



Appendix C
Recruiting, Retaining, and Advancing Hispanics in Computing:
CAHSI Progress Report

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Table of Contents

Recruiting, Retaining, and Advancing Hispanics in Computing:	1
CAHSI Progress Report	1
Executive Summary	5
BPC Goal 1: Increasing/contributing to the increase of post-secondary degrees	5
Computer Science Zero- Increasing Regard for Computing Careers for Entry Computing Students	6
PLTL: Retaining Students in Computing.....	6
PLTL: Becoming Leaders, Becoming Mentors	6
Affinity Research Groups: Advancing Undergraduates	7
Development Workshops: Advancing Academic Careers	7
Beyond the PhD—Promoting Hispanic Junior Faculty and Industry Professionals	8
BPC Goal 2: Create sustainable <i>changes in culture or practices</i> at the institutional, departmental, or organizational levels that contribute to broadening participation in computing.	8
BPC Goal 3: Increase the duration and scope of the alliance award	9
BPC Goal 4: Serving as a Visible Model/Repository for Effective Practice to Broaden Participation.....	10
Dissemination.....	10
Distribution of materials, resources	10
Introduction.....	11
Organization of the report.....	11
BPC Goal : Increasing/contributing to the increase of post-secondary degrees	11
Graduating computing professionals: CAHSI institutions in context	11
Proportion of Hispanic students receiving BS degrees in computer science	18
Graduate degree trends in CAHSI schools-Master’s degrees	19
Hispanic Computer Science Masters’ Degree Recipients	21
<i>PLTL—retaining students in computing</i>	21
PLTL: Becoming Leaders, Becoming Mentors	30
Computer Science Zero- Increasing Regard for Computing Careers	33
Advancing Undergraduate Students.....	37
Development Workshops	45
Fem Prof and Mentor Grad- Targeting Promising Students for Doctoral Study...	48
BPC Goal: What is CAHSI doing to support a positive culture or climate?	59
Promoting academic dispositions that enhance classroom learning	60
Explicit development of learning communities.....	61

Seeding faculty-student interaction	62
BPC Goal: Include complementary (social science or educational) research that informs the design of Alliance activities	63
BPC Goal: CAHSI: Serving as a Visible Model/Repository for Effective Practices to Broaden Participation	64

List of Objects

Object 1: Total Number of Computer Science Degrees from the US and Canada Reported in the Taulbee Survey, Years 2002-2007.....	12
Object 2: Total Number of Computer Science Degrees from public and private non-profit colleges and universities in CA, FL, NM, and TX , Years 2002-2007.....	13
Object 3: Total Number of Computer Science Degrees, CAHSI Institutions, Years 2002-2007.	14
Object 4: Percent of 2002 Bachelor Degree Attainment Over Time for Taulbee Schools, Regional Comparison Schools, and CAHSI schools	14
Object 5: Percent of 2002 Bachelor Degree Attainment Over Time for Taulbee Schools, Regional Comparison Schools, and CAHSI schools	15
Object 6: Comparison of CAHSI actual CS degree production with expected degree production, given US and Canada trends reported in Taulbee data, trends in CAHSI comparison school data	16
Object 7: Comparison of Actual CAHSI BS degrees earned annually with expected degree production, given Taulbee data trends	16
Object 8: Comparison of Actual CAHSI CS BS degrees earned annually with expected degree production, given CA FL NM and TX data trends	17
Object 9: Number of CE BS degrees: FIU and UPRM; CAHSI regional schools; and CE BS degrees in Taulbee study.....	17
Object 10: Proportion of Hispanic Students Earning BS degrees in Computer Science in CAHSI Schools and in Comparison Regional Schools	18
Object 11: Total number of Hispanic Computer Science BS graduates summed across regional comparison schools and across CAHSI schools	19
Object 12: Number of Computer Science Master's degrees earned, 2002-2007, from Taulbee study (national estimate) IPEDS data set (CAHSI states) and CAHSI schools	19
Object 13: Computer Science MS Graduates as a proportion of 2002 values.....	20
Object 14: Percent of Computer Science MS Degree Recipients who are Hispanic	21
Object 15: PLTL student Social Cognitive Career Theory Average scores	23
Object 16:PLTL Data comparisons between CAHSI and similar published studies in STEM education	25
Object 17: PLTL leaders' self-report of computing knowledge.....	31
Object 18: PLTL Leaders' Professional Skill Development	31
Object 19: PLTL Leaders' Computing Career Interest.....	32
Objects20-23: PLTL Leader Demographics	33
Object 24: CS-0 Student Average Scores on Social Cognitive Career Theory Constructs (Lent, Et. al. 2008).....	34
Object 25: CS-0 Comparison with publicly available data measuring similar constructs.....	36
Object 26: ARG Students' Top three Gains from Research	38

Object 27: ARG Student Comparisons of Hispanics and non-Hispanics for Research Gains	39
Object 28: Influences on ARG students' Decision to Pursue Graduate School	41
Object 29: Affinity Research Group professional activity	43
Object 30: Researcher's Self-reported Gains as Measured by URSSA.....	44
Object 31: Researcher's Self-report of Academic Research Activity	44
Object 32: Students' Reported Activities Following CAHSI Event—Academic Advancement .	46
Object 33: Students' Reported Activities Following CAHSI Event—Industry Advancement	46
Object 34: Students' Reported Activities Following CAHSI Event—Communication.....	47
Object 35: CAHSI Connections to other Alliances	66
Object 36: CAHSI Dissemination.....	67

Executive Summary

The Computing Alliance of Hispanic-Serving Institutions (CAHSI) is a partnership of seven higher education institutions with the mission of increasing the number of Hispanics pursuing bachelors and advanced degrees in computing. 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.

The executive summary, and the evaluation report itself, is structured to address several of the Broadening Participation in Computing (BPC) Goals. We analyze data across interventions to provide a holistic assessment of CAHSI's progress towards achieving its objectives to recruit, retain, and advance Hispanics in computing. We now address each of the BPC goals in turn.

BPC Goal 1: Increasing/contributing to the increase of post-secondary degrees

In recent years, computer science and engineering baccalaureate degrees have declined nationally. Evaluators compared CAHSI rates of undergraduate degree attainment with national and regional rates of computer science baccalaureate degree attainment.

The 2001-2002 academic year marked the peak of Bachelor degree production in North America. Between academic years 2001-2002 and 2006-2007, the number of degrees earned annually dropped from 16,907 to 10,284. During those years, CAHSI schools saw an increase in the number of bachelor's degrees earned in computer science, from a total of 258 to 322. **Therefore, while the US and Canada are producing fewer and fewer computer science graduates at the Bachelor's degree level each year, CAHSI schools are experiencing steady growth.** CAHSI's success is not attributable to regional anomalies either, as regional schools show an even steeper decline than the national trend.

CAHSI institutions have also increased the number of Hispanic students receiving post-secondary degrees in computing fields. We compared CAHSI to regional schools for baccalaureate graduation rates in CS departments during the target years, 2002-2007. CAHSI graduated are over one third Hispanic (ranging between 31% and 41%), while regional rates were only 9-15% Hispanic. **As computer science degree attainment among Hispanics is declining regionally, CAHSI schools are in fact showing growth in the total number of Hispanic students receiving computer science degrees.**

Evaluators also compared CAHSI graduation rates of master's degrees in computing fields to regional and national trends. Masters' degree production has been more variable in CAHSI schools than in CAHSI comparison schools, where data show a slightly declining trend in recent years. However, CAHSI's current master's degree production is still over one and one half times higher (150%) than in

2002—a rate higher than other institutions in the region. The proportion of Master's degree recipients identifying as Hispanic at the CAHSI schools also far exceeds the national and state level averages.

We now address CAHSI interventions designed to support students and faculty at each of the critical transition points in computing career pathways: high school to college, undergraduate to graduate study, and graduate study to the professoriate.

Computer Science Zero- Increasing Regard for Computing Careers for Entry Computing Students

Computer Science Zero is a course designed to introduce computing concepts to introductory students. CS-0 students took a survey developed by Lent, Brown and Hackett (2004) and based on the constructs of Social Cognitive Career Theory (SCCT): self-efficacy (sense of mastery in computing), interest in computing, outcome expectations (beliefs about the benefits of a computing major or career), and educational goals.

CS-0 influenced students' perceptions about computing careers and their interest in computing. Students reported increases in interest in computing activities (such as solving problems with computers), and enhanced outcome expectations of a computing major. Computer majors perceived supportive academic communities within their departments. When compared to findings from a peer-reviewed study of information technology students using a survey with similar constructs, CS-0 students consistently reported higher gains, including enhanced expectations for positive outcomes from a career in computing, and increased interest in computing.

PLTL: Retaining Students in Computing

Students enrolled in PLTL courses (courses receiving one hour per week of undergraduate student-led activities/instruction) took the same survey as CS-0 students, based on SCCT constructs. ***Nearly 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, access to social support, and increase in interest in computing.***

When compared to findings from national samples of students from refereed articles using the SCCT survey, CAHSI students had ***similar outcome expectations ratings, similar perceived barriers and supports, and similar or better ratings of academic self efficacy*** as more traditional populations of engineering students from two sample studies. Students from PLTL had ***higher interest in computing*** and most important for retention, ***higher educational goal ratings*** than more traditional populations of engineering students. Students had mixed results when comparing coping self-efficacy across populations.

PLTL: Becoming Leaders, Becoming Mentors

Peer-Led Team Learning cultivates pedagogical leaders, students who serve as role models for undergraduates and represent the “next steps” along the academic computing path. Peer leaders were confident they held the knowledge they needed to lead PLTL sessions effectively (100%), and most noted that leading sessions *increased* their computing knowledge (86%). Peer leaders also gained skills that may benefit them in future careers, such as interpersonal skills (91%), leadership skills (95%), oral communication skills (100%), and teaching skills (95%). Creating a cadre of mentors on campus who resemble the underrepresented students CAHSI schools serve appears to benefit not only the undergraduates receiving mentoring but the mentors themselves.

Affinity Research Groups: Advancing Undergraduates

Affinity Research Groups (ARG) are designed to socialize students into professional computer science research communities of practice. ARG students completed a survey adapted from the Undergraduate Research Student Self-Assessment (Laursen, Weston, Hunter, & Thiry, 2009).

ARG students reported roughly equivalent gains (means of 3.2 to 3.4 out of 4.0) on all of the URSSA scales: collaboration/teamwork, career preparation, personal growth, and skills. T-tests revealed that Hispanics made higher gains in career preparation and understanding the research process than non-Hispanic students. 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.

Participation in ARGs also had a strong influence on students’ aspirations to pursue graduate degrees. Students cited the research experience and their research faculty mentor as the primary influences on their decisions to attend graduate school. ARG students learned about graduate school from working with and observing graduate students. Greater knowledge about graduate school increased students’ confidence that they could successfully complete the degree.

ARG students were also able to participate in the broader computer science research community. Over three-quarters of ARG students attended a professional computing conference, and almost half of ARG students presented a poster at a conference. In addition, 13% of students authored or co-authored a journal manuscript, and 15% presented a conference paper.

When compared to a national sample of undergraduate researchers who took the URSSA survey, tests of statistical significance show that ARG students are significantly more likely to report communication skill development, and significantly more likely to attend professional conferences, author or co-author a journal article, and present a poster or academic paper. These activities are vital to students’ academic achievement and support students’ advancement in their academic fields.

Development Workshops: Advancing Academic Careers

From their participation in CAHSI annual meetings, Hispanics are advancing their careers across the academic computing pipeline. Following the annual meeting, students near the beginning of the career path applied for scholarships (26%, 13 students), inquired about graduate school opportunities (46%, 23 students), and submitted applications for graduate school (12%, 6 students). Attendance at the annual meeting also promoted networking among CAHSI students, faculty, and industry professionals. The majority of students contacted peers following the annual meeting, while close to a quarter contacted faculty or industry professionals.

Beyond the PhD—Promoting Hispanic Junior Faculty and Industry Professionals

CAHSI initiatives also target professionals in the computing field. CAHSI evaluators interviewed a sample of five Hispanic industry and faculty professionals engaged in the alliance. CAHSI professionals noted many ways that CAHSI had contributed to their professional development and career success. CAHSI provided funding, resources, information, and materials to support their academic scholarship and the advancement of their students. CAHSI professionals expanded their networks at CAHSI meetings and events. CAHSI professionals also felt a sense of support, mentoring, and community that many of them do not have in their home departments or organizations. One woman mentioned that participating in CAHSI was like an inoculation against the discomfort and isolation she sometimes felt in her job.

BPC Goal 2: Create sustainable *changes in culture or practices* at the institutional, departmental, or organizational levels that contribute to broadening participation in computing.

Researchers have studied higher education “best practices” for decades (Astin, 1975; Kuh 2008), with particular focus on elements that promote rich learning environments for retaining and engaging students. Four of these elements that have been argued to promote student learning, and foster departmental and institutional change, are relevant to CAHSI interventions:

- ***Promoting academic dispositions that enhance classroom learning***
- ***Explicit development of learning communities***
- ***Seeding or facilitating faculty-student interaction*** and
- ***Mainstreaming mentoring***

The opportunity to engage in meaningful, “hands-on” work fosters the skills, knowledge, and temperament that contribute to students’ classroom learning. ***CAHSI promotes academic dispositions that enhance classroom learning through initiatives such as ARGs and PLTL.*** Affinity Research

Groups differ from the traditional undergraduate research model because of the deliberate development of leadership, teamwork, and communication skills through structured mentoring and group interactions (Kephart et al., 2008). Likewise, peer-led team learning emphasizes cooperative learning, and deepened conceptual understanding of course material (Eberlein, 2008; Gosser et al., 2001). Student survey responses demonstrate that participation in ARGs and PLTL helped students to develop the intellectual and technical skills that will contribute to their success and advancement in their coursework.

Departments and institutions that explicitly develop structured learning communities find students are more engaged in their learning, experience greater academic and social support, and increased retention (Astin, 1975; Kuh, Kinzie, Schuh, & Whit 2005; Tinto, 1997). ***CAHSI has explicitly developed learning communities through PLTL and ARGs.*** PLTL communities are inclusive by design, and support peer mentoring opportunities. ARGs leverage the different levels of experience inherent in a research group to foster positive interdependence within the group. Principal Investigators and faculty from CAHSI institutions also describe resurgence in departmental-wide activities, such as the creation of a local computer science club and a new gaming club.

When faculty and students interact regularly, students gain more knowledge and skills than when interaction is limited to classroom participation (Astin, 1993; Endo & Harpel, 1982; Kuh & Hu, 2001). ***CAHSI initiatives have fostered student and faculty interaction***—PLTL leaders meet regularly with course instructors to go over activity planning, ARG students meet with graduate students and faculty to discuss research issues, findings, and next steps, and students who engage in CAHSI scholars, fellownet and papernet have substantive interaction around academic content and goals. Preliminary interview data indicate that CAHSI initiatives have increased faculty-student interaction.

Higher education research has continuously affirmed the notion that mentoring supports students' psychological and professional needs (Hall & Sandler, 1983; National Academies Press, 2009; Tillman, 1995; Zachary, 2005). ***CAHSI initiatives develop webs of support for students in computing departments, encouraging not only faculty mentoring but peer mentoring as well.*** Affinity Research Groups provide structured mentoring opportunities for students and 88% of PLTL students reported that they have access to a mentor in their department. CAHSI annual meetings provide opportunities for mentoring and networking. Following the annual meeting, most students (76%) indicated they had informal mentoring support from faculty.

BPC Goal 3: Increase the duration and scope of the alliance award

At the time of this writing, a BPC demonstration project proposal was under negotiation with the National Science Foundation to add three schools to the CAHSI family: Miami Dade College; University of Texas, Pan American; and California State University, San Marcos. Pending funding, they will participate as full members of the CAHSI alliance, adopting key initiatives, and contributing to leadership and

planning. This addition will broaden CAHSI's reach—combined, these three schools graduated 60 Associate degrees, 47 Bachelor degrees, and 25 Master's degrees in computing fields in 2007-2008.

CAHSI is developing relationships (e.g. Memoranda of Understanding) throughout the broader STEM community; the Hispanic computing community, and within BPC. At this writing, CAHSI has been developing informal and formal relationships with ten organizations, sharing their initiatives and gaining resources through these networks.

BPC Goal 4: Serving as a Visible Model/Repository for Effective Practice to Broaden Participation

To increase awareness of CAHSI and its objectives at the departmental and institutional levels, a new initiative was developed in the latest round of funding. Each campus has at least one student and one faculty advocate for CAHSI. Under the leadership of Miguel Alonso, a new SACI PI, advocates will document their recruitment efforts. Recruitment is aimed at increasing student knowledge of academic opportunities that CAHSI offers and increasing awareness of the broader alliance and its goals. Custom posters were developed for CAHSI institutions to promote this effort.

Dissemination

CAHSI faculty members have spread (or have plans to spread) their initiatives over 11 states via in-person training or presentations. CAHSI faculty and evaluators have shared their knowledge of effective practices in at least 8 professional venues, including HACU publications, the American Educational Research Association, the Understanding Interventions Conference supported by AAAS, and multiple Frontiers in Education conferences. However, CAHSI lacks a systematic method to disseminate broadly, and as CAHSI continues to grow, a more strategic dissemination plan may be in order

Distribution of materials, resources

CAHSI has also distributed resources and materials electronically and through partnerships with other organizations. The CAHSI website has downloadable web resources available for CS-0, PLTL, and ARG. NCWIT, a prominent BPC alliance, has published two promising practices resources that feature CAHSI initiatives, and the Anita Borg Institute highlighted CAHSI's mentoring efforts.

Introduction

The Computing Alliance of Hispanic-Serving Institutions (CAHSI) is a partnership of seven higher education institutions and the Hispanic Association of Colleges and Universities, with the mission of increasing the number of Hispanics pursuing bachelors and advanced degrees in computing. The methods of goal attainment include the implementation of several interventions that address the key causes for under-representation of Hispanics in computing. These interventions support the recruitment, retention, and advancement of Hispanic undergraduate and graduate students and faculty in the computing, information sciences, and engineering (CISE) areas, and are integrated across three critical educational transitions: high school to college; undergraduate to graduate study; and graduate study to the professoriate.

Organization of the report

This year, the progress report is structured to address many of the six Broadening Participation in Computing (BPC) Goals. We analyze data across interventions to provide a holistic assessment of CAHSI's progress towards increasing the number of students, especially Hispanic students, who earn post baccalaureate degrees in computing disciplines. The indicators used to measure success can be found in Appendix A.¹ When related or similar data is available publicly, we compare CAHSI student responses to other students' responses on similar or in some cases the same survey constructs, and compare other publicly available graduation data to CAHSI school data. Through these comparisons we hypothesize that CAHSI students, who tend to be underrepresented in computing and may lack preparation, confidence, and role models in the field, will compare favorably or equally with majority students on indicators such as computing confidence, aspirations to succeed in their field, and ability to cope with pressures in the STEM majors. We also look at "vita enhancing" academic and professional behaviors in which CAHSI students engaged, and compare them to nationally available data to see if CAHSI students are becoming better prepared for continued study in computing.

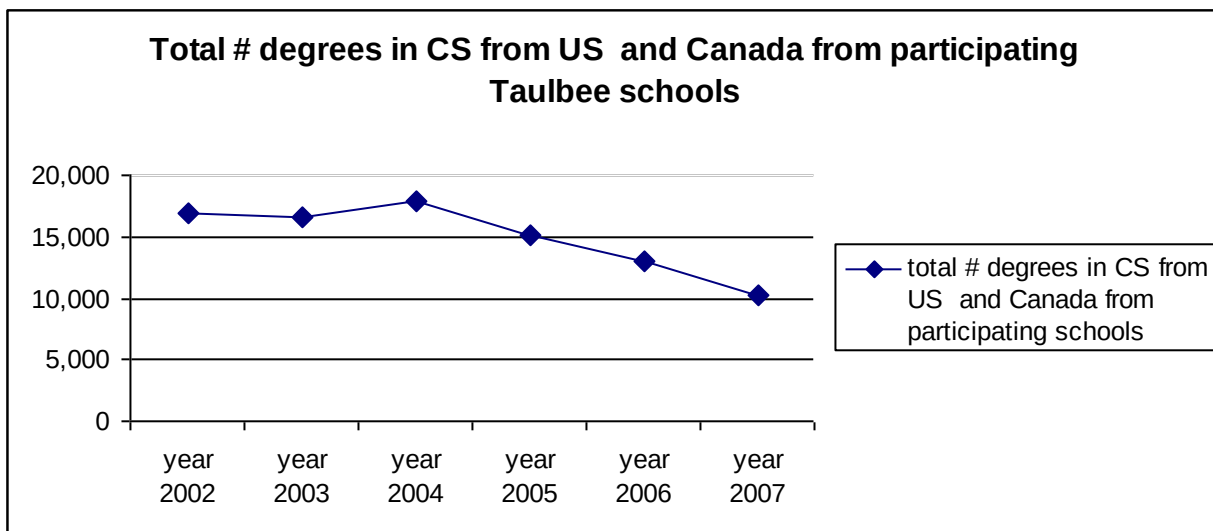
BPC Goal 1: Increasing/contributing to the increase of post-secondary degrees

Graduating computing professionals: CAHSI institutions in context

CAHSI is underway during a time of great decline nationally in computer science bachelor degree attainment. To understand how CAHSI is impacting the number of students, especially underrepresented students, receiving degrees in computing, it is important to describe the larger academic computing

¹ Note that at the time of this progress report, not all data were available to fulfill assessment at each of the indicators presented in Appendix A.

context. The Computer Research Association's Taulbee Survey provides data regarding computer science and computer engineering degree attainment in the US and Canada. The graph below shows the total number of reported B.S. degrees in computer science from 2002-2007, though this list is incomplete and can show only trends. Between academic years 2001-2002 and 2006-2007, the number of degrees earned annually dropped from 16,907 to 10,284.



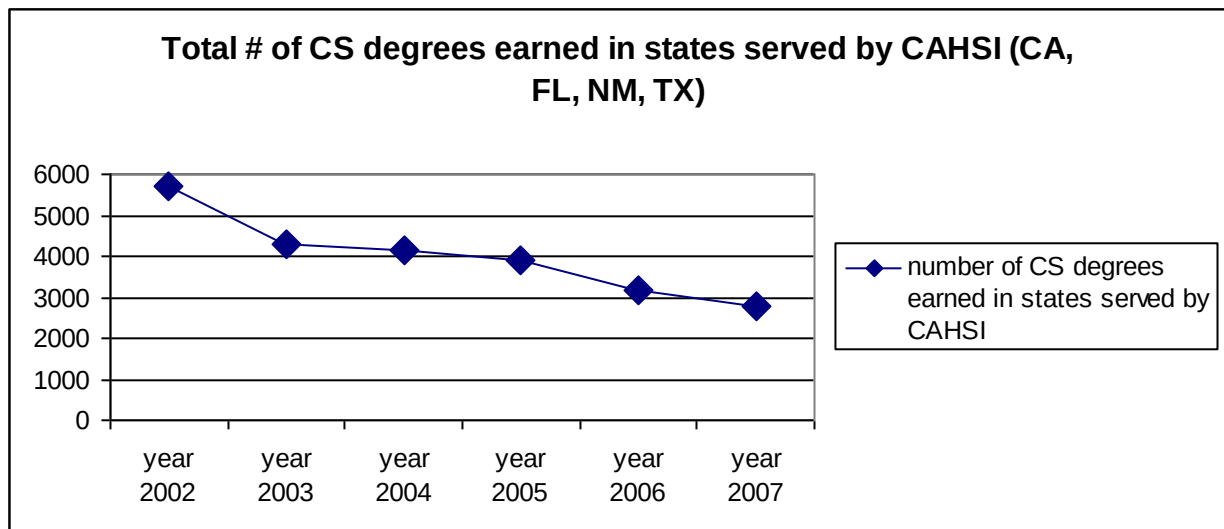
Object 1: Total Number of Computer Science Degrees from the US and Canada Reported in the Taulbee Survey, Years 2002-2007.

While the US and Canada undoubtedly experienced an overall decline in computing degree production, it was conceivable that regional differences could be masked by larger studies of computer science degree attainment. In order to detect possible regional differences in degree attainment CAHSI evaluators chose to collect data from comparison institutions most like the CAHSI schools—public and private not for profit universities and colleges in CAHSI serving states (California, Florida, New Mexico, and Texas).

The evaluators queried the Integrated Postsecondary Education Data System (IPEDS) for data on comparison schools, and were able to obtain data from all schools that fit the given parameters². As data from IPEDS was available from 2001-2002 though 2006-2007 only, we limited our study to these academic years. Note that CAHSI began during this time period, with initiative adoption at some institutions starting in 2003-2004, and alliance funding beginning in 2005-2006. Degrees in the following IPEDS categories were included in the query of computer science bachelor degree attainment: Computer and information sciences general; Computer science; Computer/Information Technology Administration and Management; and Computer and information sciences, other.

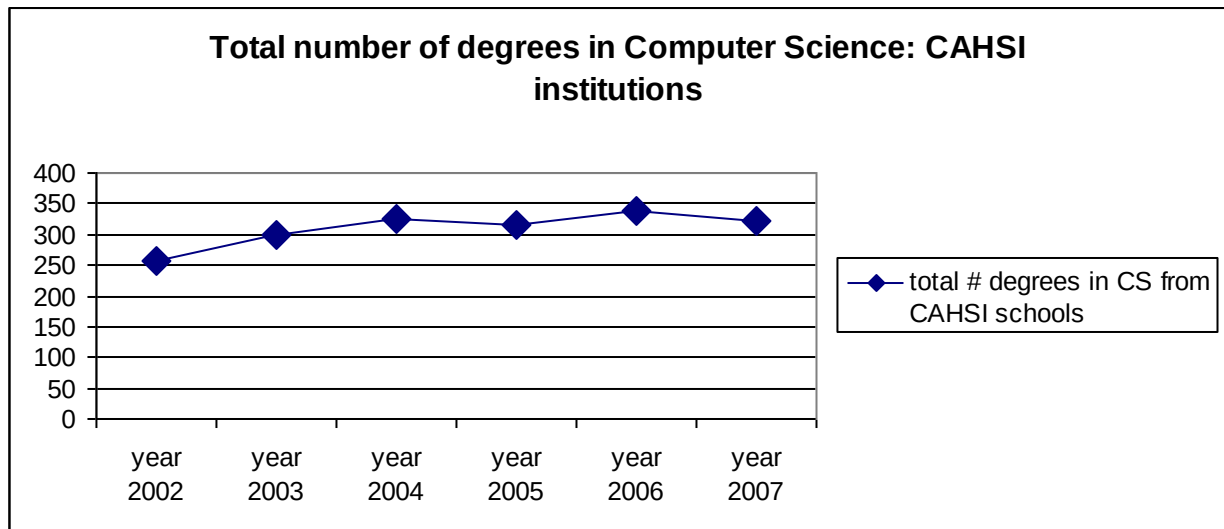
² Note that CAHSI schools are a subset of regional schools.

The trend depicted in the Taulbee Survey data can be seen in the graph of all public and private not for profit colleges and universities operating in CAHSI serving states. From 2002 until 2007, the number of undergraduate computer science degrees earned decreased from 5,693 to 2,775 annually. See figure below.



Object 2: Total Number of Computer Science Degrees from public and private non-profit colleges and universities in CA, FL, NM, and TX , Years 2002-2007

Next, we compare national and regional trends to CAHSI computer science bachelor degree attainment. To maintain consistency, we report IPEDS-generated data on the CAHSI schools, rather than the data we obtain directly from institutional research offices. During the 2002-2007 timeframe, CAHSI institutions did not experience a decline in undergraduate computer science attainment. In fact, when summed across CAHSI schools, we see an increase in the number of bachelor's degrees earned in computer science at the seven CAHSI institutions, from a total of 258 in 2002 to a total of 322 in 2007. See figure below.

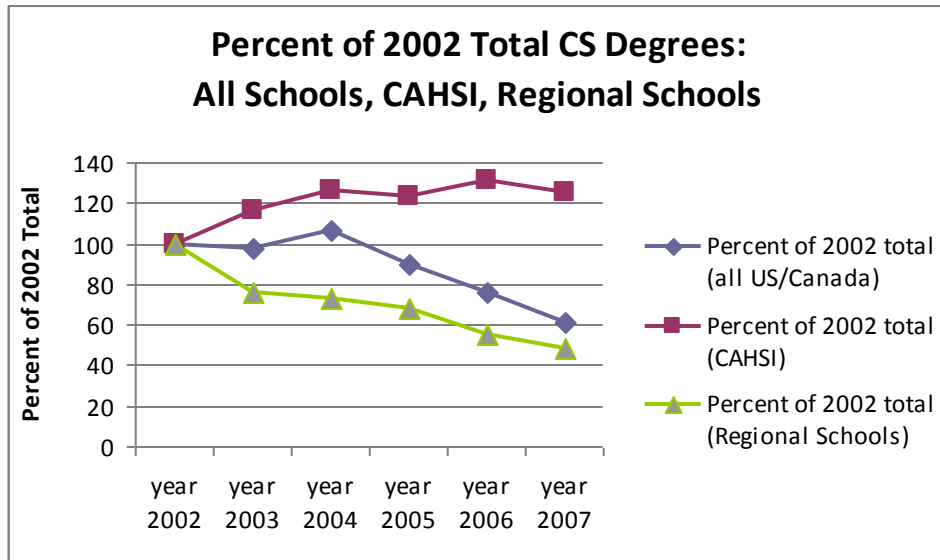


Object 3: Total Number of Computer Science Degrees, CAHSI Institutions, Years 2002-2007

To compare the decline experienced across the US and Canada with regional and CAHSI-specific trends in bachelor degree attainment, we converted all values to a proportion of 2002 computer science degree attainment in each category. In this way we can look at relative decline and relative stability, given the large difference in actual values. The original 2002 figure for each comparison group is reported in brackets within the “year 2002” row. See table and figure below.

Percent of 2002 Bachelor Degree Attainment as a Proportion of 2002 Figures for Taulbee Study, Regional Comparison Schools, and CAHSI Schools			
	Percent of 2002 total (Taulbee results US/Canada)	Percent of 2002 total (Regional Schools)	Percent of 2002 total (CAHSI)
year 2002	100 [16,907]	100 [5,693]	100 [258]
year 2003	98	75	116
year 2004	106	73	126
year 2005	90	68	123
year 2006	76	55	131
year 2007	61	49	125

Object 4: Percent of 2002 Bachelor Degree Attainment Over Time for Taulbee Schools, Regional Comparison Schools, and CAHSI schools



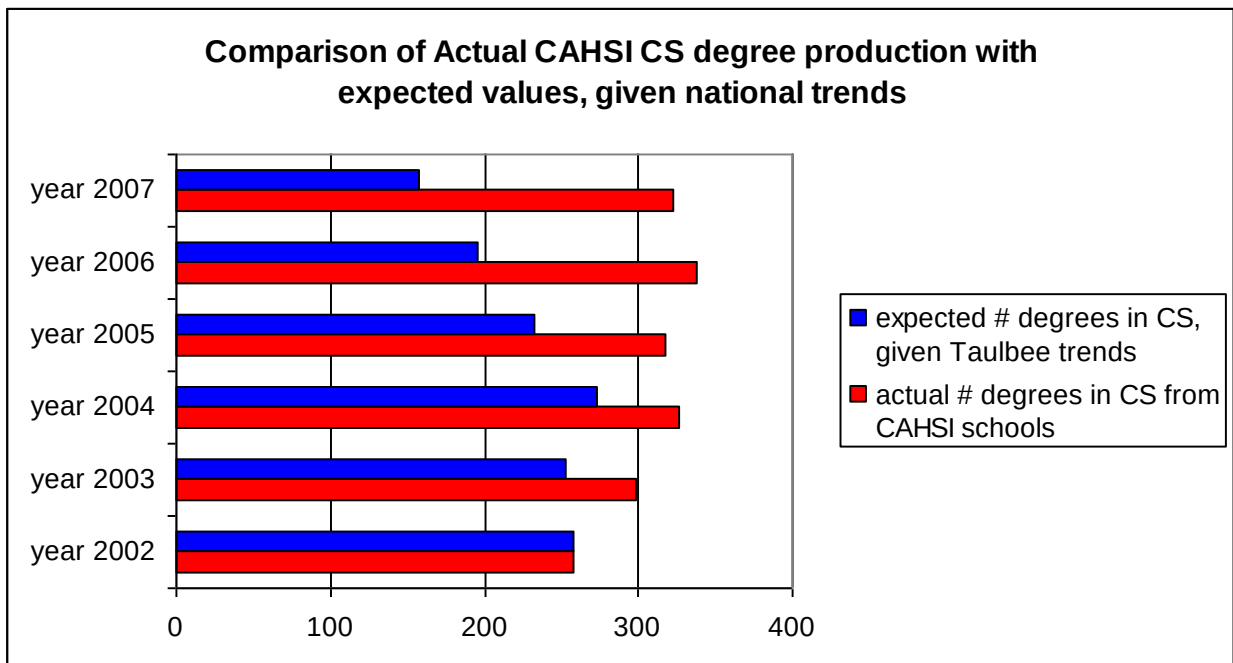
Object 5: Percent of 2002 Bachelor Degree Attainment Over Time for Taulbee Schools, Regional Comparison Schools, and CAHSI schools

The 2001-2002 school year marked the peak of Bachelor degree production in the US and Canada according to Taulbee data. ***The table above shows that while the US and Canada are producing fewer and fewer computer science graduates at the Bachelor's degree level each year, CAHSI schools are experiencing steady growth.*** CAHSI's success is not attributable to regional anomalies, as comparison schools in CAHSI-serving states show decline similar to, and in fact steeper than, Taulbee data in computer science degree production at the undergraduate level.

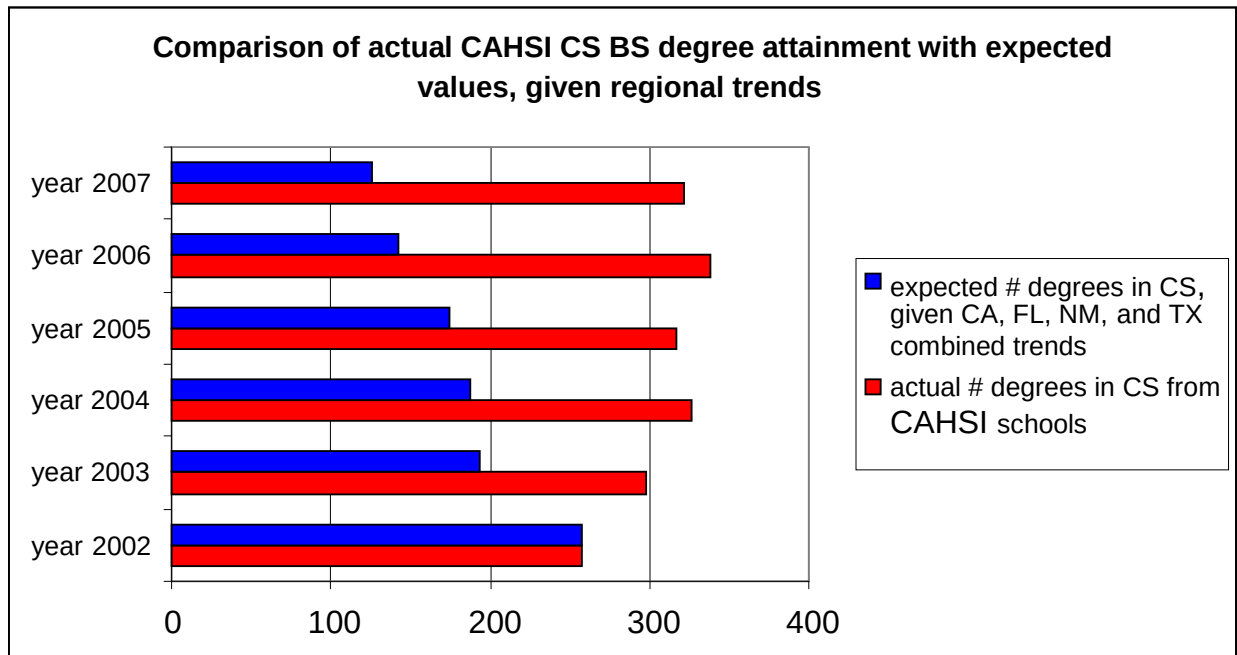
In order to represent the differences in trends in terms of real numbers of students, we continue in this line of comparison. In the figures below we calculate the difference in number of degrees experienced at CAHSI schools by calculating an *expected value* of degree earners for each year and comparing this to the *actual value* of bachelor's degrees attained at CAHSI schools. In other words, we calculate the number of degrees that would be expected if CAHSI schools followed national trends of decline, as well as the number of degrees that would be expected if CAHSI schools followed regional trends of decline. We compare these values in the following table and figures.

Comparison of CAHSI actual CS degree production with expected degree production, given US and Canada trends reported in Taulbee data, trends in CAHSI comparison school data					
	actual # degrees in CS from CAHSI schools	expected # degrees in CS, given Taulbee trends	Calculated difference between actual values and expected regional values (positive values indicate actual numbers are larger than expected values)	expected # degrees in CS, given CA, FL, NM, and TX combined trends	Calculated difference between actual values and expected regional values (positive values indicate actual numbers are larger than expected values)
year 2002 (baseline)	258	258	0	258	0
year 2003	298	253	+45	194	+104
year 2004	326	273	+53	188	+138
year 2005	317	232	+85	175	+142
year 2006	338	196	+142	142	+196
year 2007	322	157	+165	126	+196

Object 6: Comparison of CAHSI actual CS degree production with expected degree production, given US and Canada trends reported in Taulbee data, trends in CAHSI comparison school data



Object 7: Comparison of Actual CAHSI BS degrees earned annually with expected degree production, given Taulbee data trends



Object 8: Comparison of Actual CAHSI CS BS degrees earned annually with expected degree production, given CA FL NM and TX data trends

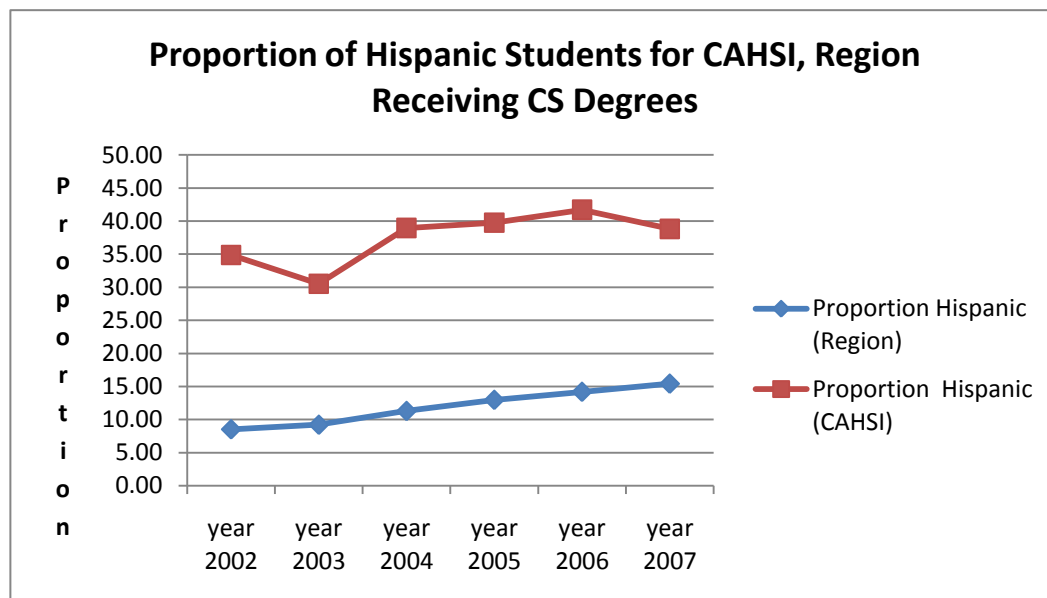
Given the data above, it seems clear that CAHSI schools are producing far more than the expected or average number of bachelor's degrees in computer science. In 2007 CAHSI graduated *more than double* the expected number of bachelor's degrees in computer science, when compared to neighboring schools and when compared to Taulbee rates of degree production.

Number of CE BS degrees: FIU and UPRM; CAHSI regional schools; and CE BS degrees in Taulbee study			
Year	Number of CE BS degrees: FIU and UPRM	Number of CE BS degrees: CAHSI region schools	Number of CE BS degrees: Taulbee schools
2002	116	1583	3770
2003	138	1812	3357
2004	105	1774	3095
2005	100	1939	3095
2006	94	1596	2494
2007	107	1349	2214

Object 9: Number of CE BS degrees: FIU and UPRM; CAHSI regional schools; and CE BS degrees in Taulbee study

Proportion of Hispanic students receiving BS degrees in computer science

The objective of the CAHSI alliance is to increase the number of students, especially Hispanic students, who receive post-secondary degrees in computing fields. We calculated the proportion of computer science Bachelor's degree earners at CAHSI schools for comparison over the target years. We also compare the proportions of Hispanic students earning BS degrees in computer science with all degree earners from private or public not-for-profit institutions in CAHSI serving states. Note that CAHSI serving states, California, Florida, New Mexico, and Texas, are among those with the highest populations of Hispanic, college age individuals in the United States. We did not make direct comparisons with Taulbee data in this category, as Taulbee surveys do not have complete information regarding student race/ethnicity. For instance, in 2008, race/ethnicity was known for fewer than three fourths of degree earners. When available, we comment regarding percent Hispanic students reported in Taulbee data throughout the text of this report section. See figure below.



***Object 10: Proportion of Hispanic Students Earning BS degrees in Computer Science in CAHSI Schools
and in Comparison Regional Schools***

While CAHSI computer science BS graduates are over one third Hispanic (ranging between 31% and 41%), comparison schools in the same CAHSI –serving states graduate only 9-15% Hispanic students in their undergraduate computer science programs. As computer science degree attainment is *declining* in the states reported here, this increase in proportion represents a decrease in total number of Hispanic student graduates. At the same time, CAHSI schools are in fact showing growth in the total number of Hispanic students receiving computer science degrees. See table below.

Total number of Hispanic Computer Science BS graduates summed across regional comparison schools and across CAHSI schools			
	All regional (Hispanic)		CAHSI (Hispanic)
year 2002		486	90
year 2003		396	91
year 2004		471	127
year 2005		505	126
year 2006		448	141
year 2007		428	125

Object 11: Total number of Hispanic Computer Science BS graduates summed across regional comparison schools and across CAHSI schools

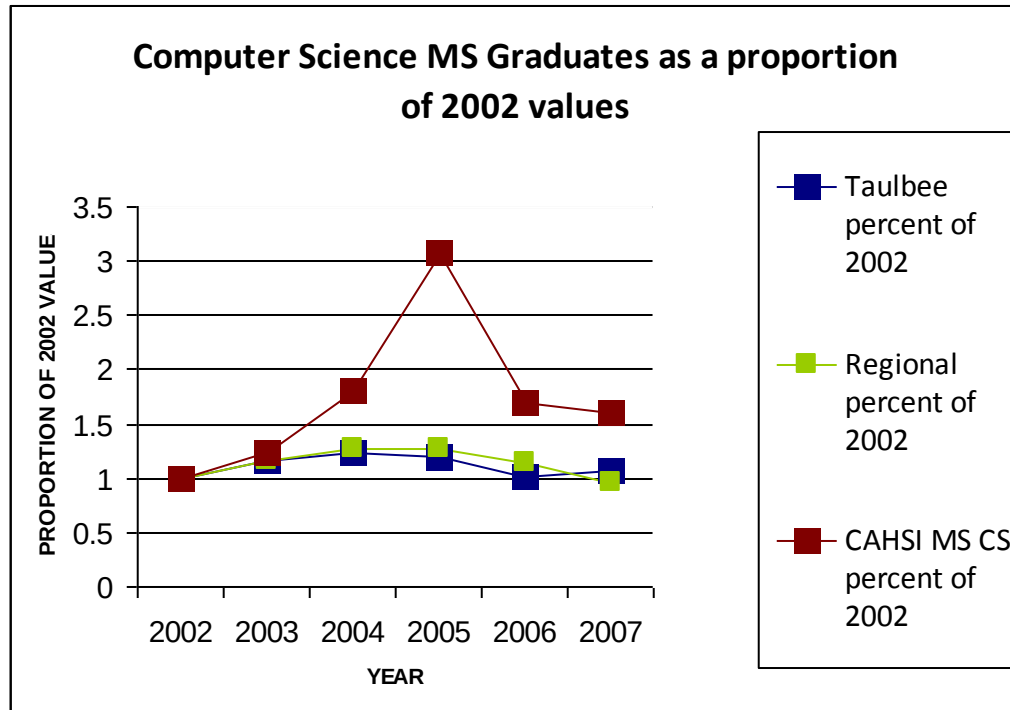
Graduate degree trends in CAHSI schools-Master's degrees

Evaluators also examined CAHSI graduation rates in comparison with Taulbee report data and IPEDS state level data. See table below for total number of MS degrees in computer science.

Number of Computer Science MS Degrees Earned			
Year	Taulbee MS CS totals	Regional MS CS totals	CAHSI MS CS totals
2002	7,031	2613	56
2003	8148	3027	69
2004	8735	3310	101
2005	8466	3336	172
2006	7117	2970	95
2007	7561	2505	90

Object 12: Number of Computer Science Master's degrees earned, 2002-2007, from Taulbee study (national estimate) IPEDS data set (CAHSI states) and CAHSI schools

In an effort to put these values in context, we again compare the trends in graduation by representing the totals as percents of 2002 graduation. See figure below.

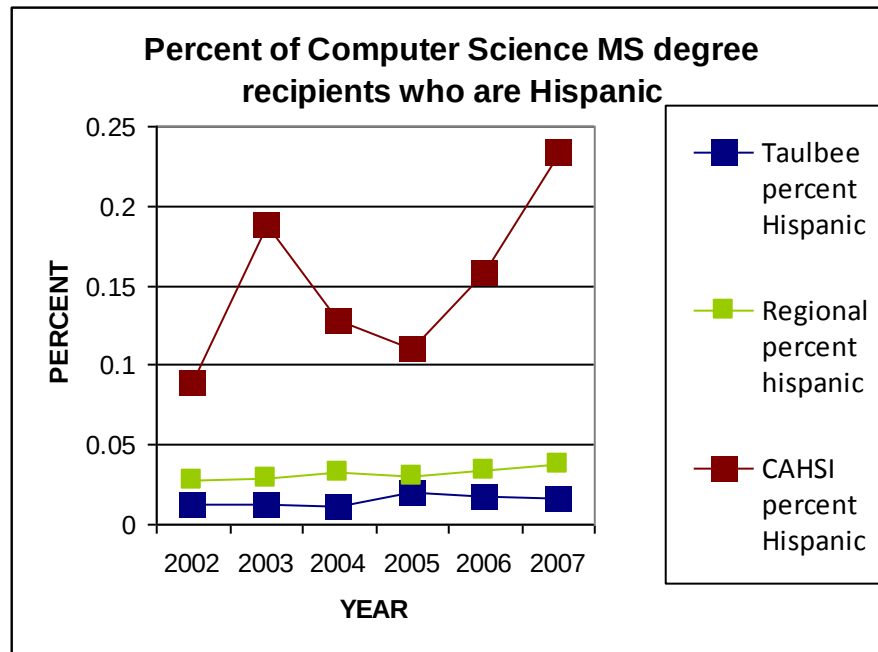


Object 13: Computer Science MS Graduates as a proportion of 2002 values

Masters' degree production has been more variable in CAHSI schools than in CAHSI comparison schools, where trends show a relatively stable, though slightly declining trend in recent years. After a dramatic peak in 2005, a year they nearly doubled production of Master's degrees in computer science over 2004, CAHSI schools showed a dip in graduate production. This decline, however, left CAHSI degree production at over one and one half times (150%) that of 2002 degree production.

This huge rise and decline is difficult to interpret, though one factor might be UTEP's early adoption of Affinity Research Groups in 1999, an initiative aimed to increase graduate enrollment. Another factor might be CAHSI students' increasing enrollment in PhD programs in CAHSI schools and beyond.

Hispanic Computer Science Masters' Degree Recipients



Object 14: Percent of Computer Science MS Degree Recipients who are Hispanic

Not surprisingly, the proportion of Master's degree recipients identifying as Hispanic at the CAHSI schools far exceeds the national and state level averages. These values do not include the many non-resident students who attend CAHSI institutions from communities on the Mexican side of border towns in Texas and New Mexico. The upward trend in student proportion of Hispanic graduates indicates CAHSI.

CAHSI has achieved moderate success in increasing Master's degree attainment in computer science, yet not to the extent of the increase in undergraduate degrees. This trend is difficult to interpret, particularly because of the variability from year to year in graduation rates of Master's degrees at CAHSI schools. Several factors may influence this trend. A primary goal of CAHSI is to increase the number of students receiving doctoral degrees in computing fields, and not all CAHSI institutions offer doctoral programs. Therefore, some students may be continuing their studies at other institutions with Ph.D. options. Another factor may be that CAHSI has focused less effort on graduate recruitment, and greater effort on undergraduate retention. Therefore, CAHSI's achievements in undergraduate degree attainment are greater than their Master's degree attainment rates.

Recruiting/Retaining Undergraduates in Computing

PLTL—retaining students in computing

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 160 student responses obtained in April and May of 2009 following the spring 2009 semester. The majority of students were Hispanic (70%), most were computer science or engineering majors (76%) and the vast majority of PLTL students were male (71%), though this proportion of males is less than expected given current female graduation rates in computing disciplines. Most students attended 90% of PLTL sessions, and two thirds of students had experienced 3 or more mathematics courses by the time they enrolled in their current PLTL course. Nearly half (44%) had taken two or more additional computing courses when they enrolled in the current PLTL 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 7.24 and 8.38, indicating the PLTL course positively impacted students.

Nearly 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, students with more mathematics or computer science course taking experience with less course taking experience. Only one subscale showed significant difference by school (interest in computing). Both schools showed positive values in this regard.

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	152	89%	135	7.65	2.03961
Coping Self Efficacy	145	88%	128	7.31	1.89383
Educational Goals	150	95%	142	8.38	1.88733
Outcome Expectations	143	95%	136	8.35	1.68608
Social Supports/Barriers	142	94%	134	7.24	1.34934
Computing Interest	134	90%	120	7.74	2.08955

Object 15: PLTL student Social Cognitive Career Theory Average scores

The goals of PLTL align with increasing educational goals, self efficacy (academic outcomes), coping efficacy, student interest in computing, and in increasing social supports/decrease social barriers to student success in computing. As status quo is for students from underrepresented groups to compare negatively with fully represented groups (in other words, Hispanics and females of all groups tend to report lower values for these constructs), ***as PLTL aims to close gaps between underrepresented groups and the majority of computer science students, a successful PLTL intervention would show CAHSI students responding similarly to majority populations.***

In order to test the hypotheses that CAHSI PLTL students (majority of whom are Hispanic) have similar social-cognitive outcomes as majority students, evaluators vetted published articles citing SCCT (Lent, Brown, and Hackett) for comparison subscale mean data. Articles including sufficient population and sampling information, as well as scale mean scores with standard deviation values for groups of engineering/computing/information technology undergraduate students were selected for comparison. The table below describes each publication's sample, sampling procedures, and details mean values for each of the Social Cognitive Career Theory subscales, when available. All values were adjusted to fit CAHSI's and Lent's 10 point scale.³

Publication/ Authors	Hug Thiry Weston Reynolds (CAHSI)	Hackett Betz Casas Rocha- Singh 1992	Lent Singley Sheu Schmidt Schmidt 2007	Lent Lopez Lopez Sheu 2008
Study participants	160 computer science students enrolled in CAHSI PLTL courses, taken during class. Majority (70%) Hispanic, three-fourths male; 20% freshmen, 35% sophomores, 31% juniors, 10% seniors, 4% graduate students. Represent four CAHSI HSIs.	197 engineering students from west coast university , mostly Caucasian (63%), with purposeful oversampling of Hispanic (23%), Asian (11%), African American (5%) and female (24%) students.	153 engineering students enrolled in an east coast introductory design course; mostly male (75%) Caucasian (68%) first year students (74%) from one eastern research university	1208 IT/computing students (CS, MIS, CE, etc.) at HBCU or PWI schools ; 42% African American/black; 39% Caucasian, 6% Asian; 5% Hispanic, 8% multiple race/ethnicity; 70% male; 51% computer science majors.
Intervention (if applicable)	PLTL	None	Design pedagogy rather than traditional lecture	None
Sampling Procedures	All students in target courses asked to take the survey and given time to complete the survey in class. Spring semester 2009	Sampled from engineering classes, underrepresented students were additionally contacted via mail survey	All students in target course asked to take the survey and given time to complete the survey in class.	Students were recruited by faculty to participate via flyers, presentations, personal contact in fall 2004.
Self efficacy	7.65 (SD 2.04)*,**	7.15	7.43	8.36 **
Coping efficacy	7.32 (SD 1.89)*,**	6.7	7.72*	7.84
Outcome Expectations	8.35 (SD 1.69)	7.8	8.29	8.18
Interests	7.74 (SD 2.09)*,**	6.1**	Not available	7.76
Social Supports &	7.24 (SD 1.35)**	7.1	Not available	6.97 **

³ For example, scales reported on a 5 point scale were multiplied by 2 to create a comparable value, and scales that were reported with a 0-9 scale were shifted 1 point higher for better comparison. Note these comparisons are approximate, and not based on the same instrument but on the same construct (e.g. self-efficacy).

Barriers			
Educational Goals	8.38 *	7.54*	9.18

Object 16:PLTL Data comparisons between CAHSI and similar published studies in STEM education

*Self Efficacy*⁴

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"

T-tests were performed for all comparison groups to determine whether CAHSI PLTL students differed in their degree of engineering/computing self-efficacy from more typical populations of engineering students. The evaluators view the engineering groups of students in columns 2 and 3 as the most appropriate comparison groups to the CAHSI PLTL sample, because they are comprised of students enrolled in engineering courses, have more similar sampling procedures to CAHSI (beginning sampling procedures within target courses), and resemble the typical US proportions of race and ethnicity populations within engineering disciplines. We include the computing sample in column 4, though we caution that sampling procedures favoring participant self-selection, variety in computing majors (from engineering departments, business schools, and other interdisciplinary programs), and combination of HBCU and PWI institutions all complicate interpretation of measures.

Publication/ Authors	Hug Thiry Weston Reynolds (CAHSI)	Hackett Betz Casas Rocha- Singh 1992	Lent Singley Sheu Schmidt Schmidt 2007	Lent Lopez Lopez Sheu 2008
Self efficacy	7.65 (SD 2.04)*,**	7.15(SD 1.5m- 1.9f)*	7.43 (SD 1.92)	8.36 (SD 1.53)**

PLTL aims to close the gap between Hispanic students and majority students. We find that following PLTL course experience, CAHSI students report similar levels of self efficacy to engineering students in an east coast engineering design course composed of majority students (column 3), and report *greater self efficacy* than the group of west coast engineering students (column 2) ($t=3.03$ two tailed, $=0.003$). PLTL students did not report self efficacy at the level of computing (e.g., computer science, business, IT) students from HBCUs and PWIs.

⁴ Definitions from Akbulut & Looney, Communications of the ACM, 2007, and (Lent, et.al. 2008)

In open-ended comments, students described the influence of PLTL on their sense of self-efficacy in their major: 55% of students described increases in self-efficacy in computing. Students with decreased self-efficacy noted that they had difficulty understanding the course material, or had earned poor grades. A few students also mentioned that they did not get along with or did not like their peer leader or course professor. Although these students experienced a dip in confidence, most of them were still committed to their major and hoped that they would have greater understanding of material or better grades in future computing courses.

"This was a pretty difficult course and I did not understand everything at its fullest. I hope it doesn't contribute negatively in the rest of the CS courses."

Conversely, students with increased self-efficacy often cited success in the course or good grades as factors in their rise in self-efficacy in computing. Some students also mentioned that they had learned and retained the material well, or enjoyed the subject. Finally, students reported that high-quality teaching increased their confidence in the subject.

"I have had very good teachers and TA's and I feel I've learned programming as well as confidence from them."

"Me and mathematics do not get along in any way, shape, or form. (no matter how hard I try), yet I have had many successes this semester, and I plan on continuing this growth."

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"

Publication/ Authors	Hug Thiry Weston Reynolds (CAHSI)	Hackett Betz Casas Rocha- Singh 1992	Lent Singley Sheu Schmidt Schmidt 2007	Lent Lopez Lopez Sheu 2008
Coping efficacy	7.32 (SD 1.89)*.**	=6.7 (SD 1.6)**	7.72 (SD 1.50)*	7.84 (SD 1.46)

PLTL student coping efficacy compares negatively with the groups in columns 3 and 4, though PLTL students had higher reported coping efficacy than the group of west coast engineering students. All mean values across populations 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, which we discuss in the "social barriers and supports" section of this report. Additionally, we note that our survey asked

students to describe a *change* in coping self efficacy based on the PLTL intervention, 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.

In an open-ended question, PLTL students described the influence of the course on their sense of coping self-efficacy. One-third of students noted decreased coping self-efficacy due to the difficulty of the course, or a heavy work load or time commitments for the major. These students were still committed to their major, yet had begun to realize that it may be more difficult than anticipated.

"Because there are many responsibilities other than going to school and studying, and taking this course makes me realize that this is a demanding major."

On the other hand, two-thirds of PLTL students reported that supportive faculty or peer leaders, and academic success in the course had positively influenced their confidence to overcome obstacles to degree completion. This increase in coping self-efficacy was particularly important for non-traditional students returning to college later in life.

"Support from faculty has been one of the main reasons I haven't lost confidence and been able to acclimate to the classroom environment after returning to school."

"I was completely new to computer programming but excelled in my class. This gave me more confidence for my future classes."

Outcome Expectations

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?"

Publication/ Authors	Hug Thiry Weston Reynolds (CAHSI)	Hackett Betz Casas Rocha- Singh 1992	Lent Singley Sheu Schmidt Schmidt 2007	Lent Lopez Lopez Sheu 2008
Outcome Expectations	8.35 (SD 1.69)	7.8 (SD 1.0-1.4)	8.29 (SD 1.03)	8.18 (SD 1.40)

PLTL students have similar or higher outcome expectations for their computing discipline than the comparison groups. CAHSI students had higher outcome expectations than the west coast university

students with a more typical population of students (in terms of representation). Data show that students' experiences in PLTL show them the benefits of studying in the field.

Computing Interests

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?”

Publication/ Authors	Hug Thiry Weston Reynolds (CAHSI)	Hackett Betz Casas Rocha- Singh 1992	Lent Singley Sheu Schmidt Schmidt 2007	Lent Lopez Lopez Sheu 2008
Interests	7.74 (SD 2.09)*.**	6.1**		7.76 (SD 1.34)

CAHSI students exhibit similar interest levels as the computing students from PWIs and HBCUs enrolled in computing-related disciplines, and greater interest (to a statistically significant degree) in their career field than west coast university engineering students surveyed. East coast introductory design students were not asked to describe interest levels.

Social Supports/Lack of Social Barriers

Social Supports/Lack of Social 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?”

Publication/ Authors	Hug Thiry Weston Reynolds (CAHSI)	Hackett Betz Casas Rocha- Singh 1992	Lent Singley Sheu Schmidt Schmidt 2007	Lent Lopez Lopez Sheu 2008
Social Supports & Barriers	7.24 (SD 1.35)**	7.1		6.97 **

CAHSI students responded similarly to the east coast introductory design students regarding the support and barriers they experience in engineering majors. CAHSI students in PLTL felt significantly *more* supported in their endeavors than the computing students from PWIs and HBCUs. West coast student data did not include this measure.

Educational Goals

Educational Goals- Student intentions to persist in their computing discipline

“(To what extent do you) feel you will excel in your discipline over the next semester?”

Publication/ Authors	Hug Thiry Weston Reynolds (CAHSI)	Hackett Betz Casas Rocha- Singh 1992	Lent Singley Sheu Schmidt Schmidt 2007	Lent Lopez Lopez Sheu 2008
Educational Goals	8.38 (SD 1.89)*		7.54 (SD 1.44)*	9.18 (SD 1.22)

PLTL students compared favorably with east coast introductory design students regarding their intentions to persist in the computing major—the differences between the two populations were statistically significant. PLTL students did score significantly lower than the IT students from HBCUs and PWIs. All mean scores for all groups were above 7.5 on a 10 point scale.

In an open-ended question, PLTL students addressed the influence of the course on their intentions to persist in the major and pursue a computing career. Some students (48%) began to have second thoughts about a computing career due to the difficulty of the coursework and the amount of time required for a computing major.

“This major requires a lot of effort and time to obtain, probably a lot more than I had anticipated.”

On the other hand, one-third of students reported that their interest in a computing career had increased as a result of their PLTL course. Several students commented that the coursework was interesting and they would like to learn more about computing.

“Interesting work, I would like to go deeper into it.”

Some students also mentioned that peer leaders, faculty mentors, or a positive departmental climate had encouraged them to persist in computing. It was important for CAHSI students to have a sense of support from peers and faculty in order to want to continue in the major and pursue a computing career.

“The good feeling that there are people in the CS department that really want you to succeed.”

“The peer leading made me see how this career could be fun.”

Impact of PLTL- Creating supportive environments, Encouraging strong educational goals

The HBCU and PWI population of IT students tended to score higher than the PLTL students on most measures, except supports and barriers. The sampling procedures and the variety of students surveyed suggests this population is significantly different from the PLTL students, as they are studying in a variety of departments, and were recruited for the study in multiple ways by faculty in their schools rather than the course specific distribution of surveys like in PLTL and the other two samples. Given the differences in samples, we focus on comparisons of engineering student samples with PLTL students from CAHSI.

Following PLTL experiences, students at HSIs have ***similar outcome expectations ratings, similar perceived barriers and supports, and similar or better ratings of academic self efficacy*** as more traditional populations of engineering students from two sample studies. Students from PLTL had higher interests in computing and most important for retention, ***higher educational goal ratings*** than more traditional populations of engineering students. Students had mixed results when comparing coping self-efficacy across populations.

PLTL: Becoming Leaders, Becoming Mentors

Peer-Led Team Learning cultivates pedagogical leaders, students who serve as role models for undergraduates and represent the “next steps” along the academic computing path. While leaders serve to promote undergraduate student development, the practice also solidifies their own computing knowledge, develops communication skills, decision-making skills, and other vital attributes of a competent 21st century computer science worker. Evaluators sought to discover whether the PLTL leadership experience *led to the increase (or contributed to the increase) of undergraduate students, particularly underrepresented students, earning bachelor’s degrees in a computing field*. We view students’ development of professional skills, interest in the computing field, and computing knowledge as retention factors of interest for PLTL leaders.

PLTL Leaders' Computing Knowledge					
Please answer to the best of your ability with regard to your PLTL leader experience.					
Answer Options	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
I am typically able to answer students' computing questions.	0	0	8	13	1
Leading PLTL has increased my computing knowledge.	0	3	10	9	0
I understand computing concepts well enough to be an effective peer leader.	0	0	7	15	0

Object 17: PLTL leaders' self-report of computing knowledge

Leaders were confident they held the knowledge they needed to lead PLTL sessions effectively (100%), and to answer student posed questions (95%) and most note that leading sessions *increased* their computing knowledge (86%) as well.

PLTL Leader's Professional Skill Development					
Please answer to the best of your ability with regard to your PLTL leader experience.					
Answer Options	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
Leading PLTL has improved my interpersonal skills (in other words, my ability to cooperate with others).	0	0	13	7	2
Leading PLTL has improved my leadership skills.	0	0	14	7	1
Leading PLTL has improved my decision-making skills.	0	3	10	4	5
Leading PLTL has improved my oral communication skills.	0	0	8	14	0
Leading PLTL has improved my teaching skills.	0	0	6	15	1

Object 18: PLTL Leaders' Professional Skill Development

Leaders gained interpersonal skills (91%), leadership skills (95%), oral communication skills (100%), teaching skills (95%), and to some extent, decision-making skills (64%) as they guided their peers.

PLTL Leaders' Computing Career Interest		
Answer Options	Affirmative Response Percent	Affirmative Response Count
Has your experience as a Peer Leader influenced your thoughts and/or impressions about being a computer science professor?	53% (Yes)	10
My role as a PLTL leader has increased my interest in a computing career.	91% (strongly agree, agree)	20

Object 19: PLTL Leaders' Computing Career Interest

Guiding students through lessons on computing concepts influenced peer leaders' impressions of becoming professors (53%). For most, the experience was positive and led to increased interest or confidence—a feeling that the student could in fact become a professor.

"I always wanted to teach when I retired from my career and this has shown me that I have the skills to do so."

"It has seriously enhanced my love of teaching."

"PLTL experience has left an impression about being a computer science professor. Seeing what these students need to succeed and seeing the scenarios I faced when I was in their position has some influence that being a CSC professor is possible."

For a few students, the experience helped them realize they would *not* want to become professors because of the stress and the time involved in planning and preparing for classes.

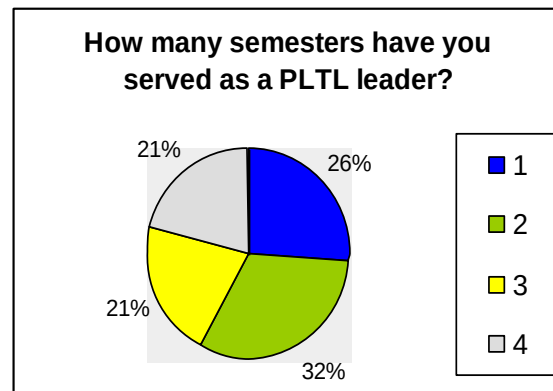
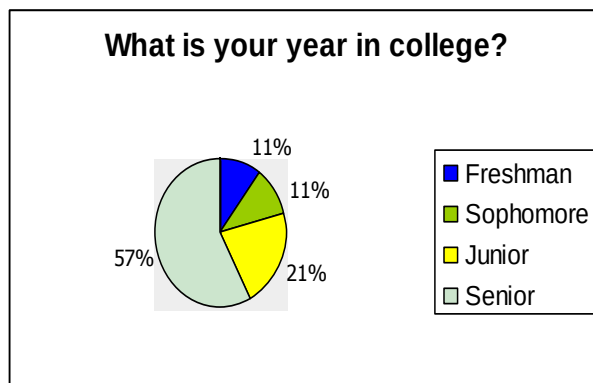
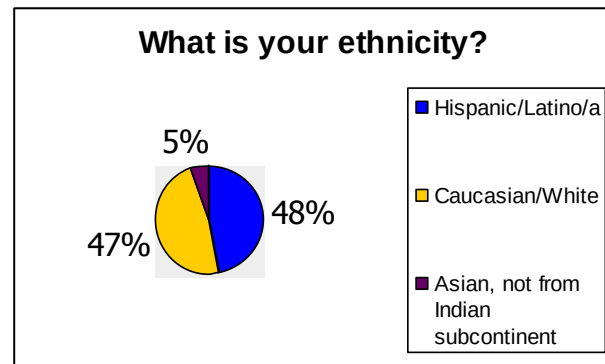
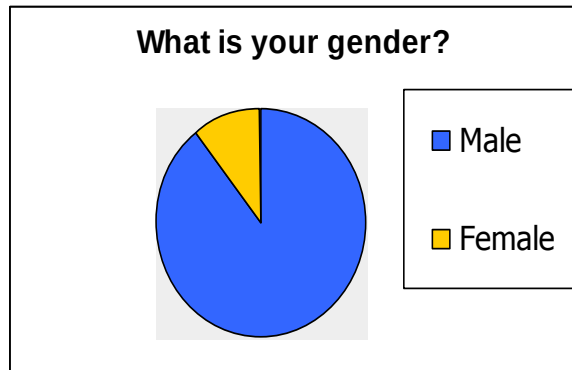
"As much as I love being a Peer Leader, I have no intentions to become a teacher."

"I now realize how tough it can be to teach students and all the work involved in preparing lessons for them. I realize that teaching as a professor is not for me."

Nearly all students found that leading PLTL sessions increased their interest in a computing career (91%). This may be the case because when they taught the concepts to others and related them to everyday ideas, they learned more about their own field.

PLTL Leaders "look like me"

Because leaders are chosen from the undergraduate pool of students who were recently successful in the target course, leaders are often known to the students they guide, are from similar communities, and share similar experiences. This resemblance to a mentor is shown to be particularly salient for underrepresented students, who rarely find like role models in the field of computing. Leaders in the spring of 2009 had the following characteristics.



Objects20-23: PLTL Leader Demographics

The majority of student leaders were seniors, though nearly a quarter were juniors. Leaders were divided rather evenly by experience, with nearly one quarter of students participating for the first, third and fourth semesters as leaders, while a lightly larger number were leading for the second time in the spring of 2009. Most of the leaders were men, and half of the leaders were Hispanic. Given that women are also significantly underrepresented in computing fields, CAHSI may be well served by attempting to recruit more female peer leaders to serve as role models for female computing majors.

PLTL seemed to increase student knowledge, interest in computing, and students' professional skills, according to PLTL leaders. PLTL student responses confirm that leaders were knowledgeable, helpful mentors through the target courses. Creating a cadre of mentors on campus who resemble the underrepresented students CAHSI schools serve appears to benefit not only the undergraduates receiving mentoring but the mentors themselves as well. It appears that PLTL is a useful practice for *increasing the number of students, particularly underrepresented students, who earn baccalaureate degrees in computing.*

Computer Science Zero- Increasing Regard for Computing Careers

Computer Science Zero Survey Responses, spring and summer 2009

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.

Students represented five schools in the spring of 2009 data set, and 15 different majors. Nearly two thirds of those responding to the survey indicated they are Hispanic, and two thirds indicated a GPA of 3.0 and above. About a quarter of students' mothers attended some graduate school or received a post baccalaureate degree, about a third attended some college and/or received a 2 or 4-year degree, while the remaining students' mothers attended some high school or finished high school with a diploma or GED. Students fathers' were more likely to attend some college though less likely to attend graduate 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 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**.

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)	Overall Mean	Std. Deviation
Outcome Expectations (11 items)	41(7 majors)	88%	7.76	1.999
Social Supports/Barriers (majors only) (8 items)	NA (7 majors)	100%	NA	NA
Computing Interest (5 items)	38 (7 majors)	74%	6.46	2.592

Object 24: CS-0 Student Average Scores on Social Cognitive Career Theory Constructs (Lent, Et. al. 2008)

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 74% and 100% of respondents averaged over 5.5 on a 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.

It is important to note the relatively low scoring construct (6.46 out of 10), interest regarding computing activities. The items in the survey asked students to rate their interest *relative to their interest before entering the course*. 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 then is put into perspective in the CS-0 course, as they begin to understand the complexities of computer use and computer programming.

We found that 26% of students did *not* experience an increase in computing interest, though many of these same students did experience positive perceptions or changes in all other categories (8 of 10 who did not experience increase in interest), while one student had negative scores across all 6 categories and another responded negatively in one additional category. In open-ended comments, CS-0 students discussed the influence of the course on their career intentions and their sense of self-efficacy in computing. Some students noted that “good teaching” and enjoyable curriculum had influenced their thoughts on computing careers.

“I liked this course in computer programming so I think I would like to continue on this path in computers.”

Some students also mentioned that the knowledge they gained from the course, along with the success they experienced, contributed to an increased interest in computing careers.

“My first attempt to learn programming through a class in high school overwhelmed me and put me off to majoring in computer science. After this class, and seeing a slow pace that is easy to learn with, my interest in the subject has increased.”

Some students also noted an increased sense of self-efficacy in computing. For these students, experiencing success in CS-0 helped to increase their sense of mastery of computing and interest in the subject.

“Learning basic concepts of programming in the class helped me feel that programming a computer may be something I could actually do.”

CS-0 in Context—Comparing CS-0 results with publicly available data from similar students

As we searched for results for comparison to PLTL students, we found a recent study of majors’ and non-majors’ interest in information technology careers that provided adequate mean, standard deviation, and sample description for inclusion in this report. Survey constructs resembled but did not correspond exactly to social cognitive career theory constructs as described, as can be seen in the table below.

Publication/ Authors	Hug Thiry Weston Reynolds (CAHSI)		Johnson, Stone, & Phillips (2008)
Study participants	Forty seven students enrolled in CS-0 courses in the spring of 2009. Represent four CAHSI HSIs.		Two hundred fifty seven students from two southeastern colleges/universities, ~60% African American and 40% Caucasian; from all majors
Intervention (if applicable)	CS-0		None
Sampling Procedures	All students in target courses (for dual HS/college credit and for college credit) were asked to take the survey and were given time to complete the survey in class. Spring semester 2009 and summer 2009.		All students recruited from various introductory undergraduate courses with various majors
Student sample described in data column	All students (including CS majors)	Only non-majors	All respondents (majors unspecified)
Outcome Expectations/ Attitudes towards job in IT “A job in IT would be very satisfying”	7.76	7.36	6.10*
Interests	6.46	5.9	
Social Supports and Barriers	7.70	Na	
Occupational stereotypes (reversed to compare with social supports/barriers) “People who work in IT look like nerds”			6.22*

Object 25: CS-0 Comparison with publicly available data measuring similar constructs

Comparison with published data regarding career interest in information technology shows that CS-0 students have more positive attitudes regarding CS/IT jobs, and perceive fewer social barriers/more social supports regarding entering the CS/IT field.

Advancing Undergraduate Students

Affinity Research Groups (ARG) are designed to socialize students into professional computer science research communities of practice. ARG students were invited to complete a survey in the spring and summer of 2009. The survey was adapted from the Undergraduate Research Student Self-Assessment (Laursen, Weston, & Hunter, 2009), an instrument designed and rigorously tested to assess students' intellectual, personal, and professional gains from participation in research. Fifty-three students completed the survey during spring and summer 2009.

ARG students were primarily undergraduates, with a few graduate student participants. Undergraduate students tended to be upperclassmen. Many ARG students were relatively inexperienced researchers. The majority of students (55%) had only completed 1-2 semesters or summers of research. ARG students were predominantly Hispanic (69% of students), and male (81% of students). 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).

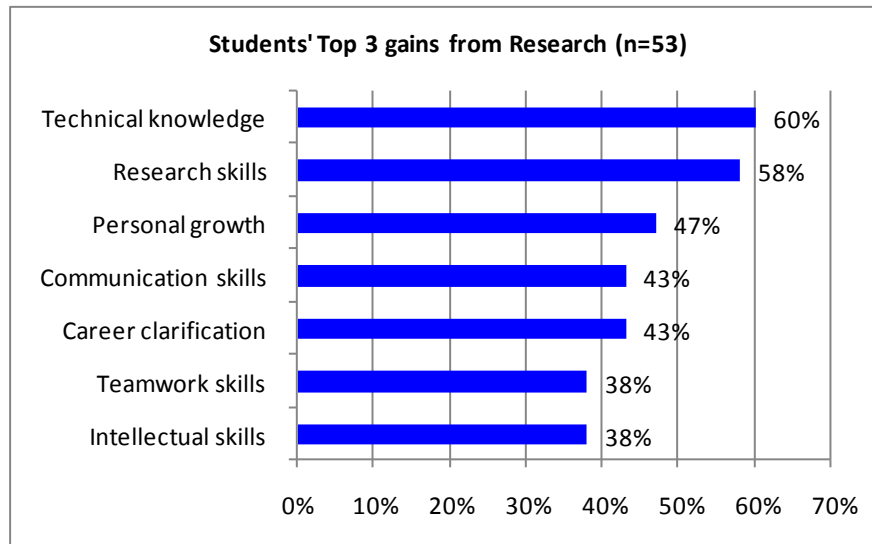
ARG students understood their research tasks and goals

Affinity Research Groups teach students valuable research skills, dispositions, and understandings through structured mentoring within the research group, and deliberate emphasis on skill building, project management, and goal setting. ARG 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 (3.49 out of 4.0),⁵ 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, 2010).

Students' top gains were technical knowledge and research skills

Students were asked to pick their top three gains from their research experience. The most frequently selected gain was technical knowledge. Students also cited research skills, personal growth, and communication skills as prominent areas of learning. Students' selections of their top three gains areas are outlined in the figure below.

⁵ All gains items were rated on a 4.0 point scale with 1=strongly disagree, 2=disagree, 3=agree, and 4= strongly agree.



Object 26: ARG Students' Top three Gains from Research

Research gain scales

Students evaluated their growth and development in several areas:

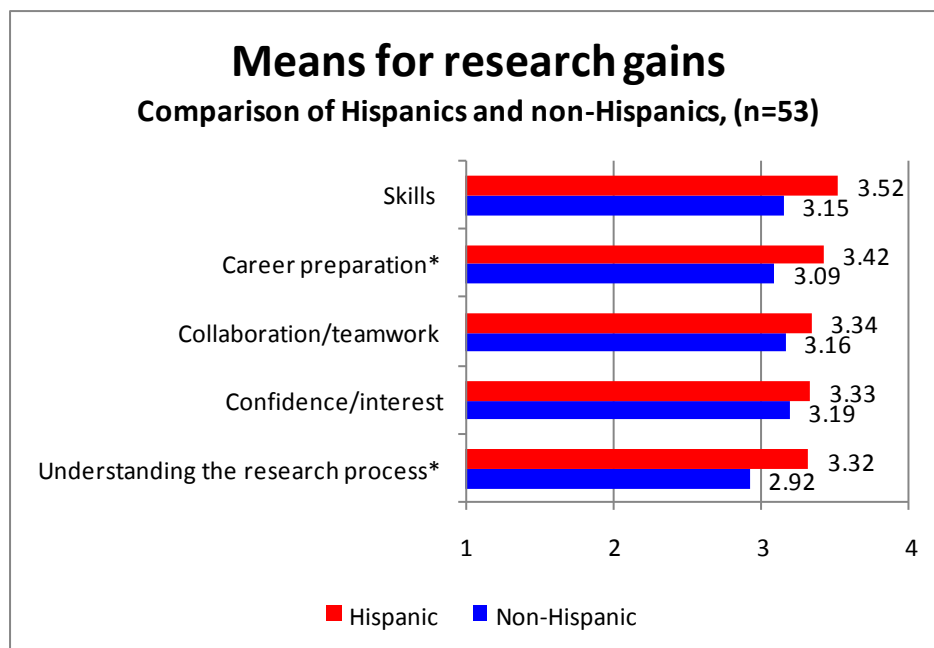
- *Career clarification*: Clarification and/or confirmation of students' career and educational goals.
- *Personal growth*: Growth in confidence, interest in computer science, independence and responsibility.
- *Collaboration/teamwork*: Increases in teamwork skills, and the extent to which students worked collaboratively with their research groups and contributed to the work of the larger group.
- *Skills*: Increases in communication skills, and intellectual and problem-solving skills.
- *Understanding the computer science research process*: Increases in students' understanding of the research process in computer science, and greater appreciation for the relevance of computer science coursework to research.

Students made roughly equal gains in all of the above categories (means of 3.2 to 3.4 out of 4.0). Tests of statistical significance revealed no statistically significant differences for gender, institution, or amount of research experience. However, there were statistically significant differences in outcomes between Hispanics and non-Hispanics.

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. The figure below illustrates the means for Hispanics and non-Hispanics on all of the research gains scales. Hispanics reported higher gains on all scales, with statistically significant differences in career preparation and understanding the research process. 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. See figure below.



Object 27: ARG Student Comparisons of Hispanics and non-Hispanics for Research Gains

ARG students gained intellectual and communication skills

Students' reported gains in skills as their strongest research gain. Students gained a variety of skills from their research experience, including intellectual and problem-solving skills as well as communication, oral presentation, and scientific writing skills. The Affinity Research Group model emphasizes communication skills and provides students with multiple opportunities to learn and practice these important scientific skills. The overall mean for all students on the skills scale was 3.4 out of 4.0.

ARG students gained confidence and interest in their field

Participation in research helped students to gain confidence in their abilities, become more independent as learners, and increased their interest in computer science. The overall mean for all of the items related to personal growth was 3.28 out of 4.0, indicating that students made strong gains in this area, although not as strong as higher rated areas such as skills and career clarification. Gains in confidence and interest are particularly important for minority students because their persistence in their majors is more closely linked to their enthusiasm for their discipline than it is to their GPA (Grandy,1998).

ARG students became more interested in graduate school

Students rated gains in career and educational preparation as one their top gains areas. The overall mean for items related to the clarification or confirmation of career goals was 3.31 out of 4.0—the second highest mean of any gains scale. Therefore, students strongly believed that research helped to prepare them for graduate school and/or a career and helped their decision-making process about their future goals.

Additionally, 72% of students felt that their research experience had influenced their thoughts and impressions about graduate study, increasing their likelihood of pursuing terminal degrees. Students had the opportunity to expand on their answer in an open-ended comment. The most common response (44% of students) was that students had learned what graduate school and research are like from working with graduate students during their research experience.

“I now know how the working environment, research expectations and team communication is like.”

“I now understand that graduate school for Computer Science majors involves a significant amount of research. Therefore I am now more interested in continuing to perform undergraduate research to be better prepared for graduate school.”

Greater knowledge about graduate school also instilled confidence in students that they could successfully complete the degree; thirty-six percent of students described increases in confidence or interest in computing as a result of the their participation in Affinity Research Groups.

“Working close to Graduate students helps me feel more comfortable with the possibility of attending graduate school.”

A few students (12%) had already decided to attend graduate school before participating in an ARG; therefore, research did not influence the decision. However, participation in research helped to reinforce their decision as they realized that they were on the right educational path.

I found the research interesting first of all. I've always had graduate school in the back of my mind but it was through the experience of the research fellowship that reinforced my wanting to pursue graduate studies

A few students also commented that their faculty research mentors had played a key role in their increased interest in graduate school.

With the advice from my faculty mentor and after discussing career options we came to the conclusion that graduate studies is the best course for me.

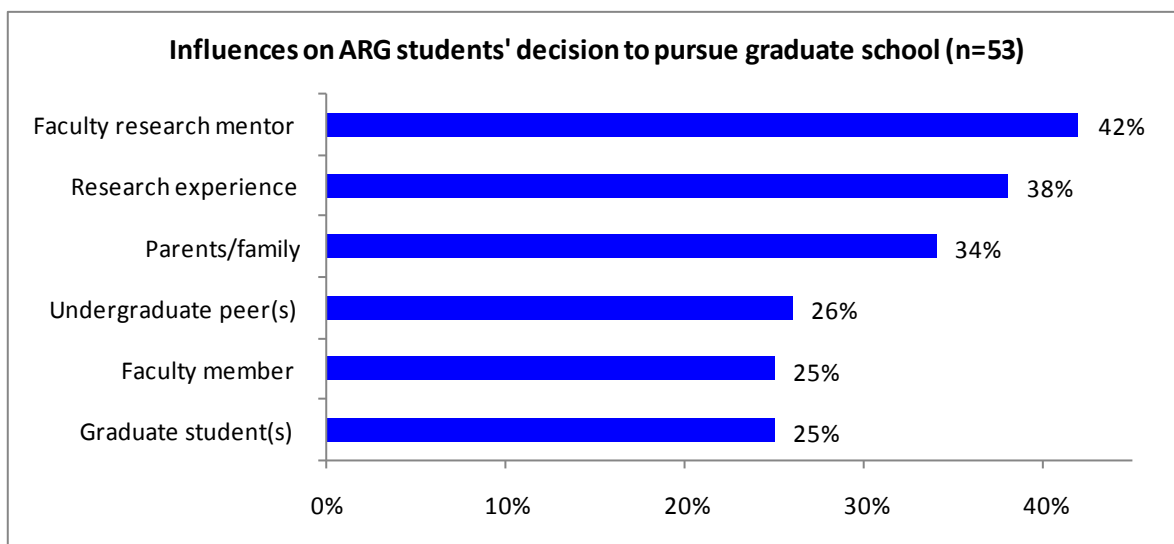
No students reported that they had been negatively influenced about graduate school from their research experience. Indeed, poor research experiences can give students negative impressions of graduate study and “turn them off” from graduate school (Thiry, Laursen, & Hunter, 2010). Therefore, it is

encouraging that students only reported positive impressions of graduate study from their experiences in ARGs.

Research experience and faculty mentors inspired students to pursue graduate school

Students enrolled in or interested in attending graduate school noted a range of influences on their decision to pursue a graduate degree. Students' faculty research mentor and the research experience itself were their primary influences to attend graduate school. The data suggest that research experiences and supportive mentoring are essential for encouraging underrepresented minority students to pursue graduate school.

Parents and family were also important influences in students' educational decisions, and to a lesser extent, graduate students or undergraduate peers. See figure below.



Object 28: Influences on ARG students' Decision to Pursue Graduate School

In sum, participation in research helped students to confirm, clarify, or refine their career and educational interests and goals. Students' research experience was the most influential factor in helping them to decide whether to enroll in graduate school. Students benefited from observing graduate students at work and learning about the roles and responsibilities of graduate students.

Participation in research had little influence on students' aspirations to be a professor

In contrast, few students reported that participation in research had influenced their thoughts or intentions to be a professor. In fact, 72% of students commented that their research had no influence on their aspirations to be a professor because they had never considered it as a career path. Other students felt the goal was too distant and that they needed to focus on near-term goals before contemplating the professoriate.

“At this stage, the idea of ever becoming a professor is quite distant, although it does not mean I will not consider it. My view is to concentrate on the closer goals, namely completing my undergraduate degree, and then concentrate on graduate degree. Not until somewhere during my graduate studies I could consider a doctoral degree.”

However, some students (18%) were motivated and inspired to become a professor as a result of their participation in research. These students decided that they enjoyed teaching and helping other students and that the professoriate would allow them to help and mentor students in their career.

“I really feel that my research within the computer science field had motivated me more to this career choice. By helping others within the research group gives me a feeling of accomplishment and enjoyment. This would really be wonderful to work with and help other aspiring computer science students.”

Affinity Research Groups modeled effective strategies for teamwork and collaboration

Affinity Research Groups are deliberately designed to provide structured mentoring opportunities for students, and to help students develop research skills, disciplinary knowledge, and teamwork skills. ARG students reported strong gains in developing collaborative relationships and teamwork skills, although this was their fourth-highest rated gains area. Students were asked a series of questions about the collaboration among their research group. The overall mean for the questions on this scale was 3.28 out of 4.0. Students felt that they were an essential part of the research group and that they contributed to decisions that impacted the direction of the research group. Students also valued their research mentors, reporting that they felt comfortable talking to their mentor or professor about problems. Students also felt that they had the appropriate amount of guidance that they needed on a project.

In an open-ended question, students documented their processes for resolving disagreements within their research groups. By far, the most frequent response (60% of students) was the use of discussion and debate to resolve differences. Students emphasized that they resolved conflict as a group with each person contributing and debating. Students did not depend on a leader or faculty advisor to solve their problems for them.

“Essentially, as a group we have all talked about said problems and discussed ways to better the group, manage time, and what could be done to better achieve our goals quicker and better than before. These new suggestions that are made come from the group itself, not just the group leader.”

To a lesser extent, students (30%) described a process of analyzing and examining options, choosing the best solution and developing a plan to implement it. Many students emphasized that they chose the solution that would be best for the project as a whole, rather than what might be best for a particular individual in the group.

“People provide arguments for their sides until one side’s argument is shown to result in the greatest net positive effect for the project, or particular aspect thereof.”

Therefore, ARG students felt that they were valued members of their research group who contributed to the work and direction of the group. Students also felt comfortable with their research mentors and peers.

Students participated in professional computer science research communities

Affinity Research Groups also socialize students into professional computing communities of practice, thereby helping students to develop identities as computer science researchers. An important step in develop an identity as a researcher is communicating research results to the larger scientific community. Thus most ARG students had the opportunity to disseminate their research results in a professional forum of peers and experts. Almost all 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). Nevertheless, almost half of ARG students presented a poster at a conference in the past year, 13% of students authored or co-authored a journal manuscript, and 15% presented a conference paper. Therefore, ARG students seemed to have had ample opportunities to engage in authentic research that led to publishable results.

Affinity Research Group student report of professional activity		
Professional activity undertaken in the past year (n=53)	Number of students	Percentage of students
Attended a professional conference	41	77%
Authored or co-authored a journal paper	7	13%
Presented a conference paper	8	15%
Presented a poster at a professional conference	25	47%

Object 29: Affinity Research Group professional activity

Comparison to national data: Do CAHSI research opportunities compare favorably to related programs?

While it is difficult to imagine a “control group” of students to compare with ARG students at CAHSI institutions, it is possible to compare ARG student gains to other students who also are involved in undergraduate research in the sciences. In this report, we compare ARG student gains for those at

CAHSI institutions with a large sample of students who engage in undergraduate research across the United States. The comparison sample of students represented a variety of STEM disciplines, They were predominantly from research-extensive universities, although students from primarily undergraduate institutions, master's degree granting institutions and UR programs designed for underrepresented minority students, were also represented. We compare CAHSI student means on parallel survey items from the Undergraduate Research Student Self Assessment (URSSA) to a sample of 573 undergraduate researchers⁶. Our hypotheses regarding these comparisons were:

1. *The ARG CAHSI respondents will have more opportunities to engage in academic activity than those in the comparison study, because of CAHSI-related venues for presentation, and funding for travel.*

The ARG CAHSI respondents will report similar gains in research skills and knowledge as those from the comparison study. See tables below. Those with statistically different scores at the two tailed (research gain) or one tailed (professional activity accomplished) 95% confidence interval are marked with **.

Researcher's Self-reported Gains as Measured by the URSSA		
Research gain (4-point scale)	CAHSI Mean (s.d.) n=53	National sample of summer REU students Mean (s.d.)
Communication skills [t= 7.705]	3.40 (.885)**	2.39 (.902) n=428
Career Preparation [t=0.1016]	3.31 (.487)	3.30 (.697), n=469
Personal and professional gains [t= 0.9891]	3.28 (.455)	3.17 (.795), n=483
Intellectual gains [t=0.6269]	3.19 (.497)	3.12 (.796), n=492

Object 30: Researcher's Self-reported Gains as Measured by URSSA

Researchers' Self-report of Academic Research Activity		
Professional Activity Accomplished	Proportion of ARG CAHSI Students	Proportion of National Sample Students
Attended a Professional Conference [z=8.114]	77%**	23%
Authored or Co-Authored a Journal Article [z=1.647]	13%**	6%
Presented a Paper or Poster at a Professional Conference [z=6.517]	51%**	14%

Object 31: Researcher's Self-report of Academic Research Activity

Comparisons were made using two-tailed t-tests for the measure of gains (based on hypotheses that there would be no difference in gains) and using one-tailed z-tests to compare proportions of students who have participated in the above academic research activity (based on the hypothesis that CAHSI

⁶ Data were obtained in a related project at Ethnography and Evaluation Research at the University of Colorado at Boulder <http://colorado.edu/eer/research/undergradfaqs.html>

students would have more opportunities to participate in academic research activity). Comparisons show that ARG students at CAHSI schools are much more likely to report communication skill development than other students in other research for undergraduate positions. This could be attributed to the ARG model and its focus on communication between members of the research group.

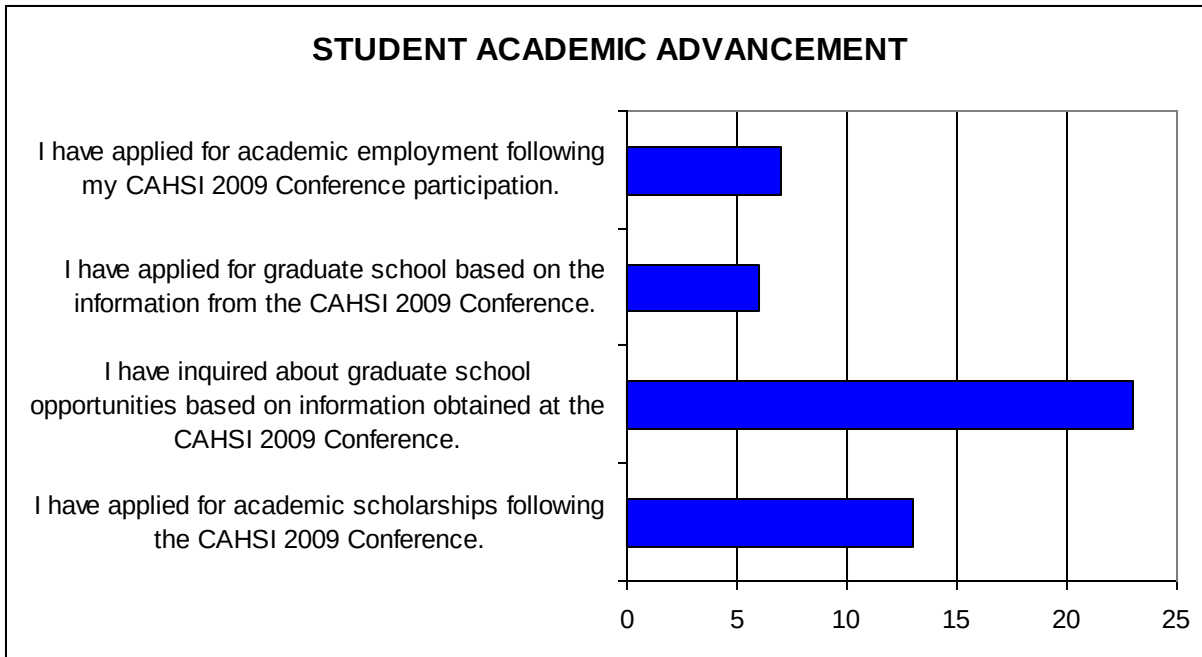
CAHSI students were much more likely than the comparison groups to attend professional conferences, author or co-author a journal article, and present a poster or academic paper. These activities are vital to students' academic achievement and support students' advancement in their academic fields.

Conclusion

Participation in research has numerous benefits for students and the Affinity Research Group model has boosted students' interest in computing careers and graduate school and their confidence in the field. In keeping with the ARG model's emphasis on teamwork and communication, students learned to work collaboratively within their research group and gained skill in democratically resolving disagreements among group members. Many students also had the opportunity to attend professional conferences and a sizeable minority disseminated their research results through conference papers or peer-reviewed journal articles. Clearly, Affinity Research Groups have contributed to the professional socialization of undergraduate students and their aspirations to advance in computing fields.

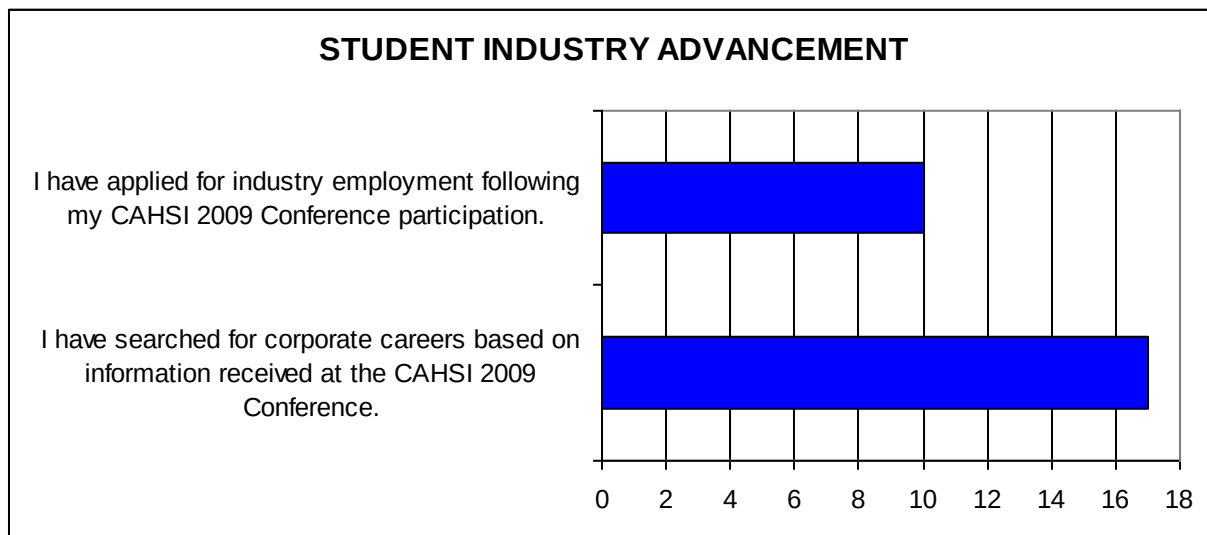
Development Workshops

CAHSI students are advancing their academic careers across the academic computing pipeline as a result of their participation in the CAHSI annual meetings.. Students near the beginning of the career path applied for scholarships (26%, 13 students), inquired about graduate school opportunities (46%, 23 students), and submitted applications for graduate school (12%, 6 students). Also, advanced students sought academic positions following their time with CAHSI (14%, 7). 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.



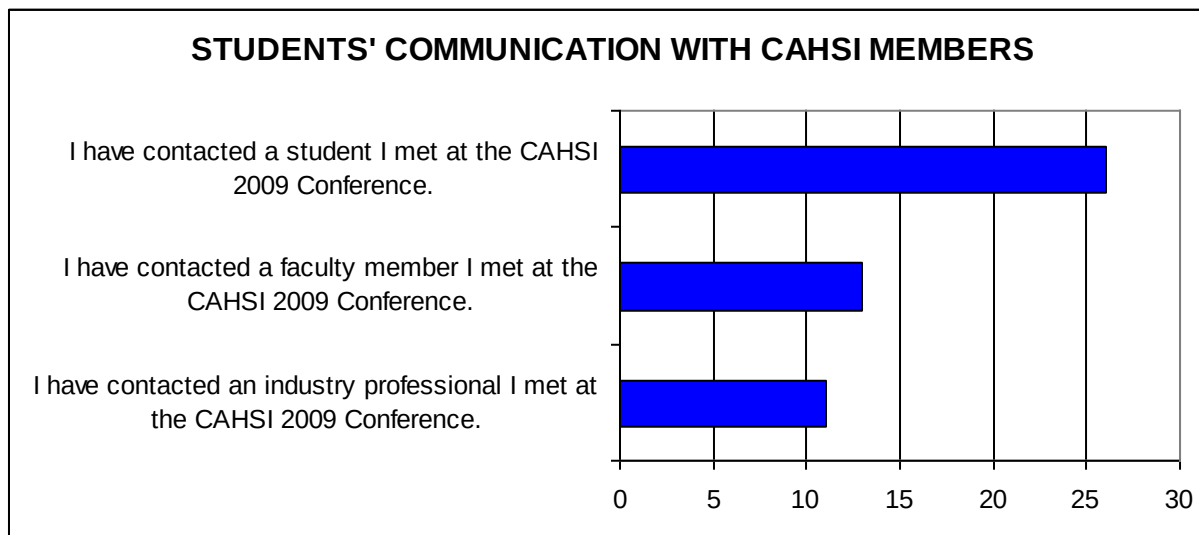
Object 32: Students' Reported Activities Following CAHSI Event—Academic Advancement

Over one third of students who responded to the survey have since searched for corporate careers following the CAHSI annual meetings based on information received at the conference (34%, 17 students). Also based on information from CAHSI, students applied for industrial professional positions (20%, 10 students).



Object 33: Students' Reported Activities Following CAHSI Event—Industry Advancement

Students who responded to the CAHSI meeting survey were most likely to contact other students following their participation at the January 2009 meeting (52%, 26 students). To a lesser degree, students made contact with faculty (27%, 13 students) and industry professionals (22%, 11 students). Additionally, 11 students volunteered to become CAHSI advocates at their schools.



Object 34: Students' Reported Activities Following CAHSI Event—Communication

Dissemination of ARG outside CAHSI- evaluation of workshops to new adopters

Affinity Research Group workshops were held in national venues to disseminate the ARG model to non-CAHSI participants. Data from two university workshops, one student SACNAS workshop, and one SACNAS faculty workshop are reported here, constituting 40 responses.

Overall workshop experience- organized, resource-rich, and relevant

Students and faculty alike saw the workshop as well organized (90%, 36 participants), full of resources (88%, 35 participants), and relevant to their studies or careers (88%, 35 participants). Workshop participants found the presentation of material to be clear (90%, 36 participants).

Expanding professional networks, learning from colleagues

The majority of workshop participants found the workshop gave them an opportunity to learn from colleagues (88%, 35 participants) and to expand their networks through interaction in the workshop (90%, 36 participants). A majority of participants would in turn recommend the ARG workshop to colleagues (90%, 36 participants).

Workshop helped to achieve goals

Getting better at communicating with a team, solidification and clarification of best practices in research, and academic critique were listed as skills developed or knowledge gained. Some faculty stated they will be better prepared to incorporate undergraduates into research work, and undergraduates said they were learning how to better facilitate team work. Students found the critique of academic posters a valuable exercise, as they needed to know how they will be judged in the future.

Dissenting opinions

A few participants consistently marked low scores for the workshops. Two of them may have been clerical errors, as the open-ended responses indicated they learned a lot from the workshops. Those participants with a negative opinion of the workshop indicated they found the collaborative method condescending, had anxiety when working in groups during professional development, and/or needed more guidance during group work activity.

Fem Prof and Mentor Grad- Targeting Promising Students for Doctoral Study

The purpose of this section is to summarize evaluation findings regarding Fem Prof over the past year to describe and analyze the benefits of the National Science Foundation Demonstration Project, specifically regarding the following aspects: *Student recruitment, Research mentoring, Career path mentoring, and Feminist empowerment*. We provide recommendations based on data regarding participants' experiences. Data were collected from the following sources:

- Surveys of student participants, research mentors, and Fem Prof coordinators
- Interviews with student participants and Fem Prof coordinators
- Participant observation at national meetings, conferences, campus events, and workshops
- Focus groups with student participants

Fem Prof Program Goal 1: Recruitment

Recruitment of women into the Fem Prof program has been challenging at both UHD and UPRM, as so few women are enrolled in computing majors nationally and locally. Both schools have targeted each woman in computing majors, and UPRM has expanded to cover young women in electrical engineering. The dearth of females have led to smaller numbers in the 2009 cohort year thus far, though all coordinators report continued efforts to recruit.

Fem Prof participants are spreading the word, holding events on campus for recruitment of new students. Faculty are attending computing courses and presenting the program to prospective students, and seeking out the students during their course schedules in an effort to increase participation. As

CAHSI initiatives take hold in the Fem Prof institutions (e.g. PLTL, CS-0, ARG), coordinators may see larger cadres of female students to recruit into Fem Prof.

“Opting out” of Fem Prof—Two Students withdraw from the Program

The lead evaluator had an opportunity to speak with two students who withdrew from the program at the fall 2009 Grace Hopper conference. Both chose to formally discontinue their participation based on experiences within and outside of the program. This section briefly documents their decisions to withdraw from the program. Note that both women were traveling with the Fem Prof group of students and faculty, indicating the two past participants and the current group of participants continue collegial relationships.

Yolanda* received a scholarship from the Anita Borg foundation to attend the Grace Hopper conference. She had attended the previous year and enjoyed the conference, leading her to actively seek funding to attend in 2009. Yolanda stated that in her summer research experience at another campus, she learned her strengths and weaknesses as a computer scientist. She found that she is skilled when following instructions or following strict procedures, but that developing new programs and fulfilling loose programming requirements with limited direction was not something she could do with ease. In her REU, she had difficulty developing new ideas and determining a plan of action for developing code. For the most part she worked with a pair of undergraduate students with limited guidance from faculty, and felt “lost” most of the time. She said “I (saw) that I didn’t have all the skills (I needed) to go to graduate school.” Her outside research experience led her to decide that she was *not capable of developing new knowledge through research. It is important to note that research experiences can “de-motivate” students when they are not well guided or facilitated in a way that promotes self-efficacy in the field.*

According to Tea*, her personal experiences with industry internships and her new-found knowledge about what is required to earn a PhD led her to decide the path was not for her. “You need to like to study to go to graduate school,” Tea said. She realized through the program that she *did not enjoy studying enough to continue through graduate school.* Tea said “Working at a small company...in an information technology department would be a better fit for me, and that’s what I want to do when I graduate.” Her attendance at Fem Prof program events helped her make an informed decision regarding her career path. She says Fem Prof leaders directed her to industry opportunities of interest at the Grace Hopper conference, and support her decision.

Fem Prof Program Goal 2: Research Mentoring

Research skill development

On average, students demonstrated moderate gain in developing a range of research skills: critical thinking, problem-solving, taking extra care with techniques and data collection, creative thinking, presenting/defending ideas, and solidifying knowledge through teaching/presentation. One exception is the ability to understand how to frame research questions, where 54% of the students indicated good gain.

Confidence and pride in research efforts

According to Fem Prof research mentors, the majority of the students demonstrated confidence gains – 91% experienced at least moderate gain in their ability to do science, and 82% in presenting/defending ideas. Similarly, 82% of the students took ownership of elements of their research project. All students showed at least moderate gain in taking pride in their accomplishments.

Fem Prof Goal 3: Career Path Mentoring

Career Path Progress: Five Students Accepted to Programs, Continuing Students Aspire to Attend Graduate School

All of the five Fem Prof women who graduated this year were accepted into doctoral degree programs in 2009. The goal of Fem Prof is to reach students before their final year as undergraduates, but five promising and interested seniors (fourth year students at UHD, fifth year students at UPRM) joined in 2008. Two pairs of students were accepted to graduate school together in 2009-2010, one pair at a local institution.

Evaluation results show a shift in thinking that some students made as they engaged in Fem Prof. Some of their statements indicate different goals for their futures after being exposed to research, academic conferences, and support for applying to graduate studies. A few students expressed regret that they had to rush to complete their applications and GRE preparation; as students in their final years of study, the women were not members of the targeted group of juniors and fourth year students Fem Prof hoped to recruit. Their accomplishments are thus more impressive—as one Fem Prof student put it, *“I can’t imagine what the next years’ students will be able to accomplish.”*

Fem Prof Program Goal 4: Feminist Empowerment

Throughout the Fem Prof program, we have focused on feminist empowerment as a construct of interest. Research questions that address this focus are: Are Fem Prof students becoming more cognizant of male dominance in the computing field, and of how that dominance may affect their academic paths and careers in the field? Are Fem Prof students developing strategies for coping with male dominance in the computing field? Qualitative data uncover the *critical incidents* that both focus

student attention on issues of gender discrimination and encourage the Fem Prof women to take on proactive, empowered stances toward gender discrimination in the computing fields.

Denying and Discounting Gender Bias—“Why are we always talking about this?”

Throughout interviews and focus groups in 2008 and 2009, we found some Fem Prof students would rather avoid the topic of gender and its impact on their academic and professional careers. When asked (in some cases for the third time) about any instances in which they felt men and women were treated differently in class, many would quickly restate the answer they provided in previous discussions, *explicitly mentioning* that this question was asked on previous occasions.

The impression made was that this topic was covered already, and that students felt the same as they had before. Titus (2002) writes about students engaged in social justice curriculum and programming. She states students often discount or deny that bias exists, treating the subject matter as “no longer a problem”. In the beginning of the Fem Prof program, many women took this stance. *Two events seemed to change these perceptions, causing a shift for some women in how they view being female in a male-dominated discipline—attending the Grace Hopper conference as a Fem Prof cohort, and presenting a panel at the annual CAHSI conference.* The Grace Hopper conference was the first national event that showed Fem Prof students the struggles faced by technical women, as well as the possibilities for women in computing. In essence, the conference showed students that *gender matters in their field*. Data suggest the experience of leading a panel on gender bias seemed to empower female presenters (as well as their peers) to discuss matters of gender bias in computing.

Mentor Grad –Encouraging Students to Advance

For the most part, students illustrated an increase in several BPC goals, often crediting CAHSI for their progress. Interviews with students uncovered a self-reported increase in interest in computing education, coping with STEM program demands, sense of community in the department, and opportunities for career-enhancing activities. These four goals are discussed below.

Interest in Computing Education

When discussing their interest in computing education, students described how Mentor Grad gave them access to knowledge about computing education and computing careers, something of particular importance to first generation college students. Furthermore, students recognized the role of professors, graduate students, research projects, and courses in providing them with access to information about graduate work and careers.

"Well, pursuing a master's degree is something that I always wanted. ...I didn't have much information about it because most of my family has never even gotten a bachelor's degree. So, I really didn't have anybody to go to who had a first-hand experience (with graduate school). So the research program actually gave me that, you know, I saw that opportunity there. I saw all of that information that I was seeking for graduate school."

"My mentor is great, he taught me a lot about grad school and things I can do to prepare but even if I didn't have a mentor like Dr. Kross, I think that going to symposium provide a lot of tools for you to find out about opportunities out there. The program gives you better access."*

Students report that Mentor Grad helped them to decide to continue on to graduate school and emphasized the critical role that professors play in that decision process.

"The program definitely helped nudge me in that direction. It made me certain that's what I want to do, before that it was just a thought and didn't commit to it; I wasn't planning on it."

"So the program 'Mentor Grad' really kind of put the seeds in my mind to go to graduate school because previous to, um, talking to Dr. Goff about it I really wasn't thinking about, um, graduate school ...I wasn't thinking that it was a possibility for me to be a professor. "*

The importance of graduate school was frequently mentioned; however, students also recognized the importance of working in the computing field and how their internships helped them to see that they need hands-on experience outside of academia.

"I want to say, you know, the ultimate goal would be to get your masters degree. I want to pursue that I do, ahh not immediately...I think would feel much more confident if I had much more knowledge than I do right now. Going out there and actually doing (computing) work on the outside would give me that confidence that I am looking for."

Although some students mention that conversations with professors encouraged them, others discuss how they were discouraged to pursue graduate work by faculty outside of their institutions. This finding points to the need for systemic change in the computing culture that goes beyond the work of one BPC alliance, and in turn for the need to counsel students through negative feedback. One student reported that a professor in her department encouraged her to be a professor; however, after talking with a professor from another university she changed her mind.

"I was interested in becoming a college professor. Dr. Paul actually talked to me about it and it sounded like something I would be interested in doing. ...The flip-side of that is when I went to a meeting this year Dr. Paul wanted me to go to, I talked to a computer science professor and he was actually pretty negative about, about me becoming a professor because he felt like I was too old."*

When students spoke about their interest in pursuing graduate work schools that offer specialized computing programs, such as game development, were especially appealing.

"I'm looking forward to applying for a Ph.D. because some of the schools, like the University of Southern California or UH main campus – they're going to have a game development field for computer science "

Another theme that became evident in interviews with CAHSI students was that students readily connect the skills they are gaining in school with real world applications of their degree. In other words, whether students are continuing on with graduate work or heading into a computing career, the direct connection between their education and a job is clear.

"When I was undergrad there were a lot of classes that I still wanted to take and I really felt that I wanted to push myself even farther. An undergrad advisor recommended to go into grad school to better acquaint myself with programs I'm learning. (He said that graduate school) would also give me higher advantage when I get out there and start looking for jobs."

Students reported a range of reasons that prompted their interest in computing. Some students said that they have always been interested in computing and that their high aptitude for the academic coursework has helped them to be successful. Some students report that individual drive is critical for succeeding in the computing major, rather than recognizing any outside support as having an influence.

"The whole computer gaming aspect caught my interest—to see how you could apply everything you learned into an interactive experience for other users."

Other students report that support and encouragement from professors was a major reason why they chose, or chose to continue with, their computing degree:

"When I began computer science my undergrad advisor was the first professor I had, and she pushed me, said I had a lot of potential because I am a problem solver and good at breaking things down into basic blocks. She was really the one who pushed me and helped me to continue with my computer science career."

Coping with Demands of Computing Degree

In terms of learning to cope with the demands of their computing degrees, students once again identify the support of professors as significant. Having approachable professors and mentors was repeatedly mentioned as important. In addition, some students also noted how professors vary in making themselves available for students.

"It is mainly the support of my professors. I appreciate Professor Tilly was the professor that actually made me keep on moving forward even though it was difficult at the very beginning and I am glad she did. I am progressing and my professors are there for me."*

"In our department they have tutoring for people who need help with computer science. There's a tutor lab for that. ...If I have any questions or doubts I just go up to them. Uh, sometimes the professors are available, like if you have questions they'll, you know, ask you. Some of them, they're just not there are all."

"I have no problem approaching (my professor), asking him questions, he's a good resource. I can talk to him about anything— he's a good mentor for me."

Seeking out help from department resources was another coping strategy that some students identified as a way to handle the challenges of a computing degree. Students mention how they sought help from professors and tutor labs in the department. Many students emphasized that it was essential to take responsibility and the initiative for being successful in their computing degrees.

"Since I had taken like a 20 year break I talked to a professor who let me audit his calculus 1 class. He was so good at teaching calculus 1. He was reviewing the lower level math for other students in calculus 1. So, I attribute my math success after that for calculus 2, differential equations to that calculus one class."

"No matter who the person is, I am not afraid of anybody I just want to make sure I do well in school and that I get the help I need. Whatever you do not understand you go and ask the proper person who might know the answer or at least guide you (to the answer)."

Sense of Community

Many students shared similar responses when discussing their sense of community, asserting that it is cultivated through more involvement in activities, research, and academic courses. Most indicated an increase in their feeling of "fitting in" within the computing major, especially because many did not feel a sense of community when first entering the program, and had to make an effort to be included or to feel a sense of belonging.

"I've been part of the [computer department club] for the past 2.5 years... you have to make an effort to do things with the clubs or the other members in order to feel the sense of community."

"I was the new kid and it didn't take very long to socialize, so I've expanded my social circle that way, now I know a lot of the people at the same level of computer science. As far as professors, I tried to get more involved with volunteer work and have established relationships with at least three to four professors."

Some students reported that they feel a sense of community because they belong to the department both socially and academically. They described having many friends in their department, helping others in the community, and feeling comfortable asking peers and professors for assistance.

“I feel that I am [part of the campus computing community], I like to spend a lot of time in the computer lab and whenever I see a student, usually an undergrad or a group of students having trouble, I like to go over there and offer to help. I think that’s the way I feel that I’m a part of computing community, by being there assisting others.”

Finally, many attribute this evolving community feeling to their involvement in Mentorgrad.

“I chose to participate in research on campus and in CAHSI because I thought it would be interesting to get involved in community-oriented experiences, especially to have a chance to work with other people, and meet more people.”

Career-enhancing Activities

Students also found CAHSI to be valuable in terms of enhancing their careers. Many students indicated an increase in career-enhancing activities through CAHSI, especially due to attendance at conferences. They detail that, conferences are beneficial because they provide great networking opportunities, educational seminars, and detailed information about graduate school.

“The conferences are great, and they have given me opportunities, and I look forward to going to them They’re focused towards what I need in terms of computing. [The biggest benefit of conferences is] the knowledge that you can pick up just talking to someone – for example, tips on cleaning up your resume.”

Finally, one student indicated that conferences have been useful because they have seminars specifically for women in computing, to help them succeed in the field.

“I got to go to a couple conferences, with CAHSI and FemProf. They sent me to Grace Hopper. I think that would be a great opportunity for other females who are just coming in as students to get an idea of what type of occupations women have in computing, and how to succeed in our industry.”

Interviews with undergraduates involved in CAHSI’s Mentor Grad initiative paint a picture of supportive computing departments where students feel a part of social and academic activities. Students and professors serve as mentors, and CAHSI workshops give them academic opportunities that support their advancement.

Beyond the PhD—Promoting Hispanic Junior Faculty and Industry Professionals

Professionals in the computing field are also targeted by CAHSI initiatives. The alliance supports early and mid-career Hispanic professionals with networking opportunities, funding, mentoring, technical and career related information, as well as training opportunities. In order to understand the role of CAHSI in promoting Hispanic computing professionals, CAHSI evaluators interviewed a sample of five Hispanic industry and faculty professionals engaged in the alliance. This section begins with one faculty member's story, then describes the benefits of CAHSI participation across all five Hispanic computing professionals interviewed.

Graciela's Story: CAHSI community supports scholarship and student advancement

An assistant professor from a commuter school in an economically depressed community learned about the CAHSI annual meeting and requested funding to attend with her two students. At the meeting, Graciela presented her technical work along with her students at the poster session. She met multiple mentors, most of them Hispanics in the field, who continue to provide support and advice. She learned about a workshop for faculty and students held at Berkeley labs, and decided to attend the event with her students.

Based on information gained at CAHSI, one student applied for and received scholarships to attend college, and is no longer balancing full time employment with a heavy evening course load. The three students are now considering graduate school, something they never thought about before their time at the CAHSI annual meeting at Google. Through their participation at Berkeley, they met and worked with other faculty members from around the country who are experts in their field.

"If I had to compare, if I wouldn't have had the help, not only the funding help but the reception of the people and the network in CAHSI I don't think I would have made it here."
-Junior faculty member

On campus, Graciela found funding for her students to help her in her research, which lessened her work load and provided students with on-campus work opportunities. She has been featured in the campus publication for her work with students, and was a key note speaker at the Women in Science event at her school. She brought her students along for her presentation, because, she says "we are a team, and I want the focus to be on what students do, not just on what faculty do." She also received course materials from a CAHSI faculty member, and plans to start a new research course for undergraduates on her campus. Graciela views CAHSI as instrumental to her professional development, and to her students' success.

Benefits of Participation—Expanding Academic and Industry Networks

“For me CAHSI was a life changing experience because of the networking connections made and the information that was gathered. Meeting Ann Gates was incredible, Steve, and Miguel- we collaborate a lot...I kept in touch with a faculty member who gave a presentation and she’s been helping me with the personal side of things, the life balance, because no one tells you how to do those things.”

All of the interviewees mentioned that their involvement with CAHSI led to their expanded networks of computing professionals. The alliance’s tangential communities, like Latinas in Computing, related Broadening Participation in Computing (BPC) alliances such as the Empowering Leadership Alliance, as well as CAHSI leadership’s personal acquaintances and colleagues across the country expand the pool of mentors for early career professionals.

One woman mentioned she felt her role in CAHSI was as the link between multiple communities—she would connect professionals and students to one another. Professionals were particularly impressed with the collective experience and prestige of CAHSI leaders, whom they considered mentors as well as leaders in the technical field. Another female professional in industry stated that expanding her network at the Google annual meeting allowed her to meet her peers.

“(At the Google meeting, I was) able to meet people outside of work that are in the industry and maybe doing and thinking the same things (as me). They are about my age with the same concerns I have. I got to meet a lot of people at CAHSI that were in the same boat as I was.”

Benefits of Participation—Feeling comfortable, like they belong

“(My participation in CAHSI) makes me feel I am a piece of the puzzle and I fit. I guess I am more emotional than the male researchers so I need to know that I fit in, to feel I fit in to keep on going and do my stuff.”

Professionals mentioned the comfort they felt in the company of CAHSI leadership and the extended CAHSI community. This notion of comfort and feeling like he or she belongs is noted in the research as a necessary component for the retention of underrepresented computing professionals. One woman mentioned that communicating with CAHSI and Latinas in Computing was like an inoculation against the discomfort and isolation she sometimes felt in her job. With the understanding gained at CAHSI meetings of the societal, educational, and systematic barriers Hispanics face in computing, one professional gained a broadened perspective of the problems faced at work and a new view of how to interact with co-workers who were expressing naïve ideas about Hispanic computing professionals as well as women in the field.

“(Through my participation in CAHSI) I have seen Ann Gates as a successful researcher. It is the first time I have seen a Hispanic woman who is the best. It tells me that it can be done. It can be done. If Ann did it, it can be done. There are no barriers there.”

Benefits of Participation—Curriculum Vitae -enhancing opportunities

For the most part, industry professionals see their participation with CAHSI as leading to *indirect* professional benefits (e.g., mentoring, service opportunities, feelings of belonging). However, when they were able to share their technical skill and knowledge with CAHSI audiences, they report direct professional benefits that may help them advance in their careers.

“I know (participating in CAHSI) is something my managers think is a good thing to do...It would be good to get people together on the technical side where people (from industry and academia) were working together. That would give managers a better impression of what we are doing with our time.”

While industry professionals increased their networks, benefited from mentoring and the opportunity to provide service, professionals in academia experienced these as well as other more direct benefits of participation in CAHSI. For example, CAHSI funded research opportunities for their students, allowing the junior faculty members to progress faster in their research efforts and produce more scholarship than they would on their own. Faculty also attended multiple conferences (e.g. Tapia, SACNAS, Grace Hopper, CAHSI annual meeting) where they presented technical work along with their students, elevating their reputations as scholars and educators.

Recommendations for supporting Hispanic professionals engaged in CAHSI

The following actions and resources may assist CAHSI in better serving early career Hispanics in computing:

- **Extend research funding to graduate students** to better support junior faculty in their research efforts
- **Provide early career professional resources** such as short videos or tip sheets regarding career “soft skills” (having difficult conversations with managers) and successful career path milestones (what professionals should be doing at each point in their careers to be successful)
- **House resources for internal and external audiences online** to support sharing, feedback, critique, and better communication and organization.
- **Promote and/or seed technical, research focused collaboration** between industry and academic members of CAHSI.

Issues in Increasing/Measuring the Increase of Students Earning Degrees in Computing

Pipeline programs and studies are complex. BPC alliances are spread across multiple contexts, and hope to change the attitudes, aspirations, and everyday practices of faculty and students. The issues in supporting and measuring “success” are many.

Hispanic-Serving Institutions often serve first generation students who may be less prepared for and/or less motivated to continue schooling, particularly when computing salaries for undergraduate degree holders are often in the \$50,000 range. Many CAHSI students have to work—often long hours—to support their schooling and their families. Student success and achievement can be significantly impacted when students hold several jobs or work full-time while pursuing their degrees. Fem Prof results show that with strong mentorship, multiple on-site and off-site research opportunities, and multiple avenues for professional development, students may develop aspirations for graduate degrees, though many of the students in the Fem Prof program had fewer financial concerns than the typical CAHSI student.

CAHSI goals will take time to achieve—the average freshman could hope to become a professor in 9 or 10 years—yet evaluation must be ongoing from the first year of implementation. Once students matriculate to graduate programs, they are, to date, difficult to track, particularly when they move out of the CAHSI constellation of institutions. On a similar note, each school “marks” student demographics differently. For example, NMSU does not track the country of citizenship for non-US citizens, and UHD does not indicate citizenship standing on its documents. In Texas, students who graduate from Texas high schools can attend Texas colleges at in-state rates, and so citizenship is difficult to discern. Border towns bring issues of citizenship into question as well, as Juarez or Tijuana residents might work in El Paso and Las Cruces, for example, contributing to US technology development.

BPC Goal: What is CAHSI doing to support a positive culture or climate?

A goal of the BPC initiative is to “create sustainable changes in culture or practices at the institutional, departmental, or organizational levels that contribute to broadening participation in computing.” From our perspectives as evaluators in the initial years of a transformative education initiative, we view our role in terms of exploring how CAHSI computing departments are supporting a positive, inclusive culture or climate.⁷ In this section, we highlight the research regarding effective practices in higher education for supporting a positive, inclusive culture or climate, and describe how CAHSI evaluation data suggests (or

⁷ It is difficult to measure cultural change in many cases, because the students from whom we gather data have such short experiences with CAHSI departments, and many were not students at CAHSI schools when the initiative began. When possible we include data regarding PIs and faculty member’s perspectives regarding change in student behaviors, attitudes, or achievement.

does not suggest) that departments are indeed developing into diverse, inclusive, academically focused computing communities.

Researchers and policy makers have studied higher education “best practices” for decades (Astin, 1975; Kuh 2008), with particular focus on elements of higher education that promote rich learning environments for retaining and engaging students. Four elements of higher education schools and departments of particular relevance to the CAHSI initiative are:

- Promoting academic dispositions that enhance classroom learning
- Explicit development of learning communities
- Seeding or facilitating faculty-student interaction
- Mainstreaming mentoring

We discuss these research-based best practices for developing positive learning climates in higher education institutions in the following sections, and tie these to CAHSI.

Promoting academic dispositions that enhance classroom learning

The opportunity to engage in meaningful, experiential, “hands-on” work fosters the skills, knowledge, and temperament that enhance students’ classroom learning. Student learning and development is complemented and enhanced by student participation in “real-world” co-curricular activities such as undergraduate research, internships, student teaching, or professional jobs (Thiry, Laursen & Hunter, 2010). Recent research on student outcomes from participation in undergraduate research has demonstrated an array of personal, professional, and intellectual benefits to students. Through participation in undergraduate research, students increase their communication skills (Bauer & Bennett, 2003; Hunter et al., 2007; Kardash, 2000; Seymour et al., 2004), technical and laboratory skills (Lopatto, 2004; Seymour et al., 2004; Ward, Bennett & Bauer, 2002); teamwork skills (Ward, Bennett, & Bauer, 2002); and critical thinking, problem-solving and scientific thinking skills (Hunter et al., 2007; Kardash, 2000; Merkel, 2001; Seymour et al., 2004). Students perceive these gains as transferable skills sets that will benefit them in their coursework and in their future careers (Hunter et al., 2007; Kephart et al., 2008).

CAHSI initiatives such as Affinity Research Groups and Peer-Led Team Learning offer students the opportunity to engage in meaningful, authentic work that fosters deep learning and contributes to classroom success and retention. Affinity Research Groups differ from the traditional undergraduate research model through the deliberate development of leadership, teamwork, and communication skills through structured mentoring and group interactions (Kephart et al., 2008). Likewise, peer-led team learning emphasizes cooperative learning and the development of teaching, communication and leadership skills along with deepened conceptual understanding of course material for peer leaders. Participation in ARGs helped CAHSI students to develop the intellectual and technical skills that will contribute to their success and advancement in their coursework. Technical knowledge and research

skills were students' top gains from ARGs (the only areas cited by a majority of students as one of their top three gains). Hispanics also cited higher gains in both of these areas than majority students. Being a peer leader helped CAHSI students to deepen their computing knowledge and gain confidence and skills that will enhance their academic achievement. Eighty-three percent of peer leaders reported that they increased their computing knowledge, and 100% of peer leaders reported that they have enough computing knowledge to effectively help students. One-hundred percent of peer leaders also felt that they had increased their communication and teaching skills.

Explicit development of learning communities

Departments and institutions that explicitly develop structured communities (through a cohort model for students attending courses, through study groups, or within courses) find students are more engaged in their learning, experience greater academic and social support, and are more likely to be retained in higher education (Astin, 1975; Kuh, Kinzie, Schuh, & Whit 2005; Tinto, 1997). Research in higher education finds that students who work on campus are more likely to complete their studies (Astin 1975), and it follows that providing jobs on campus might support learning community development, as time on campus leads to additional contact with peers.

CAHSI has explicitly developed learning communities through the adoption of Peer Led Team Learning (PLTL) and Affinity Research Groups (ARG). The PLTL communities are inclusive by design, as they do not focus on "at-risk" students, marginalizing those who are less prepared or traditionally less successful in computing courses but on the class as a whole. ARGs leverage the different levels of experience apparent in a research group to foster positive interdependence on one another within the group. Some additional findings that support the notion that CAHSI's explicit development of learning communities creates an inclusive, positive learning climate in computing are highlighted below.

- PLTL evaluation data show that classroom learning communities impact students' perceptions of support in the major and career—in fact 94% of PLTL students in spring of 2009 report an increase in feeling supported following PLTL participation, and average scores on perceived support exceeded comparison groups of majority students.
- Data collected (in the form of survey responses) indicate CAHSI funded (or contributed to the funding of) 53 research positions and 22 PLTL leader positions on campus from Spring 2009 through summer of 2009. All PIs note that without CAHSI, they would have fewer employed students on their campuses.⁸

⁸ Our reported numbers are conservative, and based on the number of students from whom we gathered data in spring and summer of 2009.

- Principal Investigators and faculty from CAHSI institutions describe resurgence in computing-related clubs and the institution of new groups that meet on campus, including a local computer science club and a new gaming club

Seeding faculty-student interaction

When faculty and students interact regularly, students gain more knowledge and skills than when interaction is limited to classroom participation (Astin, 1993; Endo & Harpel, 1982; Kuh & Hu, 2001). CAHSI initiatives have built in student and faculty interaction—PLTL leaders meet regularly with course instructors to go over activity planning, ARG students meet with graduate students and faculty to discuss research issues, findings, and next steps, and students who engage in CAHSI scholars, fellownet and papernet have substantive interaction around academic content and goals. Evaluation findings suggest that CAHSI seeds faculty-student interaction.

- Preliminary data from student interviews suggest the time faculty spend with students has increased with CAHSI initiatives, particularly with travel to conferences such as the CAHSI annual meeting, Grace Hopper, SACNAS, and Tapia. Students say these trips help them get to know professors better and feel more comfortable with them.
- A quarter of students who attended the CAHSI annual meeting contacted a professor following their participation in the meeting, indicating conference participation seeds faculty-student interaction.
- Students engaged in Fem Prof, the model for CAHSI Scholars/Mentor Prof, state they have more interaction with faculty since beginning participation in the program, which promotes the professoriate for high achieving undergraduates. They interact with faculty in workshops, trips to conferences, planning meetings, and recruitment events, and receive feedback regarding their academic and professional efforts.

D. mainstreaming mentoring

CAHSI initiatives develop webs of support for students in computing departments, encouraging not only paired mentoring relationships (such as faculty student matches) but also student to student opportunities for mentorship. Higher education research has continuously supported the notion that mentoring is beneficial to students and faculty for supporting psychological and professional needs (Hall & Sandler, 1983; National Academies Press, 2009; Tillman, 1995; Wright & Wright 1987; Zachary, 2005). Opportunities for all students to engage in mentorship support an inclusive, positive departmental culture.

- For example, open-ended survey items from PLTL students indicate that 88% of students found it likely that they would have access to a mentor in their computing department, and

86% found it likely they would have access to a role model in their computing department after participating in the initiative.

- Following the CAHSI annual meeting, most students indicated they had informal mentoring support from faculty (76%). This figure compares favorably to a recent study by MentorNet, which indicated of the 1,876 science technology engineering and math students surveyed currently engaged in Mentor Net, only 62% had an important mentor in their undergraduate years (www.mentornet.org). Not only do students report they are being mentored, they are also serving as mentors for other students—65% of students who attended the CAHSI annual meeting report they serve as a mentor for a younger (or less experienced) student.
- A vignette regarding mentoring captures the orientation of the CAHSI PIs towards the practice. During a CAHSI business meeting, a junior faculty member began to describe her research areas of interest. The PIs in the room digressed from the meeting topic at hand, and started to name others in the computer science research field who also studied in the areas. They asked the junior faculty member if she knew these contacts, and offered to make introductions.

BPC Goal: Include complementary (social science or educational) research that informs the design of Alliance activities

The formation and development of a social science network has been a struggle for CAHSI. Interviews with key stakeholders suggest a lack of a clear role for social science experts, lack of funding to support social science research at CAHSI schools, and lack of regular communication among social scientists listed in the network and CAHSI leaders. In some cases, the difference between evaluation of a program and social science regarding key programmatic ideas was not clear to PIs.

However, CAHSI initiatives are grounded in strong research from education, computing, and social science disciplines, in some cases complementary to or built from the work of the social science network. Evaluators, who are trained in the social sciences, have collaborated with PIs and social scientists already engaged on CAHSI campuses to disseminate CAHSI findings within social science networks (e.g., American Educational Research Association, AAAS Understanding Interventions, International Conference of the Learning Sciences). Similarly, CAHSI PIs are actively engaged in computing education conferences, and disseminate within that community with regularity. It would behoove CAHSI to redefine, reconfigure, and reexamine the social scientists' roles before seeking additional funding. One idea CAHSI PIs put forth was to engage social science graduate students on CAHSI campuses, and put CAHSI forward as a research site for exploration. It may also make sense to incorporate those who are already engaged in social science at the CAHSI institutions in a social science network.

CAHSI-SACI: adding campuses to the alliance

At the time of this writing, a BPC demonstration project proposal was under negotiation with the National Science Foundation to add three schools to the CAHSI family: Miami Dade College, University of Texas, Pan American, and California State University San Marcos. Pending funding, they will participate as full members of the CAHSI alliance, adopting key initiatives of the alliance, adding to leadership and planning meetings as well. This addition will allow CAHSI to reach more students—combined, these three schools graduated 60 Associate degrees, 47 Bachelor degrees, and 25 Master's degrees in computing fields in 2007-2008.

A tension that has been apparent in planning meetings as CAHSI has discussed growth is negotiating quality and commitment in the adoption of programs with expanding to reach more schools and, through them, more Hispanic students. The schools chosen to become members of the core community have had faculty participation in ARG and CS-0 training, faculty attendance at CAHSI annual meetings and meetings on site at related conferences (e.g. Tapia conference CAHSI meeting, SACNAS-CAHSI meeting), and are connected through computing networks to the CAHSI PIs. “CAHSI as la familia” is a feeling and an approach to the alliance that supporters and members hope to sustain with growth, according to interviews with PIs.

BPC Goal: CAHSI: Serving as a Visible Model/Repository for Effective Practices to Broaden Participation

This section describes the ways in which CAHSI is becoming a visible model for effective practices to broaden participation in computing fields. We focus on the expansion of CAHSI to other institutions, the dissemination of CAHSI initiatives and findings, the visibility of CAHSI in CAHSI departments and on CAHSI campuses, and the adoption of CAHSI curriculum, materials, and courses at other institutions, and within other BPC alliances.

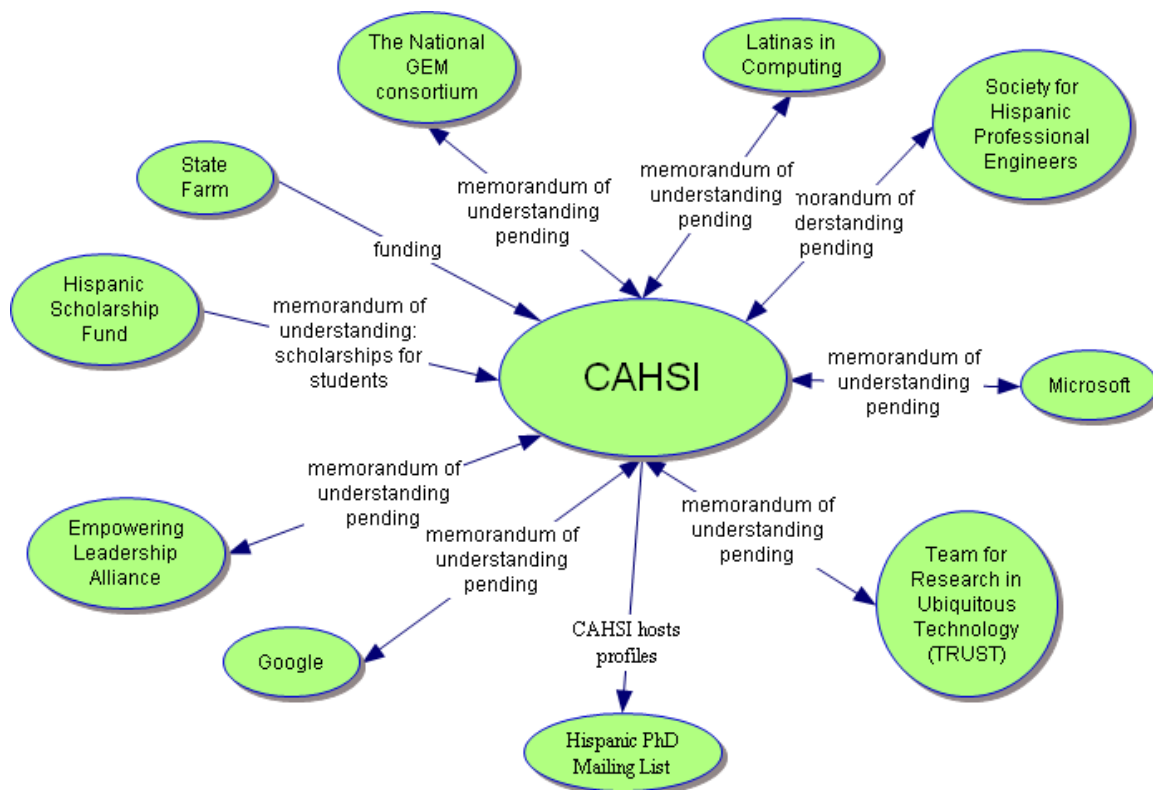
Starting at home: Developing support and awareness through CAHSI advocates

A new initiative was developed in the latest round of funding to boost campus awareness of CAHSI opportunities. Each campus has at least one student and one faculty advocate for CAHSI. Under the leadership of Miguel Alonso, a new SACI PI, advocates will document their recruitment efforts, including one main event per semester. The recruitment is aimed at increasing student knowledge of academic opportunities that CAHSI offers. PI's impressions were that some of the students were receiving the benefits of CAHSI (in CS0 and PLTL, for example, which serve all students enrolled in target courses) with no knowledge of the broader scope of the BPC Alliance. The evaluators will collect data from advocates (expected December 2009) regarding their efforts on campuses, the perceptions of CAHSI communicated by their peers, and the number of students and faculty they communicated with regarding

CAHSI. Custom posters were developed for CAHSI institutions to use to promote the effort. Institutional website visibility of CAHSI is an area for improvement—not all schools have permanent, CAHSI-related information or links to the main site. Principal Investigators recount how their departments and their administration perceive CAHSI. One PI mentioned that his faculty are not all involved in CAHSI, but because he is the department chair, they have an awareness of the alliance. His impression of their attitudes is that they see that PLTL impacts the preparedness of students in later classes. Two faculty members were aware of university administrators leveraging the CAHSI effort, one for policy changes across engineering and for receiving additional opportunities to develop academic engineering programs. Others are not sure their administration is aware of CAHSI and what it does. A previous suggestion to contact all university presidents with a targeted publication about CAHSI was mentioned this fall as a possible solution to uneven knowledge about CAHSI at the administrative level.

CAHSI Creating tiers of membership and support

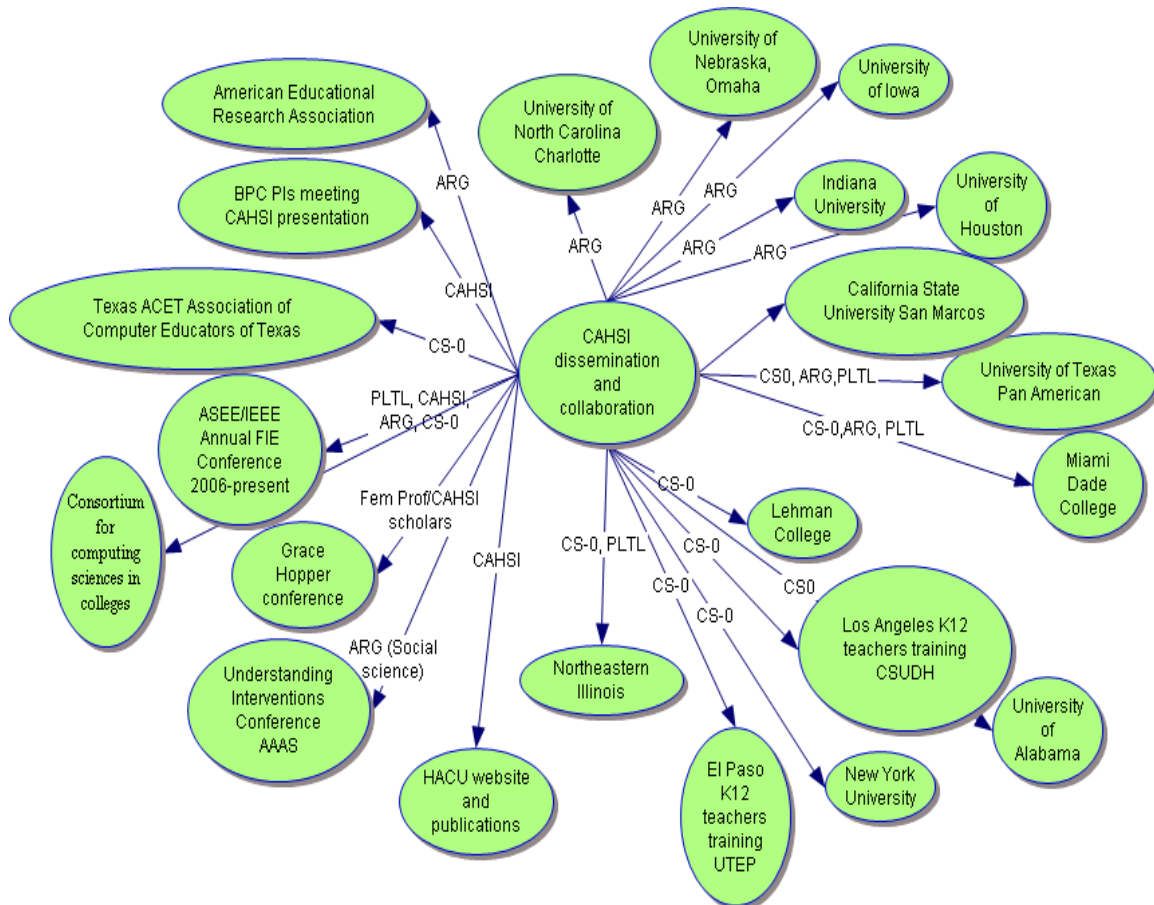
CAHSI is developing relationships (e.g. Memoranda of Understanding) throughout the Hispanic STEM community; the academic Hispanic community, and within BPC. At this writing, CAHSI has been developing informal and formal relationships with ten organizations, sharing the initiatives widely through these multiple networks. Memberships to CAHSI have been tightly controlled as membership often relates to funding for initiative implementation and travel. However, CAHSI and their collaborators are creating tangible benefits for all parties—for example, GEM is allocating a set of scholarships for CAHSI participants. This practice ensures a wider recruitment base for GEM and additional, outside funded academic opportunities for CAHSI students. These substantive collaborations are a promising first step towards sustaining CAHSI financially. See figure below.



Object 35: CAHSI Connections to other Alliances

Dissemination and Opportunistic Allotment of Resources

CAHSI faculty members have spread (or have plans to spread) the main initiatives over 11 states via in person training or presentations. CAHSI faculty and evaluators have shared their knowledge of effective practices in at least 8 professional venues, including HACU publications, American Educational Research Association, the Understanding Interventions Conference supported by AAAS, and multiple Frontiers in Education conferences. Up to this point, faculty members from other institutions have learned of CAHSI via professional networks, interaction at conferences, and other chance encounters. CAHSI stakeholders arrange for training, conversations, and/or sharing of resources. This method of dissemination has assured that the learners are committed to the effort, though it lacks a systematic attempt to disseminate broadly, and perhaps, means that the resources reach “the choir”, or the faculty who are already promoting equity and pedagogical change in computing. As CAHSI continues to grow a more strategic dissemination plan may be in order. See figure below.



Object 36: CAHSI Dissemination

Distribution of materials, resources

The CAHSI website has been dynamic, with varied degrees of usability, according to interviews with faculty. Its multiple purposes have been a challenge—the website needs to be the face of CAHSI for students and the public as well as a portal for sharing internal and external resources. The current iteration of the website has downloadable web resources available for CS0, PLTL, and ARG. CAHSI stakeholders' impressions are that more funding for web developer and full time program manager have been instrumental in CAHSI organization and web improvement. Evaluators are attempting to gather information from those who download materials from the site, to better understand how CAHSI is becoming a model of effective practices. NCWIT, a prominent BPC alliance, has published two promising practices resources that feature CAHSI initiatives, and the Anita Borg Institute highlighted CAHSI's mentoring efforts.

Possible next Steps: A community of research excellence

A new research opportunity has emerged for CAHSI institutions through the Center for Excellence at Purdue University regarding Command, Control and Interoperability in collaboration with UHD, one of the institutions chosen to collaborate in this Center. UHD hopes to bring in research expertise from CAHSI institutions to address the visualization research questions brought to bear in issues of homeland security. Evaluators intend to follow this new opportunity, to inquire about ways in which the collaboration influences the following: a) connections of students from CAHSI schools with Research I schools, b) research funding opportunities garnered by students or professors at CAHSI schools, c) presentation and/or publication opportunities for students and faculty engaged in CAHSI.

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Appendices:

1. Increase (or contribute to increasing through any of the following methods) the number of U.S. citizens and permanent residents receiving post secondary *degrees* in the computing disciplines, with an emphasis on the proportion of students from communities with longstanding underrepresentation in computing: women, persons with disabilities, and minorities (African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, and Pacific Islanders).
2. Engage the computing community in developing or implementing innovative strategies and methods to improve *recruitment, retention, and advancement* of targeted students and professionals at the undergraduate, graduate, and career levels, especially with respect to academic careers.
3. Create sustainable *changes in culture or practices* at the institutional, departmental, or organizational levels that contribute to broadening participation in computing.
4. Serve as visible models or repositories for *effective practices* to broaden participation.
5. Include complementary (*social science or educational*) *research* that informs the design of Alliance activities.
6. Increase the *duration and scope* of the Alliance award, by introducing additional targeted student groups, partners, and/or projects (in collaboration with middle and secondary schools, government, industry, professional societies, and other not-for-profit organizations), leveraging existing efforts both across and within underrepresented communities.

The CAHSI Alliance measures the effect of the activities on the participants

Outcome indicators (we know CAHSI is successful if we can show):

BPC Primary Goal: Increase (or contribute to increasing through any of the following methods) the number of U.S. citizens and permanent residents receiving post secondary *degrees* in the computing disciplines, or contribute to the advancement of computing professionals.

1. IPEDS data and institutional research office data regarding student graduation and/or enrollment rates, particularly for underrepresented groups in CAHSI schools that demonstrate (see note at end of document):

Favorable comparison over time

Favorable comparison to Taulbee survey results of national computing degree production

Favorable comparison to similar schools in similar regions (public or private non-profit schools in CA, FL, NM, and TX)

2. Using Lent's model of career theory (Social cognitive career theory, measured using Lent's computing career survey, obtained from Bob Lent in 2009), determining whether specific CAHSI course initiatives influence the following:

A.) Self-reported increase in student confidence & interest in:
BA computing
MA/MS computing
PhD computing

B.) Self-reported increase in knowledge or awareness of:
Computing careers
Benefits of computing careers

C.) Self-reported increase in coping with STEM program demands, including opportunities for mentoring

D.) Self-reported increase in sense of community in department, or feeling of "fitting in" within the computing major

(with comparison of above data to published results of students in STEM fields when applicable)

3. Institutional Research data from all CAHSI schools that show:

Favorable comparison of student success rates in PLTL courses since implementation of CAHSI

Favorable comparison of student success rates in CS1 following CS-0 participation

Favorable course taking patterns since the inception of CAHSI (e.g. fewer repetitions, shorter time to graduation)

4. Self-report and CAHSI advocate report of change in students' behaviors needed for application to graduate school:

Taking GRE

Inquiries about graduate school

Applications for grants, scholarships, etc.

Sending applications to graduate school (with comparison of target group to national averages, when applicable, e.g. rates of students taking GRE test)

4. Self-report and CAHSI advocate report of change in students' "vita-promoting" behaviors needed for success in academia:

Presenting technical papers

Presenting technical presentations

Publishing articles

Serving as a tutor/peer leader

(with comparison of target groups to other REU programs, when available)

5. Self report of increase in career-enhancing activities, behaviors, or roles (e.g. leadership roles, publication, presentation, funding for students leading to increased research productivity or advancement) provided junior faculty and early-career professionals (especially Hispanic professionals) via CAHSI.

BPC Goal: Serve as visible models or repositories for *effective practices* to broaden participation.

6. Documentation of dissemination of CAHSI resources (e.g. training, materials, presentations, publications) outside of CAHSI, and relevant evaluation of dissemination when available (e.g. training evaluation data).

7. Documentation of shifting outsider perceptions or more broad recognition of CAHSI via interviews with computing professionals.

BPC Goal: Increase the *duration and scope* of the Alliance award, by introducing additional targeted student groups, partners, and/or projects (in collaboration with middle and secondary schools, government, industry, professional societies, and other not-for-profit organizations), leveraging existing efforts both across and within underrepresented communities.

8. Student self report of student attendance at or engagement with other alliance activities, such as:

Attendance at Tapia

Participation in GEM workshop

Engagement in STARS Alliance project

9. Documentation of additional funding (proposed and obtained) leveraged to support CAHSI activities, including:

Department funds

Institution funds

Scholarship funds (via MOU with other groups, SHPE, Hispanic Scholarship Fund, GEM)

10. Documentation of CAHSI's establishment of related BPC demonstration projects, connections with other BPC alliances, and outreach activities that extend beyond the intended CAHSI target groups.