of faculty provided by PIs- in most cases, evaluators contacted faculty and course instructors listed on departmental websites. All PIs completed a related survey, in an effort to triangulate data from multiple department perspectives. See table below.

Table 12: Response rate by institution

School	Number of faculty in department (PI survey response)	Number of Faculty survey responses
CSUDH	14	4
UTEP	10	9
TAMUCC	14	5
UPRM	17	10
NMSU	10	6
FIU	13	3
UHD	11	3

To understand whether the respondents were more likely to be participants or non-participants in the CAHSI program, Principal Investigators and project leaders were asked to list the faculty and instructors who are participating in the alliance, then compared the participation of those individuals with respondents.

DEMOGRAPHICS OF FACULTY SURVEY RESPONDENTS

Faculty respondents came from all seven institutions. The chart below describes participation throughout the alliance institutions. The pie chart indicates number of faculty and percent of total respondents from each institution.

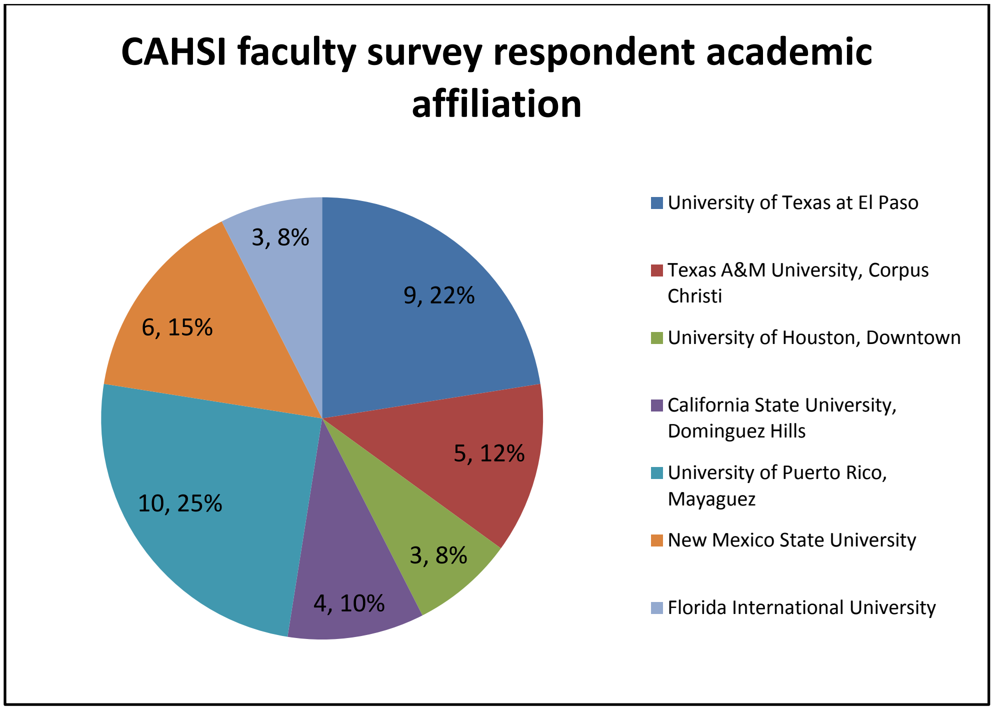
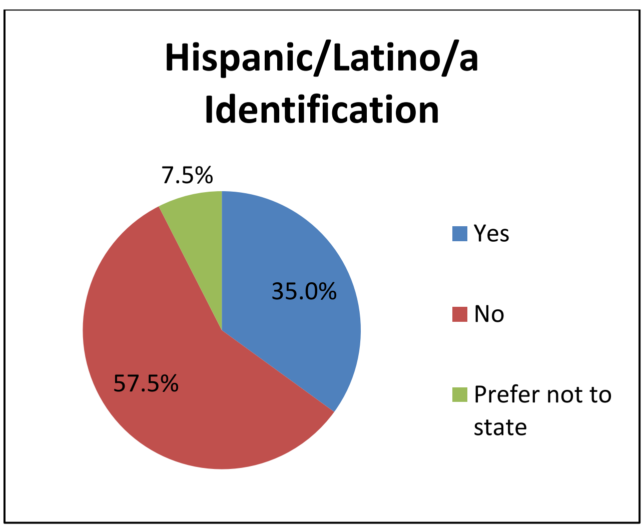
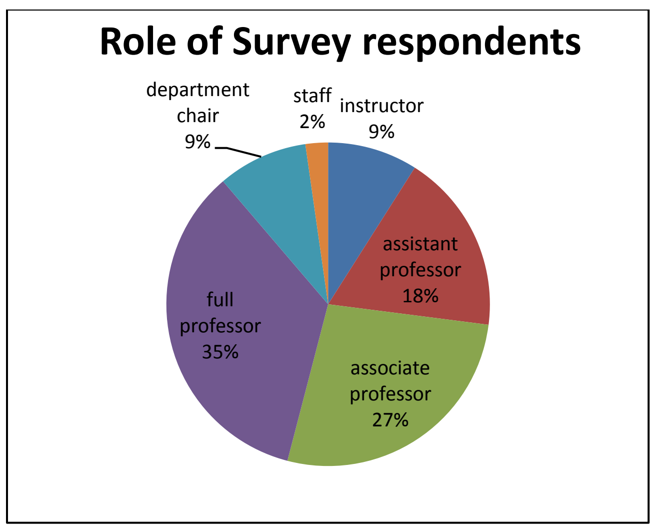


Figure 14: Respondents' academic affiliation

A third of respondents (14, 35%) indicated they considered themselves Hispanic/Latino/a, a large portion of faculty, compared to the proportion of faculty in computing nationally who identify as Hispanic (1.7% according to Taulbee 2008). The majority of survey respondents were tenured professors (15 full professors, 12 associate professors) and the next common position held by survey respondents was that of assistant professor (8). A small number of instructors (4) and staff members (1) participated. Four respondents were also department chairs.





Figures 15,16: ethnicity of respondent, departmental role of respondent

FACULTY BREADTH AND DEPTH OF KNOWLEDGE, EXPERIENCE WITH CAHSI

Trends in CAHSI faculty awareness data show a critical mass of survey respondents engaged in CAHSI early in its development (fall 2005), and a gradual increase in CAHSI participation can be seen over time, from 13 faculty and staff to 28 across seven institutions. A quarter of respondents stated they were not aware of CAHSI. See table below.

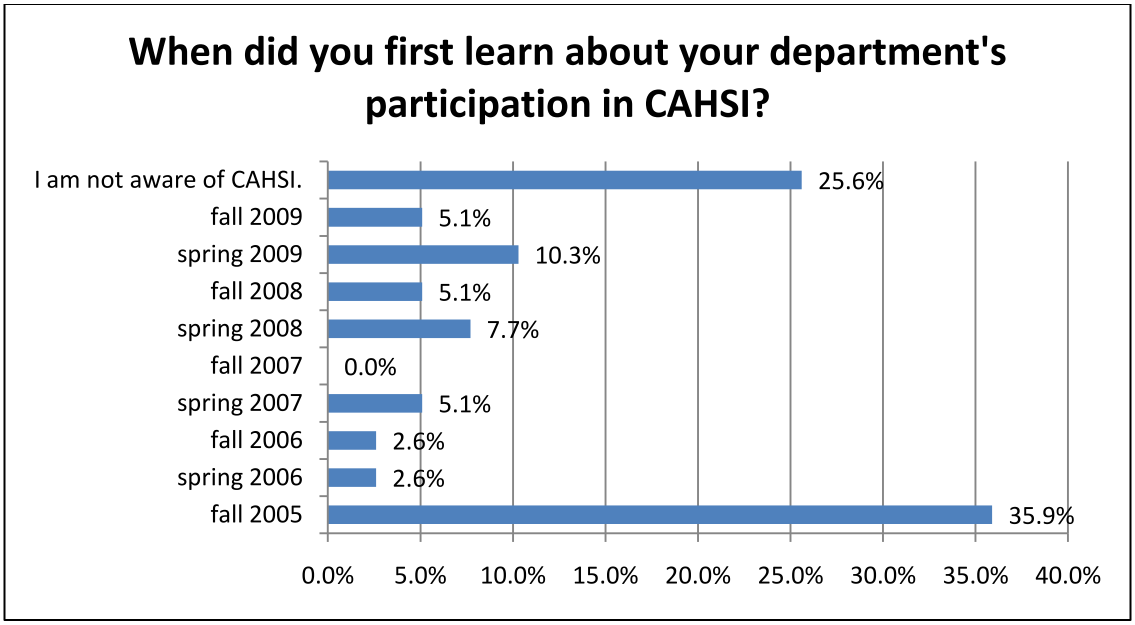


Figure 17: Faculty awareness of CAHSI, by semester of awareness

A similar trend can be seen in participation, with only a few participants who are aware of CAHSI indicating they do not participate in CAHSI. Note a time lag between awareness and participation that exists in the data. For example, four survey participants became aware of CAHSI in spring of 2009, and five indicate they began participating in fall of 2009.

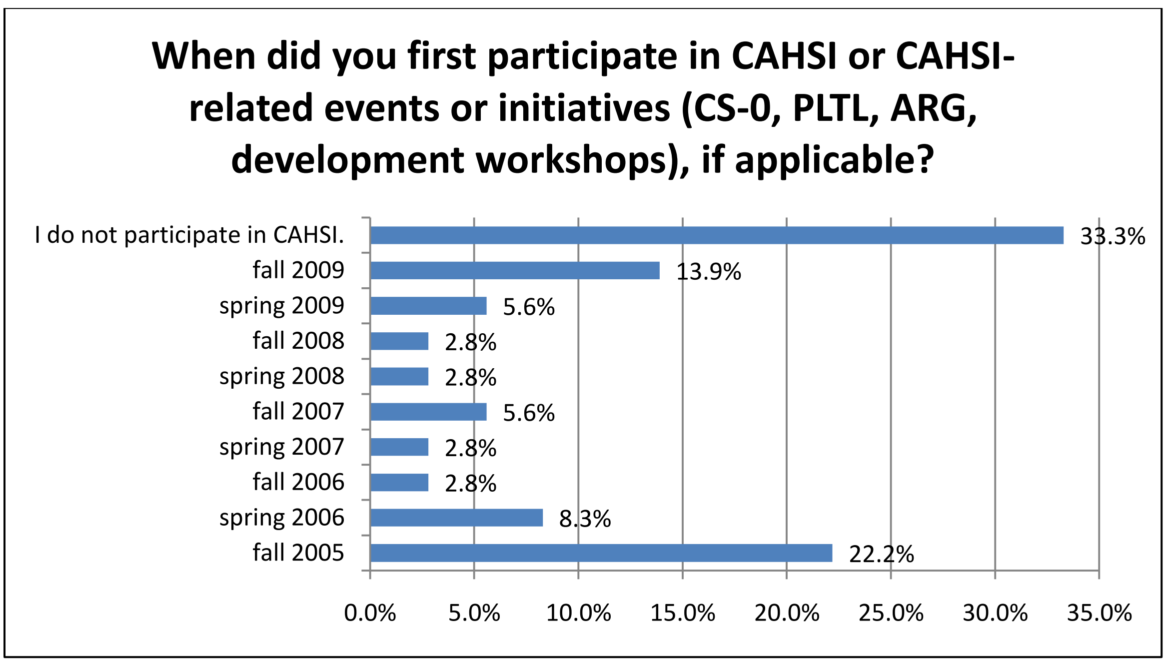


Figure 18: Faculty participation in CAHSI by semester of first participation

FACULTY PARTICIPATE IN CAHSI THROUGH MENTORING, TEACHING, ORGANIZING EVENTS

Faculty and instructors indicated the CAHSI activities in which they participate. Respondents chose activities from a list. Twenty three participants surveyed listed participation in an average of 4.6 activities per participating respondent, 106 responses in all. Five additional respondents state that while they do not participate in CAHSI, they know that their students are engaged in the initiative.

CAHSI FACULTY MENTOR STUDENTS, LESS SENIOR FACULTY

About a third of survey respondents across institutions mentor students regarding research, graduate school application, and academic careers, 14 of the 40 respondents indicated at least one of the three mentoring activities they perform through CAHSI. The majority of positive responses came from associate professors (4-5 of each student mentoring response). Six of the seven CAHSI institutions are represented in the "mentoring of students" data. The four faculty members who say they mentor CAHSI professors are associate and full professors representing three institutions. See table below.

Table 13: CAHSI faculty participation in mentoring activities for students, other faculty

CAHSI faculty participation in mentoring		
	Percent of respondents	Number of respondents
I mentor a CAHSI student regarding research (e.g., in an Affinity research group)	32.4%	11
I mentor a CAHSI student regarding graduate school application	29.4%	10
I mentor a CAHSI student regarding academic careers	35.3%	12
I mentor a CAHSI PROFESSOR regarding research (e.g., in an Affinity research group)	11.8%	4
I mentor a CAHSI PROFESSOR regarding his or her academic career	11.8%	4

CAHSI FACULTY TEACH, DEVELOP CURRICULUM

A fifth to a quarter of faculty members who participated in the survey were engaged in student teaching or training in CAHSI initiatives, particularly CS0, PLTL and ARG. Those who taught were more likely to be instructors (3) and those who trained and developed courses were more likely associate/full professors (4 and 6, respectively). Six of seven campuses were represented in positive responses to these items, and according to PIs, four receive outside funds to do this curricular research work.

Table 14: CAHSI faculty participation in training and teaching CAHSI initiatives

CAHSI faculty participation in training, teaching		
	Percent of respondents	Number of respondents
I train students in CAHSI initiatives (e.g., ARG, PLTL leaders)	26.5%	9
I teach a CAHSI-sponsored course (PLTL, ARG as a course for credit, CS-0)	20.6%	7
I assist in developing a CAHSI-sponsored course	23.5%	8

CAHSI FACULTY DEVELOP, PARTICIPATE IN CAMPUS BASED, NATIONAL ACTIVITY

The number of faculty members who engage in the organizational operations of CAHSI are, as expected, smaller than the number of faculty members who participate in the day to day operations of CAHSI implementation. CAHSI is represented nationally by a cohort of faculty core to its operation. A quarter of responding faculty members attend on-campus CAHSI events and a larger portion of faculty members (35%) attends national events. This discrepancy may be due to some institutions' lack of CAHSI activities beyond classroom interventions and research opportunities. See table below.

Table 15: faculty participation in CAHSI activities

Faculty participation in CAHSI activities		
	Percent of respondents	**Number of respondents**
I advise faculty regarding CAHSI's mission and goals	**11.8%**	**5**
I serve as the appointed CAHSI advocate at my institution	**15.2%**	**6**
I represent CAHSI at national or international events	**17.6%**	**6**
I coordinate CAHSI activities on campus	**20.6%**	**7**
I attend CAHSI event(s) on campus (e.g., student workshops, speaker series, recruitment events)	**29.4%**	**10**
I attend CAHSI event(s) off campus, such as workshops, Broadening Participation in Computing conferences, or the CAHSI annual meeting	**35.3%**	**12**

FACULTY IMPRESSIONS OF DEPARTMENTAL COMMUNITY

In an effort to understand faculty impressions of departmental community since the CAHSI alliance began, the survey included items that relate to the evaluation team's operational definition of "academic community". The survey addressed whether faculty perceived change in the following:

- Change in student research participation
- Change in student collaboration with peers
- Change in student-initiated event development
- Change in faculty interaction with students (self report and impression of other faculty members' interactions with students)

Survey response numbers are not sufficiently large to divide analysis by institution, and so overall responses are reported. Evaluators look across items to detail the different patterns of community responses, and to indicate the overall number of faculty reporting change in one or more departmental community areas.

Nearly all faculty aware of CAHSI perceive gain in departmental community

Evaluators looked across related items to ascertain how many faculty members noticed a difference in at least one area of departmental community since CAHSI began. Of the 29 individuals who were aware of CAHSI and therefore completed the related change items, 22 (76%) mentioned a positive change in one of the departmental community elements of CAHSI. The specific changes in departmental community are described across CAHSI in the following section.

Increase in undergraduate research on campuses, according to most faculty

Engaging students in on campus work is thought to increase retention and sense of community for students (Astin, 1987[5]) .The majority of faculty state that the CAHSI initiative has increased students' participation in computing research (64%) though 36% noted it has not changed students' behavior regarding computing research. Of the 10 respondents indicating no change, two mention that CAHSI initiatives were in place before the beginning of the Alliance at their institution.

[5] Astin, A. (1987). *Achieving educational excellence.* San Francisco: Jossey-Bass.

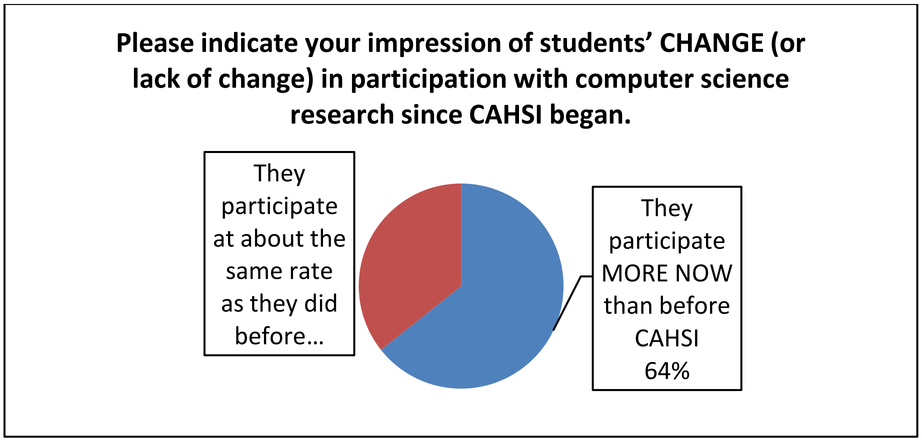


Figure 19: Faculty impressions of students' change in research participation

A slight majority of faculty who responded to this item agreed that students participated more in research since CAHSI began. Of 29 who answered this item, 16 felt student collaboration had increased, while 13 thought peer collaboration in the department was the same as it was before CAHSI.

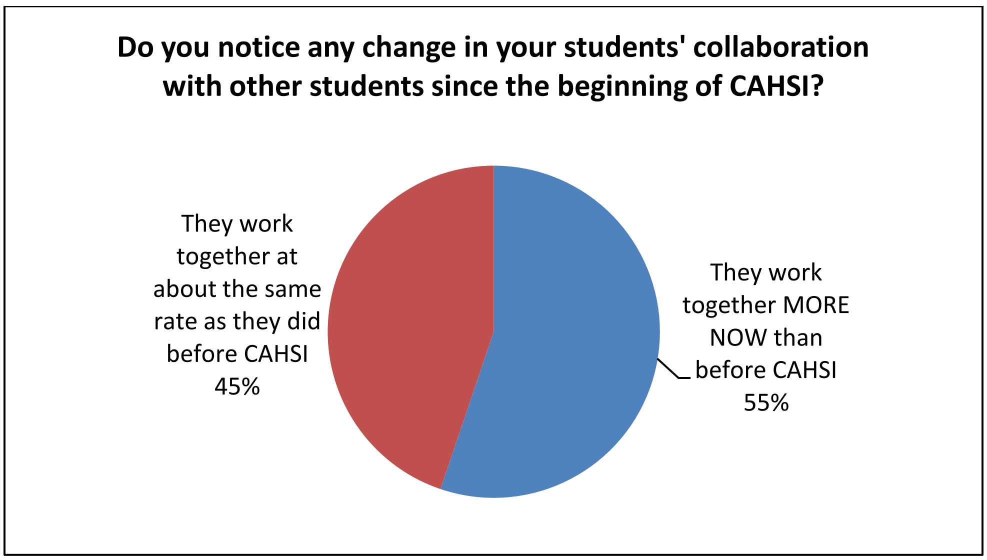


Figure 20: Faculty impressions of change in student collaboration with peers

Some change in faculty interaction perceived by CAHSI faculty

Faculty impressions of student interaction changes were slightly less apparent for CAHSI faculty—less than half (45%) state they spend more time interacting with students and less than a third (31%) find other faculty spend more time interacting with students since CAHSI began. It is important to note that research shows Hispanic-serving institutions tend towards greater faculty interaction than predominantly white institutions (PWIs) (www.luminafoundation.org, Kuh, et al 2005), and so faculty impressions of lack of change in this area may indicate that a great deal of faculty interaction with students was already in place when CAHSI began.

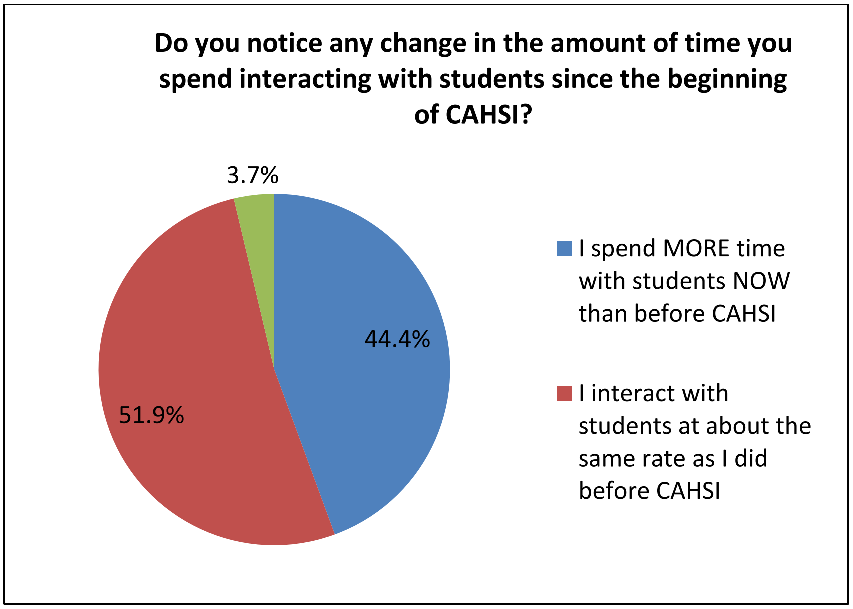


Figure 21: Faculty impressions of their change in student interaction

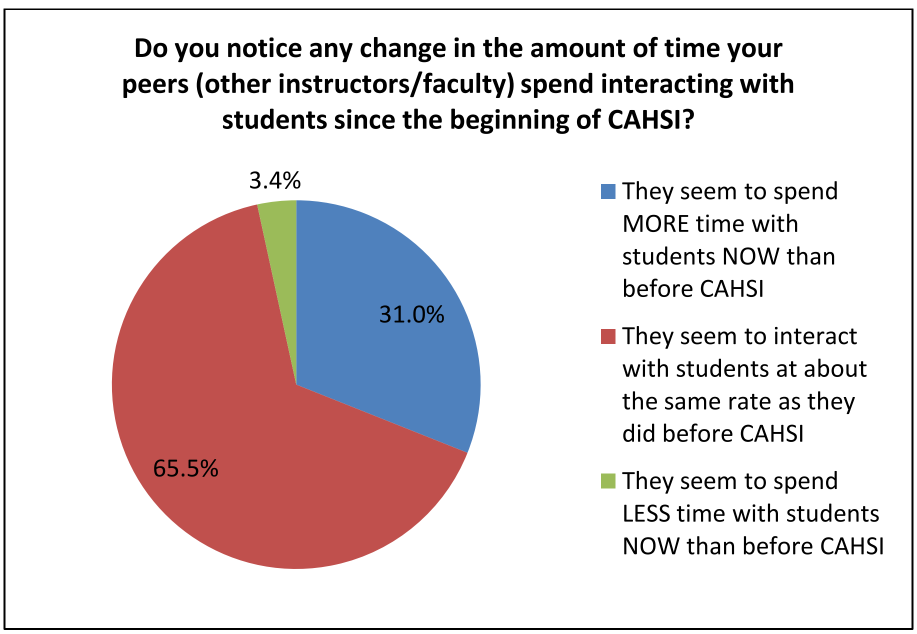


Figure 22: Faculty impressions of other faculty members' change in student interaction

CAHSI FACULTY IMPRESSIONS OF DEPARTMENTAL VISIBILITY, REPUTATION CHANGES SINCE CAHSI

Though not one of CAHSI's intended goals, a positive consequence of the CAHSI alliance mentioned by a few PIs and determined anecdotally by evaluators has been the impression that the CAHSI alliance may elevate departmental visibility and reputation. According to faculty survey results, ***nearly a third of respondents described a change in visibility on campus (12 of 35 responses) and a quarter of faculty (8 of 33 responses) said visibility increased beyond campus.*** Those who explained their responses indicated faculty members' achievements and departmental activities sponsored by CAHSI led to greater visibility. This visibility may be leading to increased collaboration- six funded research in education projects have been funded across campuses since CAHSI began, and five separate computing research projects help to keep CAHSI alliances connected. Faculty members mentioned their peers know of CAHSI because of industry interest in the alliance, and that faculty among the alliance are better acquainted with other member institutions through continual CAHSI participation. Regional schools express interest in joining the alliance via CAHSI faculty as well.

EXTENDING, LEVERAGING CAHSI THROUGH ADDITIONAL PROPOSALS

Faculty members were asked to describe whether or not they had participated in grant proposals that reference the activities of CAHSI. Of the 38 faculty who responded to this item, more than half (21 faculty, 55%) had participated in a grant proposal that leveraged CAHSI, seven of them (18%) participated in 3 or more such proposals. These proposals spanned K12 through undergraduate education, four CAHSI initiatives, and at least five funded programs.

SUMMARY OF FACULTY SURVEY ANALYSIS

Many faculty survey respondents at CAHSI institutions are aware of and participate in CAHSI initiatives, activities, and events, though awareness across departments shows room for improvement at the faculty/instructor level. Those aware of CAHSI report positive elements of departmental change since the beginning of the Alliance, including increased student collaboration, more opportunities for student research, and increased faculty interaction. Responses indicate a division of labor in which instructors tend to run the day to day work of campus-based initiatives and senior faculty are meeting and organizing the greater effort across campuses-additional faculty collaboration across career stages may be beneficial. The notion that CAHSI is creating more visibility for departments is a positive indicator that CAHSI's alliance is viewed as cohesive, and lends support for the potential of sustainability of the effort.

FROM CLIMATE TO CAPACITY : BEGINNING MEASURES OF ORGANIZATIONAL CHANGE AND SUSTAINABILITY

As CAHSI intends to retain and advance students at the departmental level and collectively serve as a "unified voice" for Hispanics in computing, departmental capacity and alliance capacity must be considered. The development and sustained growth of CAHSI as an alliance that thrives beyond NSF grant funding depends upon the institutions' collective and individualized attention to human resources, leadership, knowledge development, revenue development and opportunities for continuous engagement (Eib & Miller, 2006; Henderson, 2007; Newmann, Kings, & Young 2000). The indicators developed for this rubric are based on research on institutional change, program capacity, and sustainability, particularly the model presented by Johnson, Hays, Center, and Daley (2004). We attend primarily to the authors' stated goal of infrastructure capacity building. According to the authors, infrastructure capacity building objectives include the ability of the organization to:

"a) strengthen and maintain structures and formal linkages, b) strengthen, maintain, and cultivate leadership, c) increase or maintain resources to sustain innovation, d) build and maintain expertise to sustain the innovation" (Johnson, et al 2004, p.139-140).

In this section, we describe the Alliance rubric developed based on research literature that seeks to measure CAHSI's initial efforts to increase alliance capacity and sustainability on its campuses beyond the grant funding allowed. As CAHSI has officially received five additional years of BPC National Science Foundation funding, the rubric is developed at an initial level, with the assumption that the benchmarks will change with time. The main foci of this rubric are healthy pipeline development, resource development, and faculty/student engagement. PI and co-PI surveys as well as the faculty survey described above were developed with this rubric in mind, and current results as of summer 2010 are presented below in the rubric.

Healthy pipeline development refers to the activities occurring at each institution to feed, support, and improve the flow of the computing academic pipeline. The activities described here are not an exhaustive list, and move beyond specific initiatives to look at a departments' capacity to recruit retain and advance students. Measures within this strand include:

- CAHSI academic departments with computing outreach programs targeting under represented K12 groups (young women, Hispanics) using CAHSI funds or resources

- CAHSI academic departments with at least one CAHSI faculty member funded to develop or redevelop undergraduate curriculum/ educational activities

- CAHSI academic departments with undergraduate research opportunities supported with CAHSI funds or resources

- CAHSI departments serving at least 5 undergraduate students with **formal** graduate school application preparation with CAHSI funds or resources (e.g., Mentorgrad/Fem Prof activities using GRE materials provided by CAHSI faculty, supporting CAHSI student travel to Grad Lab with CAHSI funds)

Resource Development and Training illustrates ways CAHSI institutions are supporting faculty and student knowledge development related to CAHSI initiatives, through training, resource creation and resource sharing. While it is not necessary for all schools to fill both of these tasks, a goal for CAHSI is to spread responsibility and leadership to ensure a large cadre of faculty are prepared to extend training beyond CAHSI schools and within CAHSI schools if funding were diminished. Measures within this strand include:

- CAHSI academic departments that have hosted a CAHSI training for faculty or students on their campus

- CAHSI academic departments with a faculty member engaged in leading CAHSI training beyond his or her campus

Faculty/Staff Engagement refers to the depth and breadth of campus faculty engagement with CAHSI activities, knowledge development, and dissemination. Unlike other strands, this strand reports the proportion of faculty members and instructors who teach undergraduate courses and are 1) aware of or 2) engaged in and 3) trained in CAHSI activities. Measures within this strand include:

- Proportion of department faculty who are aware of CAHSI (survey responses by institution)

- Proportion of department faculty who participate in CAHSI on campus (survey responses by institution; PI report)

- Proportion of department faculty who have been trained in CAHSI initiatives (survey responses by institution, records of attendance)

Indicator	CSU DH	FIU	NMSU	TAMU CC	UHD	UPRM	UTEP	CAHSI
Healthy Pipeline								
K12 outreach								
Develop/restructure curriculum								
Research opportunities								
CAHSI graduate application								
Resource Dev Training								
Host training								
Led training								
Fac/Staff Engagement								
CAHSI awareness (50%) (faculty survey)								
CAHSI participation (33%) (faculty and PI surveys)								
CAHSI-trained (15%) (PI survey)								
Key=	**exemplary**		**developing**		**Not present**			

Figure 23: Organizational Capacity Rubric CAHSI Spring/summer 2010

From the rubric developed for the 2009-2010 school year, it seems that two areas of interest for development within CAHSI are the department-wide faculty engagement and awareness of the CAHSI initiative, and recruitment and curricular development efforts across CAHSI. CAHSI institutions have been able to train faculty through widespread hosting and leading of training for faculty and students at member institutions and joining institutions, and CAHSI's reach towards undergraduates has been strong- with each university able to provide research experiences to students and nearly all providing individualized training to undergraduates regarding graduate school application. The CAHSI evaluation team will continue to focus on these organizational capacity elements over the next five years of the CAHSI grant.

BPC GOAL: COMPLEMENTARY SOCIAL SCIENCE/EDUCATIONAL RESEARCH THAT INFORMS CAHSI

The social science network of CAHSI has provided the alliance with information that informs the theoretical and political underpinnings of the CAHSI multi-initiative strategy. The educational initiatives themselves have a rich basis in educational research, as well as anthropological, sociological, and anthropological efforts in education and related fields. The evaluators, trained social scientists from a top graduate program in educational research, bring their experience with learning theory as well as evaluation to design data collection and analysis procedures for this evaluation. In collaboration with social scientists and the CAHSI Principal Investigators and faculty, the evaluators and CAHSI team have produced XX articles and presentations, spanning educational, evaluation, technical, and socio-cultural research venues. A list of published, presented, and pending publications and presentations with collaboration from evaluators can be found below.

- **Alonso, M., Hug, S., & Thiry, H. (under review, 2011) Work in Progress: Recruiting computing students through IN-COMMAND CS-0: An INtroduction to COMputing through Mobile ApplicatioN Development. Paper presentation at the American Society for Engineering Education.**

- **Chi, W., & Hug, S. (under review, 2011). Women in Computing: Investigating the Success of a Program to Increase Female Participation. Paper presentation at the American Society for Engineering Education.**

- **Freudenthal, E., Gonzalez, R., Ogrey, A., Hug, S., and Roy M.K. (2010). A Computational Introduction to STEM Studies. Paper presented at the American Society for Engineering Education, Louisville, KY.**

- **Gates, A., Hug, S., Thiry, H., Alo, R., Beheshti, M., Fernandez, J., Rodriguez, N., & Adjoadi, M. (under review) The Computing Alliance for Hispanic Serving Institutions: Supporting Hispanics at Critical Transition Points. Invited paper for the Transactions of Computer Education (ToCE) publication, IEEE.**

- **Hug, S. Jurow, S. & Chi, W. (under review) Learning Together or Going It Alone: How Community Context Shapes Women's Scientific Identity Development. submitted to Gender and Education.**

- **Hug, S., Thiry, H., Villa, E., & Kephart, E. (2010, May) Situated Learning Theory as a Framework for Apprenticing Hispanics Into Computer Science Research in the CAHSI Community. Paper presented at the annual American Educational Research Association conference, Denver, CO.**

- **Hug, S. & Jurow, S. (under review, 2011) A socio-cultural perspective on supporting critical female advocates for equity in engineering learning communities. Paper presentation at the American Society for Engineering Education.**

- **Hug, S., Tedford, P., & Thiry, H. (under review, 2011) Learning to Love Computer Science: Peer Leaders Gain Teaching Skill, Communicative Ability and Content Knowledge in the CS Classroom. Paper presentation for the Special Interest Group for Computer Science Education (SIGCSE) conference.**

- **Hug, S., Thiry, H., Gates, A., Villa, E. & Kephart, K. (2009). Developing the identity of a scientist: Situated learning theory as a framework for apprenticing Hispanics into computing. Presented at the**

3rd Annual Conference on Understanding Interventions that Broaden Participation Research Careers, American Association for the Advancement of Science. Washington, D.C. May 7-9, 2009.

- **Jurow, S., & Hug, S. (under review, 2011) Developing female advocates for equity in science communities: A Socio-cultural perspective. Paper presentation at the International Society for Cultural-Activity Research, Rome, Italy, 2011.**

- **Kephart, K., Villa, E. Gates, A.Q., Hug, S., & Thiry, H. (in review). Affinity Research Groups in Practice: Apprenticing Students in Research, submitted to Journal of Engineering Education.**

- **McKlin, T., Bizot, B., & Hug, S. (2009, November). Indicators for Evaluating Pipeline Programs Paper presented at the annual American Evaluation Association conference, Orlando, FL.**

- **Thiry, H., Hug, S. (2010, May). The Computing Alliance of Hispanic-Serving Institutions: Supporting Undergraduate Computing Majors at Critical Transition Points. Paper presented at the annual American Educational Research Association conference, Denver, CO.**

- **Thiry, H., Hug, S. & Weston, T.J. (in review, 2010). The Computing Alliance of Hispanic-Serving Institutions (CAHSI): Enhancing the success of Hispanic Undergraduate Students in Computing Disciplines. Manuscript submitted to the Enrollment Management Journal.**

BPC GOAL: SERVING AS A VISIBLE MODEL/REPOSITORY FOR EFFECTIVE PRACTICES TO BROADEN PARTICIPATION

The CAHSI Alliance Rubric illustrates the elements of funding, dissemination, and extended collaboration internally and externally that CAHSI needs to prepare for sustainability and growth beyond the years of the grant, with emphasis on cultivating dispersed leadership, extended linkages among partners, maintain resources, and further develop organizational knowledge and expertise. Particularly regarding revenue development, the rubric is calibrated with additional years of funding in mind, and focuses on diversifying funding rather than assuming complete financial independence at this time.

- Proportion of CAHSI's programmatic initiatives with downloadable materials for CAHSI-wide use on the CAHSI website [85-100% exemplary, or 6 of 7 initiatives]

- CAHSI academic departments with funded collaborations with other CAHSI and non-CAHSI institutions regarding computing research [5-10 projects that are collaborative across over 50% of institutions]

- CAHSI academic departments with funded collaborations with other CAHSI institutions regarding education or service [5-10 projects that are collaborative across over 50% of institutions=exemplary]

- CAHSI academic departments that have referenced CAHSI and/or leverage CAHSI support in a grant proposal [10-15 proposals across 50% of institutions =exemplary]

- CAHSI departments using additional (non-BPC) funds to support CAHSI initiatives (e.g., through institutionalization, departmental discretionary funds, industry support; 5-7 institutions=exemplary)

- CAHSI initiatives receiving external financial, human, or material support organization-wide (e.g., annual meeting support from industry, volunteer papernet support from faculty) [10-15 connections with formalized agreements including actionable and or measureable sharing of resources from more than two types of organizations is exemplary- e.g., universities, research/policy organizations, professional organizations, industry, non-profits]

- CAHSI faculty as contributing authors on CAHSI publication or academic presentation regarding CAHSI supported initiatives [10-15 engaged PIs/faculty publishing or presenting in more than 2 total venues]

Alliance impact indicator	Not present/needs substantial improvement (0)	Developing/ needs improvement (5)	Exemplary (10)
Website dissemination	0-42% of initiatives with website documentation/ materials (0-2)	43%-84% of initiatives with website materials available to the public (3-5)	85-100% of initiatives with website documentation/materials (6-7) =exemplary
Cross institutional funding-research	0-1 collaborative projects	2-4 projects that are collaborative across two to four institutions	5-10 projects that are collaborative across over 75% (5 of 7) of institutions =exemplary
Cross institutional funding-education/service	0-1 collaborative projects	2-4 projects that are collaborative across two to three institutions	5-10 projects that are collaborative across over 50% of institutions =exemplary
CAHSI Alliance impact: CAHSI grant proposals	0-4 proposals across institutions	5-9 proposals across 5 or fewer institutions	10-15 proposals across 75% (6 of 7) of institutions =exemplary
Funds for CAHSI supplemented at the department level	0-1 institutions= not present	2-4 institutions	5-7 institutions=exemplary
Resources for CAHSI organization-wide	0-4 connections formed with similar organizations	5-9 connections, some with formalized agreements, across at least two types of organizations	10-15 connections with formalized agreements including actionable and or measureable sharing of resources from more than two types of organizations = exemplary
Faculty dissemination	0-4 engaged PIs/faculty publishing or presenting in 1-2 venues	5-9 engaged PIs faculty publishing or presenting in two or fewer venues	10-15 engaged PIs/faculty publishing or presenting in more than 2 total venues= exemplary

Figure 24: Alliance impact rubric

The alliance impact rubric indicates a need to continue developing website materials for a greater audience that is available for download. CAHSI alliance members note difficulty in creating a template or model for standardizing materials across institutions and continuity across initiatives. Alliance members may benefit from cross-institutional research funds, as these funds would support faculty and students as well as create opportunities for collaboration beyond the grant funding to date. CAHSI has been particularly effective at creating connections with non-profit and corporate partners and has already made use of these connections to secure tangible resources, such as meeting space, tuition and travel funds, and training opportunities. Similarly, departments have been successful at supplementing CAHSI funding with other campus-based resources, as well as securing educational funds from outside the institutions.

CONCLUSION

The Computing Alliance of Hispanic-Serving Institutions (CAHSI) is a partnership of ten higher education institutions with the mission of increasing the number of Hispanics pursuing bachelors and advanced degrees in computing.[6] To achieve these goals, the alliance has implemented multiple interventions across three critical educational transitions: high school to college; undergraduate to graduate study; and graduate study to the professoriate. CAHSI institutions are producing high numbers of computing bachelor degree earners, still above the number of graduates from 2002, a peak year in the nation. While Taulbee data (a record of computing degree production across 150 universities and colleges across the nation) shows a decline to 48% of 2002 degree completions, CAHSI continues to produce more computing degrees than they did in 2002.

[6] While ten institutions are now members of CAHSI, this grant supports the original seven, and so data will reflect the seven original institutions. See SACI for data on the newest members of CAHSI.

CAHSI schools continue to produce a large number of Master's degree recipients, particularly Hispanic Master's degree earners. In fact, in the first full years of CAHSI, seven CAHSI schools served the equivalent of 15% of the Hispanic MS computer science earners from the entire Taulbee database of 150 schools.

The *CAHSI alliance rubric* illustrates the elements of funding, dissemination, and extended collaboration internally and externally, that CAHSI needs to prepare for sustainability and growth beyond the years of the grant, with emphasis on cultivating dispersed leadership, extended linkages among partners, maintain resources, and further development of organizational knowledge and expertise. In several areas, CAHSI is still developing its capacity to disseminate its materials and expand its reach. Areas in which CAHSI is still developing impact include website dissemination and cross-institutional research collaborations and grant proposals. Areas in which CAHSI has been determined to have "exemplary" impact are cross-institutional funding for education/service, departmental-level funding contributions, organization-wide resources, and faculty dissemination of CAHSI activities or achievements. Future evaluation efforts will focus on the ways in which CAHSI provides for sustainability and growth, and the ways in which CAHSI becomes a prominent figure in computer science educational policy for Hispanics in the United States.

REFERENCES

ABET (Accreditation Board for Engineering and Technology). 2009. Criteria for accrediting computing programs: Effective for evaluations during the 2010–2011 accreditation cycle. http://www.abet.org/Linked%20DocumentsUPDATE/Criteria%20and%20PP/C001%201011%20CAC%20Criteria %2011-16-09.pdf , accessed August 17, 2010.

Akbulut, A.Y., and Looney, C.A. (2007), "Their aspirations are our possibilities: Inspiring students to pursue computing degrees," *Communications of the ACM*, 50(10), 67-71.

Alexander, B.B., Foertsch, J. & Daffinrud, S. (1998, July). The Spend a summer with a Scientist Program: An evaluation of program outcomes and the essential elements for success. Unpublished report prepared for CRPC's Director of Education and Human Resources, Richard Tapia and National Partnership for Advanced Computational Infrastructure. Madison, WI: LEAD Center. Retrieved 10/8/07 from http://homepages.cae.wisc.edu/~lead/pages/products/sas.pdf

Astin, A. (1987). *Achieving educational excellence.* San Francisco: Jossey-Bass.

Barlow, A.E. & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching*, *41*(9), 861-881.

Dryburgh, H. (1999). Work hard, play hard: Women and professionalization in engineering—adapting to the culture. *Gender and Society*, *13*(5), 664-82.

Eib, B.J. & Miller, P. (2006). Faculty development as community building. *International Review of Research in Open and Distance Learning*, 7(2), 1-15.

Gates, A.Q., Teller, P.J., Bernat, A., Delgado, N., & Della-Piana, C. (1999). Expanding participation in undergraduate research using the Affinity Group model. *Journal of Engineering Education*. (88), 409-414.

Hathaway, R., Nagda, B., & Gregerman, S. (2002). The relationship of undergraduate research participation to graduate and professional educational pursuit: An empirical study. *Journal of College Student Development, 43*(5), 614-631.

Hunter, A.B., Laursen, S.L. & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education*, *91*(1), 36-74.

Hunter, A.-B., Weston, T. J., Laursen, S. L., & Thiry, H. (2009). URSSA: Evaluating student gains from undergraduate research in the sciences. *CUR Quarterly*, 29(3), 15-19.

Johnson, K., Hays, C., Center, H. & Daley, C. (2004). Building capacity & sustainable prevention innovations: A sustainability planning tool. *Evaluation and Program Planning*. 27(2) 135-149.

Johnson, D.W., Johnson, R.T., Smith, K.A. (1991). *Cooperative learning: Increasing college faculty instructional productivity*. San Francisco: Jossey-Bass.

Kephart, K., Villa, E., Gates, A. Q., and Roach, S. (2008). The affinity research group model: Creating and maintaining dynamic, productive and inclusive research groups. *CUR Quarterly*, 28, 13--24.

Kuh, G. D., Kinzie, J., Schuh, J. H., Whitt, E. J. & Associates (2005). *Student success in college: Creating conditions that matter*. San Francisco: Jossey-Bass.

Lent, R. W., Lopez, A. M., Lopez, F. G., & Sheu, H. (2008). Social cognitive career theory and the prediction of interests and choice goals in the computing disciplines. Journal of Vocational Behavior, 73, 52–62.

Mulkey, L.M. & Ellis, R.S. (1990). Social stratification and science education: A longitudinal analysis, 1981-1986, of minorities' integration into the scientific talent pool. *Journal of Research in Science Teaching*, 27(3), 205-17.

Newmann, F, King, B & Young, P, (2000). Professional development that addresses school capacity: lessons from urban elementary schools. Paper presented at the annual meeting of the American Educational Research Association.

Nagda, B.A., Gregerman, S.R., Jonides, J., von Hippel, W., & Lerner, J.S. (1998). Undergraduate student-faculty research partnerships affect student retention. *The Review of Higher Education, 22*(1), 55-72.

Roach, S. & Villa, E. (2007). Reaching out across disciplines: Learning from each other to produce more graduates in CS. *Second Annual Technology Development Workshop: Best Practices.*

Seymour, E., Hunter, A.B., Laursen, S.L., & DeAntoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Science Education*, 88(4), 493-534.

Sperry, R. A. and Tedford, P. (2008). Implementing peer-led team learning in introductory computer science courses. *J. Comput. Small Coll.* 23(6), 30-35.

Thiry, H. & Hunter, A-B. (2008).Student outcomes from the LA-STEM Research Scholars program: An evaluation of the LA-STEM Research Scholars Program at Louisiana State University, 2007-2008. Report prepared for the National Science Foundation. Boulder, CO: Ethnography and Evaluation Research.

Thiry, H. Hunter, A-B. & Laursen, S.L. (2010). Where do students become scientists? A comparative study of research and other sources of personal and professional gains for STEM undergraduates, manuscript accepted by the *Journal of Higher Education*.

Thiry, H. & Laursen, S.L (in review, 2010). The Role of Student-Advisor Interactions in Apprenticing Undergraduate Researchers into a Scientific Community of Practice. Manuscript submitted to the *Journal of Science Education and Technology*.

Vegso J. (2010) Undergraduate CS Enrollment Continues Rising; Doctoral Production Drops. Vol. 22/No. 3 (May 2010).

Construct	Definition	Sample item
Self efficacy	**A student's judgment of his or her capability to perform effectively in a computing/engineering major**	*"Excel in my discipline over the next two semesters"*
Coping self efficacy	***A student's judgment of his or her capability to cope with a variety of barriers inherent to a computing/engineering major***	*"Find ways to overcome communication problems with professors or teaching assistants in your discipline"*
Educational goals	***Student intentions to persist in their computing discipline***	*Plans to work in computing After graduation.*
Outcome expectations	**A student's judgment regarding the likelihood that valued rewards will occur as a result of pursuing a computing major.**	*"(To what extent do you feel you are) going into a field with high employment demand?"*
Social supports/barriers	**Conditions of department, school, and social network of a student that promote successful completion of the computing major.**	*"(To what extent do you) feel that there are people "like you" in the discipline?"*
Computing interest	**An emotion that arouses attention to, curiosity about, and concern with a computing major.**	*"(How much interest do you have in) solving computer software problems?"*