NATIONAL SCIENCE FOUNDATION

BROADENING PARTICIPATION IN COMPUTING

CAHSI ANNUAL EVALUATION REPORT 2011-2012

CREATING NETWORKS TO SUPPORT HISPANIC COMPUTER SCIENTISTS

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INCREASING HISPANIC UNDERGRADUATE DEGREE ATTAINMENT

Data from CAHSI institutional research offices demonstrates that CAHSI continues to remain stable in bachelor's graduation rates in its departments. Additionally, in recent years, CAHSI departments are producing more Hispanic undergraduates. In fact, CAHSI has increased the completion rate of Hispanic students by 10% since 2006—the year that CAHSI was officially formed. CAHSI consistently confers a high proportion of undergraduate degrees to Hispanics. In 2011, 70% of CAHSI computing bachelor's degrees were awarded to Hispanics. In contrast, data from the National Center for Education Statistics indicates that only 7% of bachelor's degrees in computer science in the U.S. were granted to Hispanics. Thus, *CAHSI graduates Hispanic students at nearly 10 times the national rate of Hispanic baccalaureates in computing.*

GRADUATING HIGH RATES OF WOMEN AND HISPANIC MASTER'S DEGREES

CAHSI departments have consistently graduated high rates of female and Hispanic MS degree recipients. CAHSI has dramatically increased the number of women MS graduates from the time that it was first formed, demonstrating an increase of 62% since 2006. Over the years, graduation rates of female master's degrees have been variable, but they are currently on an upward trend. CAHSI has also graduated high numbers of Hispanic master's degree recipients. For example, from 2006-2011, *9% of all Hispanic master's degrees in Computer Science/Engineering in the mainland U.S. were conferred by the six founding CAHSI mainland schools*[1].

CONTRIBUTING TO THE POOL OF HISPANIC DOCTORAL COMPUTER SCIENTISTS

CAHSI has also consistently produced large numbers of Hispanic doctorates in Computer Science and Computer Engineering—quite significant given the overall very low rate of Hispanic computing PhD degree attainment each year in the nation. In fact, *from 2006-2011, CAHSI mainland schools graduated 22% of the nation's Hispanic PhDs in Computer Science.* This accomplishment, however, masks the infinitesimally small number of Hispanic PhDs in Computer Science in the mainland U.S. Only 27 PhDs were granted to Hispanic computer scientists on the mainland US from 2006-2011, and CAHSI US mainland schools conferred 6 of those degrees (22%).

NEW PATHWAYS TO COMPUTING SUCCESS

CAHSI institutions are continuing to innovate and develop new pathways for student success. Three of these pathways are the UTEP software engineering Master's degree, the new Master's degree in computer science at CSUDH developed during CAHSI, and the computer technology BA at CSUDH, housed in the computer science department. The software engineering degree is on track to graduate 20 students, the majority of them Hispanic students from the El Paso community. The BA at CSUDH includes CS1 and CS2,

[1] University of Puerto Rico, Mayaguez, a founding institution, is left out of this analysis because IPEDS records mainland data, and because UPRM could be viewed as skewing the data towards Hispanics, given its demographic characteristics.

and provides "tracks" for students to specialize in their technical field of interest, while still learning the core programming principles of computer science. Developing multiple pathways into technical careers embraces the changing face of computing while providing a rigorous curriculum for students.

DEVELOPING STUDENTS' SKILLS, KNOWLEDGE, AND PROFESSIONALISM

Students realize increases in confidence in computing and interest in their major from their experiences in Affinity Research Groups (ARGs). Students also gain critical thinking and other intellectual skills from working on real-world research problems. Student survey responses indicate that CAHSI ARGs are implemented in accordance with the ARG model, including distribution of expertise among group members, positive interdependence, and individual accountability. Over the life of CAHSI, ARG students have consistently published and presented at two to three times the rate in a typical REU. Participating in ARGs also seems to influence students' future educational goals: 60% of ARG students report that they are more likely to pursue graduate school because of their research experience.

BUILDING FACULTY NETWORKS, PORTFOLIOS

The CAHSI faculty survey indicates that departmental gains may extend beyond the students CAHSI was designed to support. Faculty noted the networking beyond their institution that takes place through CAHSI meetings and collaborations, and outside organizations, such as Latinas in Computing. In addition, faculty members are capitalizing on the success of the alliance—a third of faculty responding to the CAHSI survey noted they participated in a proposal that mentions CAHSI. Given that a quarter of the faculty self-identified as Hispanic, such professional opportunities help develop Hispanics at multiple levels in the computing pipeline.

EMBRACING ACTIVE PEDAGOGY

CAHSI faculty continued to redesign courses and advance pedagogy beyond the expectations of the grant. The developed initiatives are implemented in more institutions than ever before in the lifetime of CAHSI, and faculty are experimenting with the initiatives as well. For example, a CAHSI advocate designed a new course to utilize the ARG model to develop a sense of community as well as student skills and knowledge throughout the semester. A CAHSI department is integrating elements of CS-0 into the CS1 course to ease the transition into Java programming with conceptually-based lessons in a less syntax-heavy language. Similarly, a faculty member charged with larger course sizes began pair-programming in her courses, a technique she became aware of through CAHSI. Capitalizing on this continued innovation via regular dissemination across campuses would indicate CAHSI had developed a community of teaching practice that could continue after the grant ends in 2015.

FINDING FINANCIAL STABILITY

CAHSI has made great strides in finding alternate funding sources for its efforts. The SACNAS partnership charges CAHSI with developing the content delivered regarding computer science at the SACNAS conference, while also easing the administrative burden on CAHSI staff for organizing meeting

space and travel. Most schools have institutionalized the CS-0 course. It has been more difficult to find funding for undergraduate student research efforts, particularly at departments with limited outside research grant funding. PLTL is also more difficult to fund without some departmental contribution, though one department is experimenting with Major course fees as a method for supporting the effort. Looking forward, it will be important to secure resources for training opportunities as CAHSI expands beyond the alliance and as new instructors and faculty join CAHSI schools.

NEW ADOPTERS SPREAD CAHSI INTIATIVES

New adopters of CAHSI initiatives have spread CAHSI philosophies and practices far beyond the original Alliance. In the past year, 62 faculty members at outside institutions and K-12 educators have adopted and adapted several of CAHSI's initiatives, including ARG, PLTL, and CS-0. A few of these adopters have even begun to disseminate CAHSI practices themselves. CAHSI new adopters are reaching sizeable numbers of students and their reports indicate that at least half of them are fully implementing CAHSI initiatives, while the other half are partially implementing CAHSI models. CAHSI adopters report positive student outcomes, such as enhanced learning, increased confidence, and the creation of learning communities. Ensuring contact among new adopters and CAHSI faculty may instill the sense of a supportive community of educators that could enhance and improve implementation of the CAHSI initiatives.

RECOMMENDATION #1: DEVELOP COORDINATED POLICY AND INITIATIVE ALLIGNMENT

CAHSI members have had many discussions about how their initiatives align with national, institutional, or state efforts (e.g., time to graduation efforts, Hispanic college completion) yet no tangible products have been drafted and shared with the group as a whole. The purpose of this alignment effort was to garner support from other entities and through that support develop new funding sources and/or spread the initiatives beyond CAHS departments. This targeted alignment may also assist in developing policy partnerships—vital for CAHSI to make a lasting impact beyond the Alliance. Using evaluation results to support claims of "what works" for Hispanics in computing will bolster claims and may help develop the policy voice of CAHSI.

RECOMMENDATION #2: FOCUS ON MULTIPLE LEVELS OF CYBER INFLUENCE

CAHSI is growing its sphere of influence, as evidenced by new adopters and website analytics. As the community grows, it will be particularly important to develop smooth, standard communication protocols for distributing resources, communicating among and between different types of CAHSI stakeholders, and training new and returning CAHSI students, staff, faculty, and instructors. While internal infrastructure is in place, the third year of the grant may be an opportune time to ensure the cyber infrastructure is understood by stakeholders—in fact, a focus on the current tools and ways to integrate the tools into current and future practice may be a useful CAHSI-wide activity.

RECOMMENDATION #3: BUILD A SOCIAL SCIENCE NETWORK FROM LOCAL PARTNERSHIPS

Developing an overarching committee of distinguished Hispanic social science scholars has been difficult for CAHSI, particularly with no funds allocated to support the effort. However, CAHSI faculty are collaborating locally with social scientists and evaluators to study how CAHSI is making an impact at the departmental level. It may be advantageous to bring those social science partners together to brainstorm research opportunities that would benefit the social scientists academically while providing additional insight regarding CAHSI student achievement.

RECOMMENDATION #4: FOCUS DISSEMINATION TRAININGS ON DEVELOPING PEDAGOGICAL UNDERSTANDING

CAHSI has disseminated its initiatives to a variety of stakeholders from multiple institutions, disciplines, and K-12 settings to support the educational attainment and advancement of Hispanic students. However, it is not clear whether all new adopters fully understand the pedagogical and philosophical basis of these educational activities. About half of new adopters are partially adopting CAHSI initiatives, or implementing a few aspects of the initiative. If CAHSI would like to support adopters to fully adopt all, or most, aspects of their initiatives, they my consider structuring trainings like ARG workshops with an emphasis on the intellectual basis for the initiative along with opportunities to practice the initiative. Continued dissemination of workshops, resources, and materials online will also help to facilitate full adoption of CAHSI practices.

RECOMMENDATION #5: FURTHER INVESTIGATE THE FACTORS BEHIND THE DISCREPANCIES IN WOMEN'S BACHELORS' AND MASTERS' GRADUATION RATES

CAHSI's completion rates of women bachelor's and master's degree recipients reflect national trends in which women have higher degree attainment rates at the master's level than the bachelor's level in computing. CAHSI's systemic support of students and culture of mentoring should also benefit women at the bachelor's level and boost graduation rates, as they have with Hispanics. CAHSI could benefit from investigating the factors behind the differences in these graduation rates so they can more successfully recruit and support women undergraduates.

RECOMMENDATION #6: ENGAGE IN STRATEGIC THINKING ABOUT SUPPORTING INDIVIDUAL AND DEPARTMENTAL ADOPTERS OF CAHSI INITIATIVES

CAHSI has begun to successfully disseminate its initiatives to individual and departmental adopters. Many of these practices represent new ways of thinking about teaching and learning for new adopters. To date, adopters have largely been satisfied with the resources and support they have received from CAHSI. However, departmental adopters clearly have different needs from individual adopters. Departmental adopters often have a greater need for online resources and materials, supplemental funding, and more integration with the alliance. CAHSI should continue to support new adopters through personal contact and networks, CAHSI annual meeting workshops, and online resources. CAHSI should also continue to think strategically about how to meet the differing needs of small-scale and large-scale adopters.

INTRODUCTION

CAHSI has developed a network of partnerships and collaborations that support student success in computing. CAHSI's goals, strategies, and practices have evolved over time. Initially, CAHSI focused on developing and refining their student-centered educational initiatives, and sharing knowledge and skills within the alliance itself. CAHSI then focused on providing and hosting trainings to develop human capital within the alliance to implement its educational programming, and to build organizational capacity and sustainable infrastructure to support the alliance. As CAHSI has evolved, their goals have shifted beyond the alliance. CAHSI now seeks to become a voice for policy and educational reform, and an advocate for Hispanic student and faculty success in STEM. To achieve these goals, CAHSI must continue to create human and physical infrastructure to support innovation and collaboration within and beyond the alliance, disseminate its mission and its practices beyond the alliance, and serve as a unified voice for Hispanics in computing at the institutional, regional, and national levels.

In keeping with the BPC common core indicators, the CAHSI evaluation focuses on three strands of alliance activities and outcomes: individual participant outcomes, organizational capacity, and broader alliance impacts. External evaluation focuses on the following individual participant outcomes: individual participation in CAHSI activities, community-building outcomes, tracking student advancement through the major, and student and faculty experiences of CAHSI initiatives. In addition, evaluators focus each year on one or more case studies that deepen understanding of student or faculty experiences and advancement. CAHSI annual meeting data will not be included in the present report because CAHSI did not hold its annual meeting during the current reporting cycle. Instead, CAHSI has now partnered with the Society to Advance Chicanos and Native Americans in Science (SACNAS) to co-locate their annual meeting. The next CAHSI annual meeting will be held in October, 2012 at the SACNAS meeting. In addition to CAHSI participation outcomes, individual outcomes from CAHSI initiatives are now tracked in SACI schools, three institutions that began to scale and adapt CAHSI initiatives in 2009. Finally, organizational capacity measures the extent to which CAHSI departments are institutionalizing and sustaining CAHSI initiatives and broader alliance impacts focus on the reach of CAHSI beyond the original institutions.

BPC INDICATOR #1: INDIVIDUAL PARTICIPATION AND OUTCOMES

In this section, we describe the outcomes of CAHSI at the individual level, with a focus on how CAHSI programming has influenced students' (particularly underrepresented students') degree attainment and their acquisition of skills and knowledge necessary to advance in computing careers. We also profile several of CAHSI's educational practices that have been particularly successful in cultivating student success, including the ARG model, the FemProf model, and the master's of science in software engineering program housed at UTEP. These models all share the following elements that contribute to their influence on students' success with computing:

- COMMUNITY: Student experience of CAHSI initiatives as fostering a sense of community around excellence in the field

- SKILLS and KNOWLEDGE: Student acquisition of the skills, knowledge, and professional behaviors necessary to succeed and advance in computing careers

- STUDENT ADVANCEMENT: Student behaviors, planned behaviors, and aspirations leading to computing careers and advanced computing degrees

We begin with a focus on overall student participation in CAHSI initiatives. We then highlight the community-building outcomes from CAHSI at the individual, organizational, and alliance levels. Next, we present graduation data from CAHSI departments and compare it to national trends. Finally, we highlight participant experiences in specific CAHSI initiatives and educational programs, such as CS-0, Affinity Research Groups (ARGs), and FemProf, demonstrating how the community created in these initiatives helps to support students' development as computer scientists.

CAHSI PROVIDES DEPTH AND BREADTH OF LEARNING EXPERIENCES

CAHSI has continued to expand the scope of its activities and increase the rate of participation in its initiatives. The participation matrix below underscores the depth and breadth of the alliance. One of the strengths of the alliance is the duration and intensity of student experiences. Almost all of CAHSI's initiatives are extended, intensive learning experiences. CAHSI initiatives reach students from the moment they enter the department in introductory courses, and continue to provide support throughout the major and beyond.

Assuming a 15 week semester, the original seven CAHSI schools provided 11,070 hours of introductory computing content to students in 2011-12, primarily Hispanic students. The PLTL initiative gave the equivalent of 14,025 hours of undergraduate-led instruction to computing students, and Affinity Research Groups provided at least 9,300 hours of undergraduate participation in computing research (assuming a 10 hour commitment over 15 weeks). CAHSI focuses attention on Hispanics as well as female students—CAHSI's representation of women in the participation matrix outpaces the enrollment numbers at CAHSI schools. See Table 1 below.

Table 1. Student participation matrix for CAHSI initiatives, 2011-2012

Initiative	Total students	Total women	Proportion female	Total Hispanic	Proportion Hispanic	Total Other Underrep. Minorities (URM)	Proportion Other URM
CSO	**246**	**45**	**18%**	**175**	**71%**	**13**	**5%**
PLTL	**935**[2]	**200**	**21%**	**537**	**57%**	**81**	**9%**
ARG (undergraduates)	**62**	**15**	**24%**	**41**	**66%**	**0**	**0%**
Totals	**1243**	**260**	**--**	**753**	**--**	**94**	**--**

CAHSI BUILDS COMMUNITY WITHIN AND BEYOND THE ALLIANCE

In addition to individual, organizational, and broader alliance impacts, the Common Core Indicators emphasize the community-building aspects of BPC Alliances. CAHSI has focused on building community at each level of participation: individual, organizational, and beyond the Alliance. Below, table 2 outlines the community-building outcomes from CAHSI efforts.

Table 2. CAHSI Community-Building Outcomes

Indicator	*CAHSI Community-Building Outcomes*
1. Individual participation and outcomes	• 70% of CAHSI students later contacted a student they met at the CAHSI annual meeting in 2011 • 40% of CAHSI students later contacted a faculty member they met at the CAHSI annual meeting in 2011 • 23 Hispanic computer scientists belong to CAHSI's Computing Ph.D.

[2] The PLTL numbers for NMSU's Data Structures course were not available at the time of this report. We will add this data to the report as it becomes available.

	network • Since 2006, the CAHSI annual meeting grew from less than 50 participants to nearly 200
2. Organizational capacity	• Since 2006, 17 CAHSI faculty have been trained in CS-0, 18 have been trained in PLTL and 46 have been trained in ARG • Four new extracurricular computing clubs for students have been started in CAHSI since 2006 (these clubs are beyond the explicit goals of the grant) • CAHSI all-hands meetings (executive meetings) have more than doubled in number of participants since 2006 (from 7 to 20+), indicating that multiple viewpoints are honored by CAHSI leadership • Nearly two thirds (64%) of all computing faculty at CAHSI schools indicate students participate in research more now than before CAHSI, and over half (55%) state students are collaborating more since CAHSI began[3]
3. Impact beyond the Alliance	• CAHSI has partnered continuously with 3 other BPC Alliances • 25% of new adopters of CAHSI initiatives first heard about CAHSI from a colleague external to the alliance, indicating that CAHSI is expanding beyond its original members and institutions • 89% of new adopters are satisfied with the resources, materials and support they have received from CAHSI; ongoing support for new adopters truly creates Communities of Practice • Faculty at CAHSI institutions build on the work of CAHSI to develop new programs and research initiatives in their home departments. 31% of faculty survey respondents note they participated in at least one proposal that mentioned CAHSI outcomes and/or programming • CAHSI has partnered with 25 organizations to disseminate its initiatives and/or impact policy • CAHSI has MOUs in place with more than 10 nonprofit organizations that lead to specific collaborations where each party provides a service (e.g., CAHSI members serve on SACNAS board and assist in reviewing scholarships; SACNAS hosts the CAHSI meeting concurrently with CAHSI)

[3] Remaining faculty indicate students do research and collaborate "about the same" as they did before CAHSI. Note all departmental faculty were surveyed, whether they participate in CAHSI programming or not.

As demonstrated in table 2, CAHSI has built community at all participant levels: individual, organizational, and alliance. One of the important ways that CAHSI builds community is through the CAHSI annual meeting. A goal of the annual meeting is to provide a venue for Hispanic computer scientists to network and receive mentoring. The annual meeting has been effective in facilitating relationships among students, faculty, and industry professionals. For instance, after the 2011 CAHSI annual meeting, 70% of students contacted a student they met at the meeting, and 40% of students contacted a faculty member they had met at the meeting. Additionally, the annual meeting has nearly quadrupled in size since 2006, providing even greater networking opportunities among the relatively small cadre of Hispanic computer scientists. CAHSI also has close affiliations with the Latinas in Computing network that provides support and mentoring to Hispanic women in computing careers.

CAHSI has built a pedagogical and intellectual community to support student success in its departments. CAHSI has created human infrastructure to support its initiatives by training faculty in member departments in CS-0, PLTL, and ARG. Since 2006, 17 CAHSI faculty have been trained in CS-0, 18 have been trained in PLTL and 46 have been trained in ARG. Surveys of faculty in CAHSI departments also indicate that student and faculty interactions and collaborations have increased since CAHSI. Faculty members view participation in CAHSI as a way to collaborate with peers beyond their home institution.

CAHSI has begun to build community beyond the alliance by disseminating its initiatives more broadly and developing key partnerships to advance its mission. CAHSI provides ongoing support, resources and materials for adopters of its initiatives through its website and interactions among CAHSI members and new adopters. CAHSI has partnered with 25 organizations—10 of these have an official memoranda of understanding (MOU) in place—to support its mission and impact policy around Hispanics and STEM education. Thus, CAHSI has effectively built communities of individuals and organizations, within and beyond the alliance, to support the advancement of Hispanics in computing.

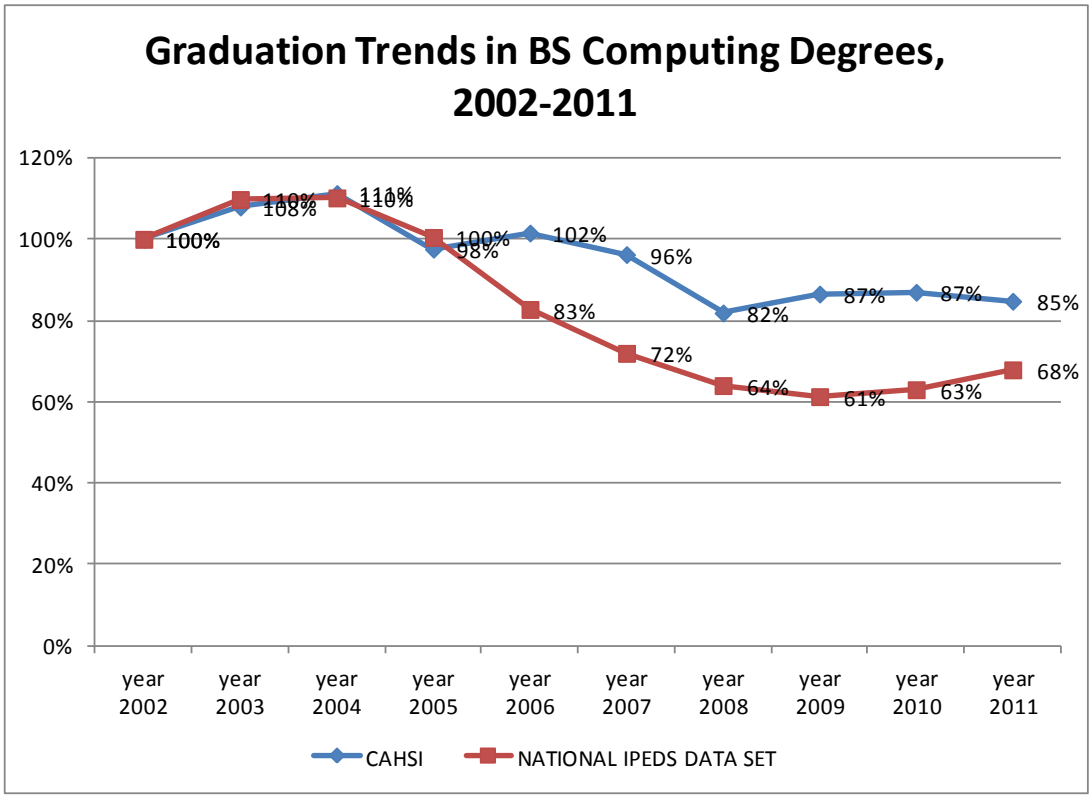
CAHSI GRADUATION OUTCOMES

CAHSI's overall bachelor's graduation rates hold steady

For nearly a decade, the U.S. has declined in rates of bachelor's degree production in computing fields, though the last two years have shown modest increases in the Taulbee dataset. However, the Taulbee data set only reflects graduation trends in doctoral-granting institutions. Evaluators have used graduation data from the Integrated Postsecondary Education Data System (IPEDS) to place CAHSI college completion outcomes in a national context across a diversity of computing programs not captured in the Taulbee data set. Comparison of CAHSI outcomes to this nationally representative sample of institutions has demonstrated that in a period of national decline in the production of computing baccalaureate degrees, CAHSI has remained relatively stable. Figure 1 details the bachelor's graduation trends in CAHSI departments from 2002-2011, comparing CAHSI departments to a nationally representative sample of Computer Science and Computer Engineering departments in master's degree and doctoral degree-granting institutions. The

comparison data set used throughout this report consists of 1711 colleges and universities[4]. Figure 1 details graduation trends of CAHSI and the national sample as a percentage of their 2002 graduation rate.

Figure 1. Percentage of 2002 degree production, CAHSI institutions and national sample, 2002-2011



Data from CAHSI institutional research offices demonstrates that CAHSI continues to remain stable in graduation rates in its departments, after experiencing a decline between 2006 and 2008. After experiencing a steep decline beginning in 2004, the national graduation rate in Computer Science and Engineering is slowly inching up. CAHSI is still at a higher percentage of their 2002 graduation than the national comparison set, yet the gap is beginning to close as the nation begins to produce more computing baccalaureates.

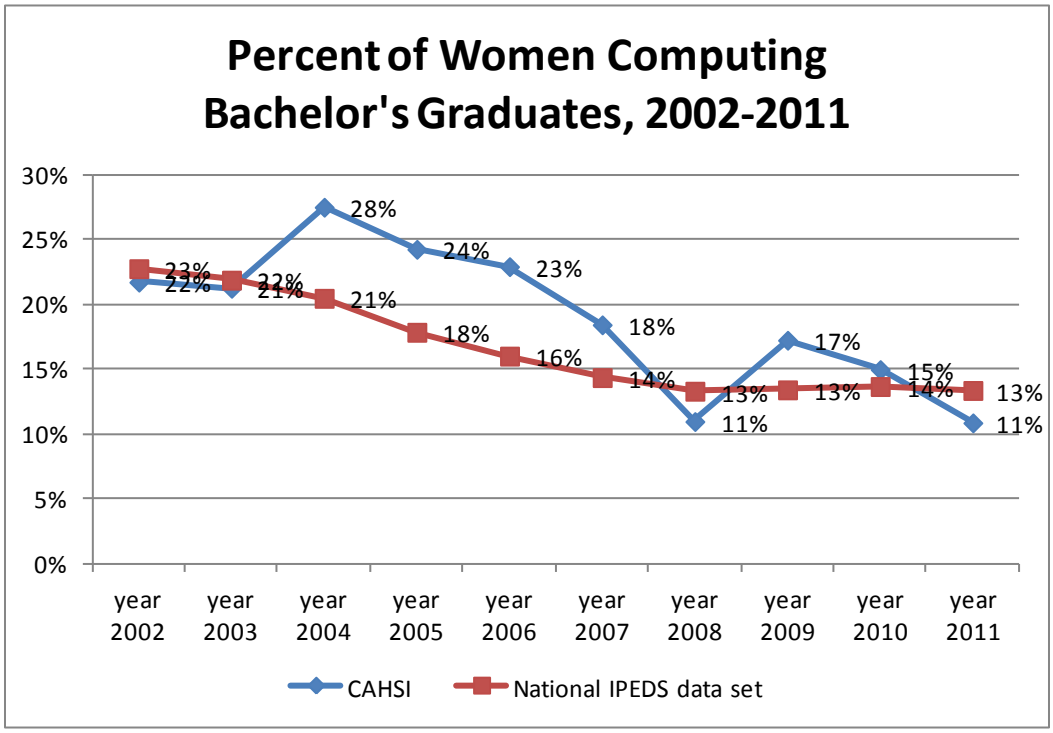
CAHSI declines in women undergraduate baccalaureates in computing

The numbers of women graduates in computing in the nation reflect past trends that show decline in female completion rates in computing majors. The figure below reflects the rate of women receiving bachelor's degrees in computing as a percentage of overall graduation rates. While CAHSI and the nation started at about the same percentage of female graduates in 2002 and 2003, CAHSI experienced a sharp increase in female undergraduate degrees in subsequent years. However, CAHSI graduation rates for women have declined since then. CAHSI had a slight increase in 2009, yet has declined in female degrees in the past

[4] The data set contains U.S. public and private not-for-profit universities and colleges from master's and doctoral granting computing programs in one of four majors codes from the IPEDs database that most closely align with CAHSI majors.

two years. Also, for the second time in the last ten years, CAHSI has dipped slightly below the national average of female graduations in the academic year 2010-11. It is unclear why these changes have occurred.

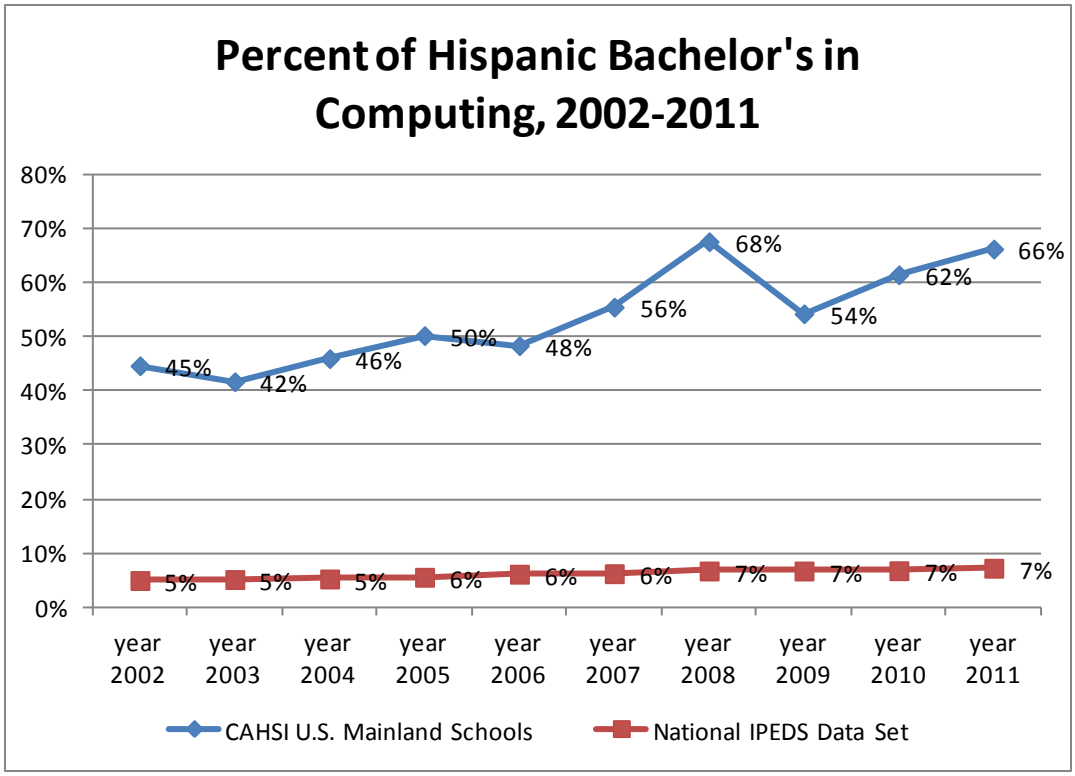
Figure 2. Percent of Women Bachelor's Graduates in Computing, 2002-2011



CAHSI increases graduation rates of Hispanic bachelor's in computing

On the other hand, after a downturn in Hispanic graduation rates in 2009, CAHSI departments are increasing the completion rates of Hispanic students. In fact, CAHS has increased the completion rate of Hispanic students by 10% since 2006—the year that CAHSI was officially formed. In 2011, 66% of CAHSI computing bachelor's degrees were awarded to Hispanics. In contrast, the IPEDS data set indicates that 7% of bachelor's degrees in computer science in the U.S. are granted to Hispanics. Thus, ***CAHSI graduates Hispanics at nearly ten times the national rate***. This analysis only includes the six CAHSI mainland U.S. schools because the inclusion of Puerto Rico may dramatically influence the composite results as it is nearly 100% Hispanic. Even without the Hispanic representation of UPRM, CAHSI graduates significantly high proportions of Hispanic baccalaureates. Increasing Hispanic college completion rates is part of the national college completion agenda advocated by Excelencia in Education, the Lumina Foundation, and the Obama White House.

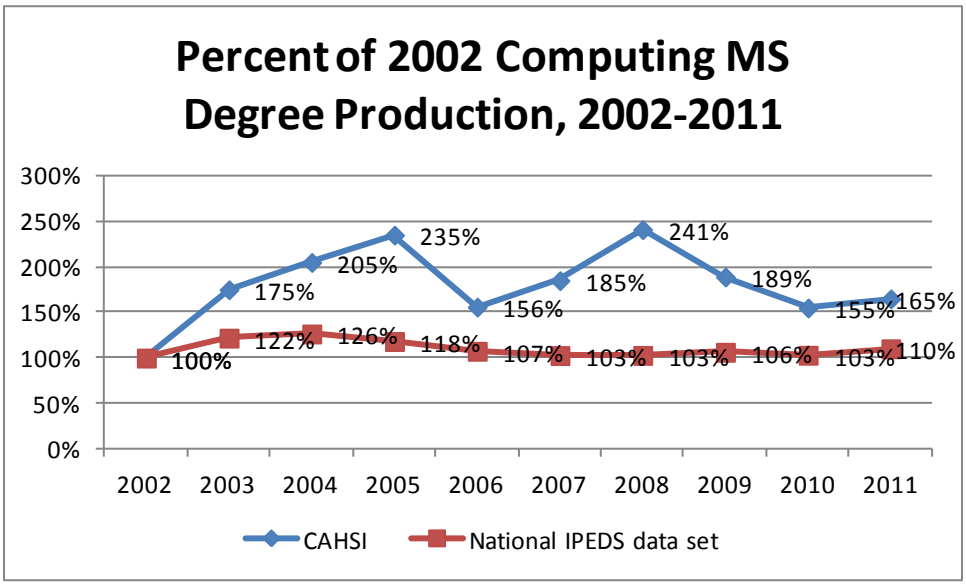
Figure 3. Percent of Hispanic bachelor's degrees in computing, CAHSI and national sample, 2002-2011



CAHSI outpaces the nation in master's degree completion trends

After a recent downward trend, CAHSI master's degree completion rates are increasing. The recent downward trend in master's degree production in CAHSI departments in 2010 most likely reflects declining enrollment rates of master's students in a few CAHSI departments. For instance, due to budgetary constraints, FIU no longer funds master's students and, subsequently, master's enrollment on that campus has declined dramatically. The recent upward turn in master's degree completions indicates that CAHSI departments are overcoming their challenges and successfully recruiting and retaining new master's students. Nevertheless, as demonstrated in figure 4, graduation rates in CAHSI departments still outpace the national average. The figure below reflects the graduation rate of CAHSI and national computing departments as a percentage of their 2002 graduation rates. As the figure demonstrates, CAHSI is still substantially above their 2002 graduation rate, while the nation has slowly increased its graduation rate of MS degrees in computer science and engineering. The addition of new degree programs in CAHSI has influenced the number of graduates completing Master's degrees.

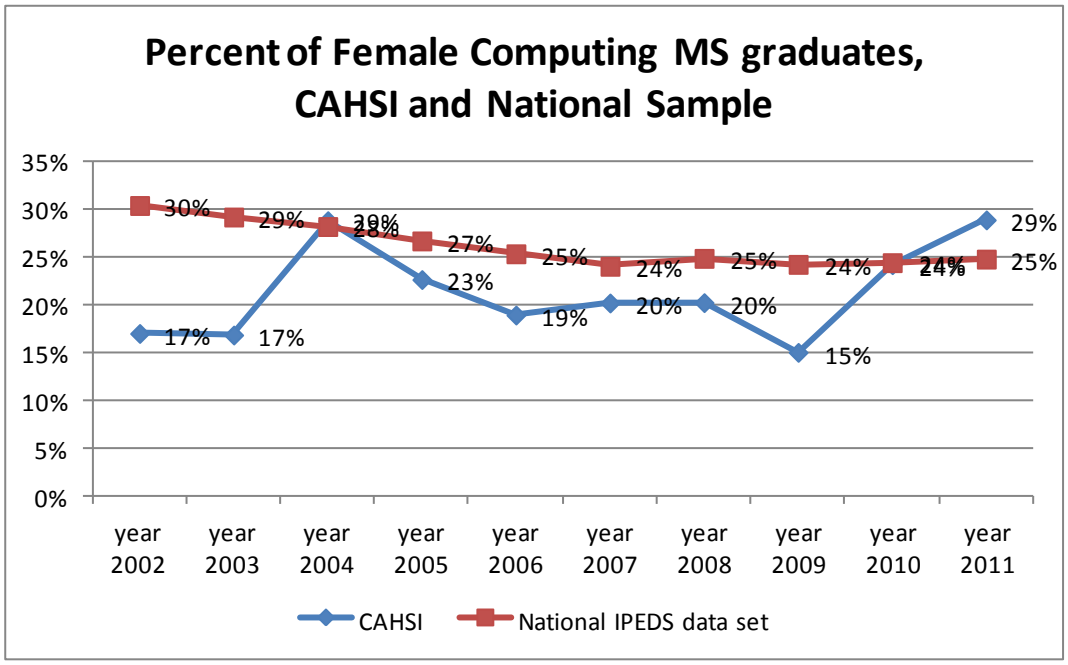
Figure 4. Percent of 2002 Computing MS Degrees, CAHSI and National Sample, 2002-2011



CAHSI substantially raises its graduation rate of female MS degree recipients

CAHSI departments have consistently graduated high rates of female and Hispanics MS degree recipients. CAHSI has dramatically increased the number of women MS graduates from the time that it was first formed, demonstrating an increase of 62% since 2006. Over the years, graduation rates of female master's degrees have been variable, but they are currently on an upward trend. In fact, ***in the last two years, CAHSI has nearly doubled its graduation rate of women with master's degrees in computing.*** In the meantime, the nation remains stable in degree production for women with master's in computer science and computer engineering. Overall, women are better represented with master's degrees than they are with bachelor's degrees, indicating that a substantial and disproportionate number of female baccalaureates in computing must be pursuing graduate degrees in computing.

Figure 5. Percent of Women MS degrees in computing, CAHSI and national sample, 2002-2011

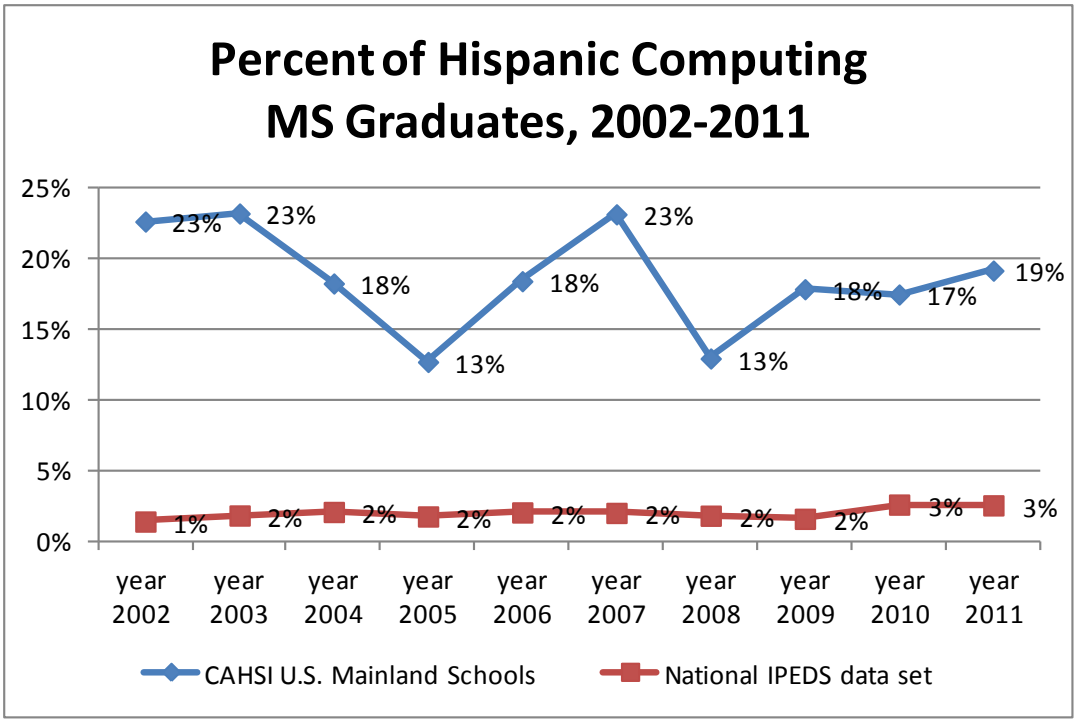


CAHSI consistently maintains high rates of Hispanic MS graduates

CAHSI has also consistently graduated high numbers of Hispanic master's degree recipients. For example, from 2006-2011, ***9% of all Hispanic master's degrees in Computer Science/Engineering in the mainland U.S. were conferred by the six founding CAHSI mainland schools.*** [5] The national rate of master's degrees in computing awarded to Hispanics remains appallingly low. While the nation awards 2 -3% of master's in computing to Hispanics, CAHSI consistently awards about 20% of master's degrees to Hispanics.

[5] University of Puerto Rico, Mayaguez, a founding institution, is left out of this analysis because IPEDS records mainland data, and because UPRM could be viewed as skewing the data towards Hispanics, given its demographic characteristics.

Figure 6. Percent of Hispanic Computing MS graduates, CAHSI and national sample, 2002-2011



CAHSI contributes significantly to the national rate of Hispanic doctorates in computer science

CAHSI has also produced substantial numbers of the nation's Hispanic doctorates in Computer Science and Computer Engineering—quite significant given the overall very low rates of Hispanic computing PhD graduates each year in the nation. In fact, ***from 2006-2011, CAHSI mainland schools graduated 22% of the nation's Hispanic PhDs in Computer Science***. This accomplishment, however, masks the infinitesimally small number of Hispanic PhDs in Computer Science in the mainland U.S. Only 27 PhDs were granted to Hispanic computer scientists on the mainland US from 2006-2011, and CAHSI conferred 6 of those degrees. In addition, during the same time period, CAHSI mainland schools conferred 4 Computer Engineering PhDs to Hispanics, representing 44% of all Hispanic CE PhDs in the mainland US (only 9 were granted overall). UPRM conferred 13 doctorates in CE to Hispanics during this time frame, but these numbers were not included in our overall counts because they would alter the findings. Our national comparison data only includes mainland US doctoral and master's degree-granting institutions. Figures outlining trends in CAHSI doctoral degree production are not included in this report because of the small number of PhD graduates and the fluctuating annual rates of doctoral degree production.

CAHSI MEMBER EXPERIENCES ACROSS THE COMPUTING PIPELINE

We now turn to the individual initiatives and educational programs that drive CAHSI success with students, and describe students' and faculty experiences of those initiatives. Some of these initiatives have been adopted CAHSI-wide, while others are housed at a single institution or within a small cohort of CAHSI institutions. We first address CAHSI-wide initiatives, and then focus on smaller initiatives that hold promise for scaling-up to a larger level. In the initial section, we discuss findings from CS-0 observations and student

surveys, PLTL course completion analysis, Affinity Research Group student surveys. We then present case studies the ARG model examining the ethic of care within ARGs, the FemProf program housed at UPRM and UHD, the Master's of Science program in Software Engineering at UTEP, and, finally, a case study of Latina professionals in computing. The ARG and Latina professionals case studies were presented at the 2012 American Educational Research Association (AERA) annual meeting in Vancouver, British Columbia in collaboration with CAHSI faculty.

> *"I learned that programming is actually more fun and easier than I thought, so I might study programming instead of other careers."*
> *CS-0 Student*

DUAL ENROLLMENT CS-0 COURSE INTRODUCES HIGH SCHOOL STUDENTS TO BASIC COMPUTING CONCEPTS

The CS-0 course has been implemented at multiple campuses, and in most cases is fully institutionalized as a course in the department. Data from previous years indicate steady, positive outcomes for the majority of students- they state that they enjoy computing, are more confident in their abilities, and are better able to reason about computing problems following their introductory course.

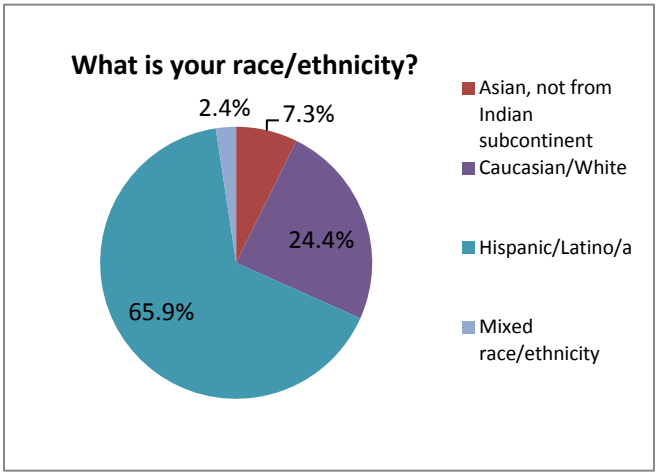


Figure 3. Race/ethnicity of CS-0 students

In addition, focus groups with students in CS-1 indicate the need for CS-0 as an introduction to more complex programming. This year, the evaluation focused on new adopters (CSU-SM from SACI) and new formulations of CS-0 as a dual enrollment course for high school students. The evaluation involved an observation of the dual credit course and student surveys. Thirteen of the survey respondents were from California State University, San Marcos, and thirty one were from the dual enrollment course at FIU. Most were male (85%) and Hispanic (66%).

Student survey responses covered six scales. The table below summarizes results from the most relevant scales, given the enrollment status of many students was high school rather than college. Differences by school ranged from 0.6 to 0.9 and were not statistically significant; therefore, summary statistics are displayed across school campuses.

Table 3. CS-0 student average scores on SCCT survey scales

CS-0 Student Average Scores on Social Cognitive Career Theory Constructs (Lent, et. al., 2008)			
SCCT constructs (Scale of 1-10) N= 31	**Percent reporting increase/ positive ratings (5.50 or better average on a 1-10 scale)[6]**	**Mean**	**Std. Deviation**
Outcome Expectations for a degree in computing	95%	8.27	1.29
Social Supports/Barriers in a computing degree program	96%	7.11	1.00
Computing Interest	92%	7.61	1.91

Nearly all students indicated increased interest in computing, strong positive attitudes regarding the benefits of a degree in computing, and feeling supported to learn in their introductory computing course. One to two students indicated a decrease in interest, outcome expectations, or perception of social support following this course. Open-ended responses allowed evaluators to understand what motivated students to enroll in the course, what they found useful about CS-0, and what motivated them to perform during the course. Students enjoyed the challenge of computer science, and the ability to create something new as well as something personally meaningful in CS-0. The dual-enrollment aspect of the course was valued by many students, as was the focus on conceptual understanding and use of strong student-centered pedagogy.

Table 4. CS-0 student survey open-ended responses

Theme	Percent of respondents	Sample quote
Computing/programming aspirations	**58%**	*"It is part of an interest of mine and I have always wanted to know more about computing."*
Motivated to take course because of dual enrollment option/need for credit	**22%**	*"I took the course to earn college credits."*
Motivated in the course by time invested/challenge	**19%**	*"(X as my favorite project because) I spent a lot of time on it and I was satisfied with the result."*
Testing CS as an area of	**42%**	*"(I took this course) to see if computer science was*

[6] Some students marked "already had high interest"- those student responses were deleted from the analysis item by item, so that the composite scale scores were computed without these scores. Two students noted "already had strong interest" across all of the interest items, and therefore did not have a composite score calculated.

interest		*right for me"*
Interested/motivated to create something personal/new	**22%**	*"(X project was my favorite, because) I combined all my prior knowledge and what the professor had taught me to create something completely independent of the class."*
Developed conceptual understanding	**14%**	*"I enjoyed experiencing the logic involved in computer programming"*
Course instructor exhibited strong pedagogy	**17%**	*"The great attitude and friendly feeling of the classroom (made the course enjoyable.)"*
Computing as strong/valued field	**11%**	*"Computing (skills) can be extremely beneficial in this increasingly technology-oriented world."*

As in past semesters at multiple institutions, results from CS-0 continue to show the course is a positive introduction to computer science concepts. The creativity involved in developing projects with Alice and other directly visual languages assures students they can be successful, and provides nearly instant feedback to students about their progress. Incorporating Alice in dual credit courses allows students to prepare for rigorous coursework in the math and science fields that they will need to succeed in a computing degree program.

PLTL OUTCOMES FOR STUDENTS

Data from PLTL courses at five universities were collected to understand course completion trends at CAHSI schools before and after PLTL was implemented. The data were collected from fall 2009 through fall 2011, as spring 2012 data was not yet available at the time of analysis. Data show that the rate of course completion was greater after PLTL was implemented.

Table 5.Course completion rate with PTL, without PLTL

Course type	*Course rate of completion (proportion of students who received a passing grade, A through D)*[7]
Non-PLTL	81%
PLTL	86%

Multiple statistical models were used to analyze the data in an effort to best account for differences in student demographics in the PLTL and non-PLTL sections (e.g., proportionally more computing majors were in the PLTL sections, and more Hispanic students in the PLTL sections). The best model for the data compared all students' course completion while accounting for differences in course type (CS1, CS2) and for

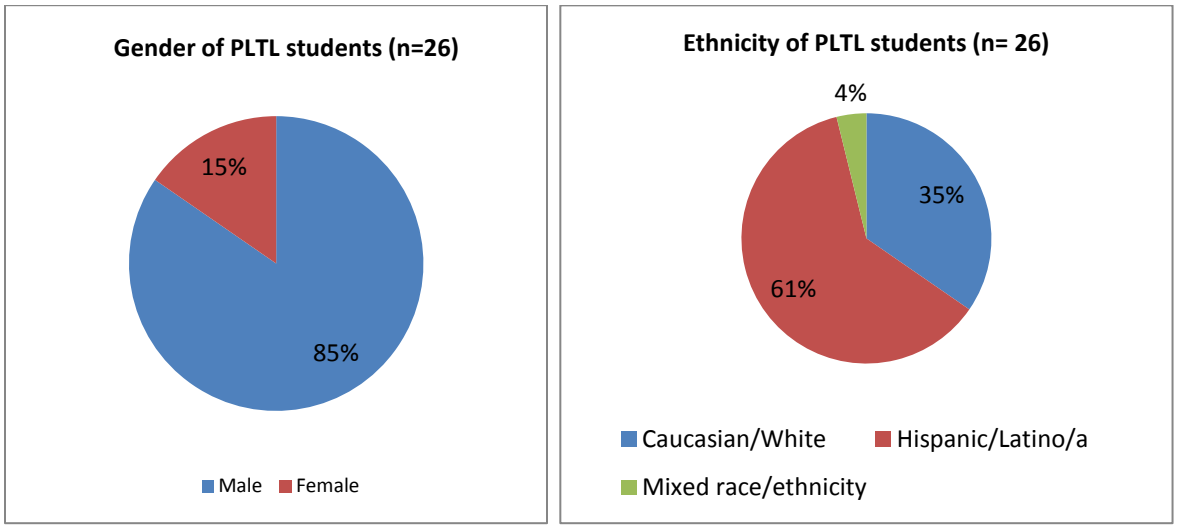
[7] Student withdrawals were dropped from the analysis for all courses, whether PLTL or non-PLTL. Students receiving an Incomplete that was not adjusted at time of analysis were counted as unsuccessful, along with F grades.

student major (CS major, non-major). This analysis shows a statistically significant difference between PLTL and non-PLTL courses, in which ***PLTL courses lead to higher student completion rates (F=7.7, P=0.005*)***. No statistically significant differences by gender or ethnicity were detected, indicating that students benefitted equally from the initiative.

In considering the aspects of "voluntary" and "required" PLTL, voluntary PLTL works just as well or better than required PLTL sessions, according to the 2012 CAHSI dataset. It is difficult to determine why this is the case, though differences in PLTL implementation for each course and characteristics of students who participate in the optional PLTL (perhaps those in greatest danger of not completing the course) may be at play. Another potential confounding variable in the data is the proportion of students who withdraw late in the semester as a method for avoiding a failing grade. As institutional research data does not differentiate between students who withdraw in the first week because of scheduling difficulties and those who withdraw near the end of a semester, these student records were not included in the analyses.

A look at student attitudes about PLTL

In addition to course completion analyses, survey data from new adopters are summarized in this section. Students enrolled in PLTL courses at CSUSM and MDC (courses receiving one hour per week of undergraduate student-led activities/instruction, or an adapted version of PLTL that met less frequently) were asked to take a survey during the final days of the semester. Students attending the courses were primarily Hispanic, and majority male. Thirty eight percent of students worked at least 20 hours outside of coursework. Sixty percent of students' mothers/maternal figures had not earned a 4 year degree, and the same proportion of fathers/paternal figures had not earned a four year degree. Nearly a third of the students had applied for an academic scholarship (31%) and nearly a quarter earned a scholarship (23%). The majority of survey respondents (83%) attended all or nearly all of their PLTL sessions.



Figures 4, 5: PLTL demographic information

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 7.10 and 8.34, indicating the PLTL course positively impacted students.

Between eighty-eight and one hundred 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.. The sections below describe a few key findings and provide qualitative data that further explain the quantitative findings.

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

PLTL Student Average Scores on Social Cognitive Career Theory Constructs (Lent, et. al., 2008)				
SCCT constructs (Scale of 1-10) N= 31		Percent reporting increase/ positive ratings (5.50 or better average)	Mean	Std. Deviation
Computing Self Efficacy		93%	7.69	1.69
Coping Self Efficacy		88%	7.27	1.80
Educational Goals		89%	7.95	2.45
Outcome Expectations		100%	8.06	1.57
Social Supports/Barriers		91%	8.34	2.11
Computing Interest		92%	7.10	1.30

PLTL supports interest, support in major

PLTL coursework strengthens interest in computing, and for some, solidified intentions to major in the discipline.

"It strengthens my knowledge of Computer Science and I intend on pursuing it as a major."

"I gained a better understanding of computer programing and saw that I would like to pursue this major."

Students who do not fit the mold in computing, because of background characteristics, Socioeconomic status, and prior experience benefit from initiatives that develop a sense of departmental community. In open-ended comments, students described the influence of PLTL on their sense of support in their major. One student described the way PLTL created a sense of comfort because of the help provided.

"I thought it was a great class, if I needed help with the material we were learning, I always received help."

Another student echoed feeling supported in the PLTL course.

"They helped me when I was stuck on problems when it came to programming. They taught me that there are different ways to get to the same solution."

Social rapport, comfort with audience needs improvement

Two respondents note the need for students to develop stronger social skill. Leading and cooperating in PLTL sessions do require, and for some, help develop, social skill in a discipline that typically involves independent work.

Conclusion: PLTL supports student learning, confidence, and achievement in computer science

Peer-Led Team Learning (PLTL) has provided 14, 025 contact hours of student-centered, collaborative instruction in critical gate-keeper courses at CAHSI founding institutions, and the implementation of the initiative at SACI schools indicates continued success. Students are passing these computing courses at greater rates since CAHSI's PLTL initiative began, leading to shorter time-to-graduation and increased retention in the major. Institutional data of student course completion rates show a statistically significant effect indicating that students were more likely to complete the course after the implementation of PLTL. Students who engage in PLTL courses indicate increased self efficacy, enhanced feeling of support in the major, as well as an ability to cope with difficulties associated with studying in the sciences.

ARG STUDENTS ENGAGE WITH COMPUTER SCIENCE RESEARCH COMMUNITY

The Affinity Research Group has been adopted on multiple CAHSI campuses and dozens of CAHSI faculty members have been trained in the model. In spring 2012, a modified version of the Undergraduate Research Student Self-Assessment (URSSA) survey was administered to CAHSI undergraduate research students. The survey measures intellectual gains, personal growth, career preparation, collaboration, and aspirations. The survey was sent to CAHSI faculty research mentors who forwarded it to their students. In all, 48 undergraduates completed the survey. Students were mainly third year (25%) or fourth year (57%) undergraduates. Students were primarily male (75%) and Hispanic (67%).

CAHSI students involved in Affinity Research Groups (ARGs) continue to outpace their national peers in NSF research experiences for undergraduates (REUS) in rates of academic presentation and publication. Nearly all ARG students (97%) in 2011-12 reported that they attended a professional conference, while only 23% of the national sample of REU students had done so [$\chi^2(1, N=512) = 90.51, p = .000$]. The medium effect size, phi=.437, indicates this is a substantial finding. As in previous years, ARG students published in refereed journals at a 50% higher rate than a national REU sample. ARG students presented conference posters at much higher rates than typical summer REU students [$\chi^2(1, N = 512) = 32.63, p = .000$], with a moderate effect size, phi=.261. Given the relatively small sample of ARG students and moderate effect sizes, we can conclude that participating in ARGs made a substantial difference in students' rates of conference

attendance and academic presentation. Frequencies of student publication and presentation for both the ARG sample and the national REU sample are presented in table 7.

Table 7. Professional activities of ARG students in 2011-12.

"In the past year I have…"	# of ARG respondents (n=48)	% of ARG respondents	# of national REU sample (n=464)	% of national REU sample
Attended a professional conference.* ** Effect size = .437 (medium effect size)	37	97%	105	23%
Authored or co-authored a journal paper.	3	9%	25	6%
Presented a conference paper or poster* ** Effect size = .261 (medium effect size)	21	44%	67	14%

****results significant at p=.000*

ARG STUDENTS ASPIRE TO GRADUATE SCHOOL

Affinity Research Groups are a central element of the MentorGrad initiative, designed to support students' preparation and pursuit of graduate school, and their advancement in the profession. ARG students reported on the steps they had taken to reach graduate school.[8] One student reported that he or she had submitted an application for graduate school and no students reported that they had taken the GRE. On the other hand, 21 students reported that they *plan* to apply to graduate school and 19 students *plan* to take the GRE in the future Questions about concrete behaviors to advance to graduate school were only asked of graduating seniors, so the small sample size of 5 graduating seniors makes it very difficult to draw conclusions about the pursuit of graduate school by the CAHSI student population as a whole. However, less advanced students are not likely to have taken these steps yet, so only graduating seniors are asked about these concrete behaviors.

[8] Data for student advancement is based on 5 responses from students who will be graduating within a year, rather than the entire sample of 48 ARG students for all other questions.

Nevertheless, ARG students attribute their interest in graduate school to their experiences in their research groups. For instance, ***60% of ARG students reported that they were more likely to attend graduate school because of their research experience***. There were no statistically significant differences in graduate school aspirations among sub-groups in the sample, such as race, ethnicity, or gender. Thus, students seem to gain substantial interest in graduate school from participating in ARGS although their actions to date have not yet advanced them towards their goals. For many ARG students, it may still be too early to determine long-term outcomes as only five survey respondents were graduating seniors.

BECOMING A COMPUTER SCIENCE RESEARCHER

Students are gaining the skills, knowledge, and confidence from ARGs that they will need in graduate school and the computing workforce. Students reported positive outcomes on all the Undergraduate Research Student Self-Assessment (URSSA) gains scales (between 3.0 and 4.0 on the 4.0 point scale, or between "good" and "great" gain). Students' highest gains were in intellectual growth and personal growth. Students' scores in intellectual gains suggest that they gained critical thinking and problem-solving skills as well as a deeper understanding of the research process. Students' scores in personal growth demonstrate that they gained confidence in their abilities and a greater interest in computing. Students also reported positive outcomes on the collaboration/teamwork scale. The collaboration scale measures the extent to which leadership is distributed, the research group works cooperatively and other markers of a high-functioning Affinity Research Group. Students' reported scores on the collaboration scale indicate that CAHSI Affinity Research Groups are operating with distributed leadership, individual accountability, positive interdependence and other hallmarks of the ARG model. Table 8 below illustrates the scale means and standard deviations for the research gains scales (4-point scale, 1=no gain, 4=great gain).

Table 8. Scale means and standard deviations on URSSA gains scales

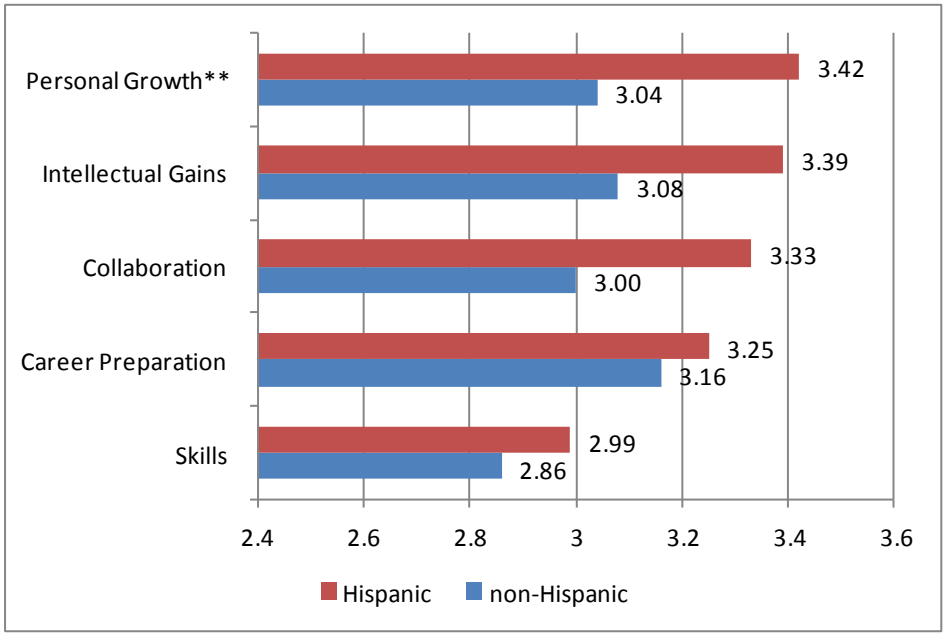
Scale	Mean (4-point scale)	Standard Deviation
Intellectual Gains:	**3.35**	**.529**
Critical thinking, problem-solving, understanding of the discipline, understanding of the research process		
Personal Growth :	**3.34**	**.495**
Self-efficacy, confidence in abilities, interest in computing, maturity, responsibility		
Collaboration:	**3.28**	**.457**
Teamwork skills, shared leadership, mentoring		
Career Preparation:	**3.20**	**.576**
Preparation for graduate school and career		

Skills: Presentation and communication skills, technical skills	**2.97**	**.566**

There were few significant differences in gains among various sub-groups in the sample, suggesting that all students benefited from their ARG experience. There were no significant gender differences, although women did rate their research gains slightly lower than men. Perhaps not surprisingly, students with outside jobs also rated their gains lower on all URSSA scales. Differences on the personal growth scale were statistically significant, *t(48)=-2.35, p=.026,* suggesting that students with external work commitments may not have had the time to invest in the group to achieve the same gains in confidence, interest, and maturity as their peers without jobs. CAHSI faculty should continue to compensate ARG students as funds and resources allow, so that students do not have to hold outside jobs that may interfere with their ARG experience.

As in prior years, ARGs seemed to be especially successful in the academic and professional development of Hispanic students. Hispanics ranked their gains substantially higher than the scores of students from groups overrepresented in computing fields (Caucasians and Asians) on the gains scales. In particular, Hispanics rated their gains in personal growth significantly higher than overrepresented students, *t(48)=3.079, p=.006*. Hispanic students reported stronger growth than their majority peers in all areas, including intellectual abilities, collaboration, career preparation, and skill development. Figure 6 details the scale means for Hispanic and non-Hispanic students on all URSSA gains scales.

Figure 6. Comparison of Hispanic and non-Hispanic student means on URSSA gains scales



*** significant at p<.001*

In conclusion, ARG students report that participating in research increased their confidence as computer scientists and their interest in the subject. Students also gained critical thinking and problem-solving skills. Student responses on the collaboration scale indicate that CAHSI ARGs are implemented in accordance with the ARG model, including distribution of expertise, positive interdependence, and individual accountability. ARG students also engage with their disciplinary research community through presenting and publishing at significantly higher rates than typical undergraduate research students.

CASE STUDY: CULTIVATING CARE THROUGH THE AFFINITY RESEARCH GROUP MODEL

The Affinity Research Group (ARG) model has been implemented at UTEP for years with demonstrated success (see Gates et al, 1999; Villa et al, in review), but is the model transferable to other institutions? The ARG model has now been disseminated to 9 CAHSI institutions with ongoing quantitative and qualitative data collection since 2008. Evaluators have accumulated a body of evidence demonstrating that the ARG model can be successfully adopted elsewhere. The results presented in this case study of ARG adoption are based on interviews with 24 undergraduate ARG students from four CAHSI institutions. Additionally, one-hundred and forty-three individual students from eight institutions completed the Undergraduate Research Student Self-Assessment (URSSA) survey in spring of 2009, 2010, 2011, and 2012. Comparison data was drawn from a diverse national sample of 464 students from 22 institutions.

ARGS foster an ethic of care

One of the factors behind the success of the ARG model is the "ethic of care" that is cultivated within the research group. The ethic of care advanced by educational theorist Nel Noddings is based on the importance of positive relationships among teachers and learners. ARGs enact an ethic of care by fostering non-hierarchical, mentoring relationships among all researchers in the group. ARGs are well aligned with several of Noddings' core components, such as caring for self, caring for intimate others (team members), and caring for ideas (Noddings, 1984, 1992). ARGs facilitate "care for self" as students gain expertise as researchers and gain confidence as computer scientists. Through caring for intimate others, students recognize that the team must function interdependently to accomplish their shared goals. ARGs also foster caring for ideas, or intellectual care about their research work and their discipline. Through these domains of care, students develop expertise, knowledge, and confidence within a community of computer scientists.

In interviews, ARG students reflected on how their research experiences served as ideal learning environments. Students were intrinsically motivated by their research, and exhibited ownership of their work in the research setting. ARG researchers felt that faculty valued and were invested in their learning.

> *"She makes everybody feel good about themselves, about what they've become, about what they've accomplished and she motivates you to reach your goals."*
> *– ARG student discussing his faculty mentor*

A pedagogy of care may be of particular relevance to undergraduate computer science students who are losing interest and perhaps confidence in their abilities. For

example, one student described how he was invited to participate in undergraduate research at a time when his interest was waning, and how the experience gave him the social and academic support network he needed to maintain interest. He reported that the non-hierarchical structure of ARG where "everyone is more or less equals" helped to bring back his interest in computer science.

Skill development in ARGs

Over the life of CAHSI, students have indicated in surveys that participating in ARGs increased their interest in the discipline, and their professional skills. URSSA survey results suggest that students in all CAHSI ARGs felt they acquired an understanding of the research process, gained scientific communication and technical skills, and other skills. Throughout the years of CAHSI, there has been a significant effect for ethnicity on the career and graduate school preparation scale, [$t(65)=2.23$, p=.029, effect size Cohen's d=.415], with Hispanics rating their gains higher than non-Hispanics. Additionally, there were significant effects for ethnicity on the intellectual gains scale, [$t(84)=3.41$, $p=.001$, effect size Cohen's d= .584] and skills scales, [$t(79)=2.63$, $p=.01$, effect size Cohen's d=.646], with Hispanics reporting higher cognitive and skills gains. Hispanics were significantly more likely to report that the ARG had increased their interest in graduate school, $t(165)=2.40$, $p=.017$, effect size Cohen's d=.408. The effect sizes are medium in magnitude and suggest that these differences are practically significant, as well as statistically significant. While all students clearly benefit from involvement in ARGs as demonstrated through their positive ratings of their gains on the URSSA, Hispanics seem to benefit greatly. Students with few, or no, familial role models in higher education or computing benefit from the deliberate skill development and caring, collaborative relationships that are built into the ARG model.

ARG students engage with computer science research community

Throughout the entire span of CAHSI, students enhanced their career and graduate school preparation by presenting and publishing in their field. Similar to the outcomes presented from the 2011-12 ARG students, over the life of CAHSI, ARG students' publication and presentation rates have been higher than the diverse, national sample of research experiences for undergraduates (REU) students. As shown in table 9, ARG students attended conferences at more than twice the rate of a national sample of REU students , χ^2 (2, n = 657) = 117.82, p =.000. Because ARG students were deliberately socialized into their disciplinary communities, they authored or co-authored journal articles, χ^2 (1, N = 657) = 9.03, p =.003, and presented posters or papers at national conferences χ^2 (1, N = 657) = 50.27, p =.000, at significantly higher rates than the national comparison group of REU students. The effect sizes indicate that these differences are meaningful differences.

Table 9. Comparison of ARG students' and REU students' report of professional activity, 2009-2012

Professional activity undertaken in the past year	Effect Size	Number of ARG students, 2009-2012 (n=186)	Percentage of ARG students, 2009-2012 (n=186)	Number of national REU sample (n=471)	Percentage of national REU sample (n=471)
Attended a professional conference***	.423 (large effect size)	**125**	**67%**	**108**	**23%**
Authored or co-authored a journal paper**	.12 (small effect size)	**21**	**11%**	**26**	**5%**
Presented a poster or paper at a professional conference***	.276 (medium effect size)	**75**	**40%**	**70**	**15%**

**** p<.001, **p<.01*

The differential outcomes between ARG students and traditional REU students suggest that undergraduates gain more from research when skill development and scientific communication are explicitly structured into the research experience, as they are in the ARG model. In conclusion, in both interview and survey findings, students reported that their ARG experience increased their interest in computing, their teamwork skills, and their preparedness for graduate study. Students also discussed how the success of the ARG model hinged, in part, on the "ethic of care" created in the group. We can conclude that the ARG model has been successfully disseminated among CAHSI institutions.

FINAL YEAR OF FEMPROF—NOTED BENEFITS OF PROGRAM PARTICIPATION

In the final year of the FemProf program, evaluators focused on qualitative data analysis to uncover how the program shaped career trajectories for the undergraduate women participating in the program. The section below outlines major shifts in participants' computing research identities, through intensive, personalized mentoring, research opportunities that involve immersion into a topic, and the development of a professional network within and outside of participants' home departments.

Mentoring through personal connections

Nearly all participants interviewed described mentoring relationships that support their development as scholars and scientists. Like any true mentoring relationship, the mentorship they experience goes beyond a purely academic or professional relationship and involves personal disclosures and support. Twelve of the fifteen interviewees (80%) describe strong mentoring from FemProf faculty and mentoring faculty that includes frequent conversations, personal and academic support, and collegiality. Research on retention in

computing indicates those with strong mentoring relationships are more likely to complete STEM majors, and so the findings in this study are of particular interest (Cohoon, 2011).

Building relationships through purposeful activity

FemProf aims to prepare young women for positions as computing faculty. Given that specific goal, much of the activity in which participants engage are designed to further women's knowledge, confidence, skill and ability in research and/or the process of becoming a good candidate for graduate study. A theme running through participants' interview responses was that FemProf participants build relationships best through purposeful activity. In other words, FemProf does not aim to create a community for community's sake, but instead creates a support network built around academic aspirations. Interviewees stated that research projects, outreach activities, conference attendance, and workshop engagement lead to closer ties with one another and with faculty. While time is built in to many of these activities for socialization, building relationships is not the only goal of activity. Thirteen interviewees out of fifteen (87%) described how purposeful activity led to a shift in personal and professional relationships. Many described their joint attendance at Grace Hopper as one of the activities that drew FemProf members together, and participants also noted how their involvement with research led to collegial relationships with students and faculty.

Developing collective pride in being a woman in science

FemProf has given women an opportunity to meet one another and build relationships around their academic and career aspirations. In some cases, women in the program had only seen other women in the halls or in the classroom, but did not have an opportunity to build peer support networks with those women until they began the FemProf program. For some, joining the program was a way to meet other technical women. The explicit aims of the program, to promote women in computing at the highest levels as a way to stimulate change, were motivating to women. Their participation is a reminder that their job is to encourage other young women in the field, as they support one another towards graduate school.

Effect of the role model designation

At UHD, FemProf participants were asked to organize the NCWIT aspiration award ceremony, held on campus in spring of 2011. Over half of those interviewed mentioned the role they took as a mentor in the UHD NCWIT activity as one of the major activities they completed as members of FemProf. The activity positioned FemProf women as knowledgeable scientists with expertise to share with a younger generation of women in computing. Not only did the activity give FemProf participants an opportunity to interact with one another, it provided industry role models for them as well. This may be particularly important for this campus, as none of the computing professors are female at UHD[9], and so seeing technical women as role models in their everyday environments is rare.

[9] Two women from UHD are involved in FemProf research and FemProf program development. Sangeeta Gad is a math instructor and Dr. Erin Hodges is a faculty member with a technical background in the math department.

Other ways students were positioned as role models included in their research groups in which they are developing specific expertise, as tutors or mentors for less advanced college or K12 students, and as ambassadors of the FemProf program within their schools. At least one participant was chosen to mentor youth by an outside organization—the student's accomplishments in her field through research participation may have been the catalyst for her designation as a role model. FemProf participants noted the responsibility they feel in bringing up the next generation of women in technical areas. Mentoring, in some cases, was seen as a way to promote gender equity in technical fields.

Femprof participants' academic identity development: future faculty

All interviewees were asked what they want to do when they graduate with their undergraduate degree. While every student indicated graduate school aspirations, nine specified interest in becoming a professor after they completed graduate school (60%). Those inspired to pursue the professoriate wanted to give back to their communities, instil interest in other young women, and pursue their own research aims in an academic setting. For some, the desire to become a professor was a long held goal, while others saw it as an evolving interest. In fact, three technical women noted an initial interest in teaching K12 that shifted towards aspirations to teach at the collegiate level. The theme of "teaching as service" permeated some of the responses from FemProf interviewees—a special interest in serving underrepresented students, providing mentoring to students as they have received from trusted advisors, and sharing the enthusiasm they have for their own technical expertise were common ways of describing what drew students to the professoriate.

Multiple students noted barriers to becoming a professor in their fields. One participant said she had no idea how to be a good teacher, as she did not have any models for excellence in instruction at the collegiate level. As someone who values good teaching, she did not want to pursue academia without a better sense of how to do it well. A perceived lack of patience and inability to communicate about their subject to others were other reasons participants were less likely to aspire to become professors. Another student, who did want to become a professor, said she will have to learn how to teach before entering the profession.

Collective aspirations support persistence

Eighty seven percent (13 of 15) of FemProf participants indicate that collective aspirations can help support students in their endeavours by encouraging persistence and retention. They view FemProf as one of many such programs that spark graduate school aspirations, and provide the knowledge and network of peers and professors committed to these aspirations. Additional opportunities to meet would enhance the network, according to some participants, though they note the meetings do not always require content to be effective. One student noted the importance of programs like FemProf for our nation's competitiveness, and another noted the need to incorporate regular meetings into students' busy schedules so they make time to help one another along in the major.

Knowledge of academic career values and milestones

In many ways, FemProf participants shared their knowledge of the academic career path. The most common way participants showed their knowledge of graduate school and faculty career paths was in their

descriptions of their biggest accomplishments in their field in the past year. The majority of students listed opportunities or experiences in research on and off campus as their biggest accomplishments, while in some cases students noted related academic accomplishments such as getting good grades in a course or maintaining a good GPA. Their responses indicated tacit knowledge of the academic system, in which research dissemination and understanding is highly regarded, knowledge of computing departments and computing professors' expertise on a national scale is important for selecting graduate programs, and high standards in academics mean keeping good grades is essential for graduate school competiveness.

FemProf women indicate their understanding of the higher education system in their interview responses, and indicate how mentors and research advisors provide opportunities for their growth and development in technical fields. Twelve of the fifteen (80%) students interviewed for the FemProf evaluation study indicated a strategy of some kind that would potentially improve their chances to advance to graduate school and a faculty position. These strategies are linked to knowledge of academic career paths and, as we will discuss in the case study of Latina professionals, such knowledge is crucial in helping Latinas to achieve their professional goals and to advance their careers in computing.

CASE STUDY: UTEP MS IN SOFTWARE SUPPORTS HISPANIC CAREER DEVELOPMENT IN COMPUTING

Computing careers are in great demand in the United States, and yet the country produces less than half the number of qualified professionals needed to fill those positions (duBow & Ashcraft, 2011). At the same time, Hispanics are underrepresented in the field, making up 16% of the United States population—even higher in younger demographic groups—and only 7% of the computer science bachelor's degree earners annually. The University of Texas at El Paso's Masters of Science in Software Engineering degree program (MSSwE) seeks to prepare Hispanics for high quality industry positions in software engineering.

The US Department of Education's Funds for the Improvement of Post-Secondary Education provided money to support students who engaged in the newly developed software engineering Master's degree program for 2010[10]. In year two (January-December 2011), data collection and analysis included survey and interview data, rubric scoring, observational data, and institutional data. The evaluator observed courses, attended an advisory board social, interviewed current MSSwE students, interviewed advisory board members, and obtained feedback on course syllabi from three advisory board members using a detailed rubric assessment form. Students documented their personal assessment of their developed design skills using an adapted version of a previously developed instrument for engineers. Qualitative data were coded and summarized across participants. Data are reported with representative quotes to illustrate participants' perspectives.

Advisory board support for program development

The program is dependent upon industry needs, and as such the director sought assistance from advisory board members. They suggested in year 1 that a productive way for them to participate would be through

[10] Fipse grant P116V090015T

curriculum analysis and review. To support this interest and to gain valuable feedback from industry and academic professionals, the evaluator developed a review packet for advisory board members. The review is available in the appendix—it indicated suggested improvements needed particularly in the construction course. Changes were made to address the weaknesses in course implementation, including a change in course instructor.

Student development of design skills

Engineering careers involve collaboration, communication of ideas, strong communication skills, and innovation. Industry values professionals who can lead and perform in a team, carry out project work in a systematic and flexible way, and create a technically sound product. Students were asked to describe the ways in which their latest software engineering course, the validation and verification course held in the fall of 2011, gave them opportunities to develop group design skills. Across the board, students note great course emphasis on design as well as strong growth in every area. The personal growth ratings are in most cases slightly lower than the course emphasis rating, though all averages are in the 4-5 range, for "significant" to "tremendous" skill development and "significant" or "major" course emphasis. Nine of the fourteen students enrolled in the program and the target course responded to the survey (response rate of 64%).

Table 10. Students' Self-reported Design Skill Development

DESIGN SKILL LABEL WITH SAMPLE SURVEY ITEMS	**COURSE EMPHASIS** **1= NO EMPHASIS----** **5= MAJOR EMPHASIS**	**PERSONAL GROWTH** **1 I NEITHER USED NOR DEVELOPED THESE SKILLS-------** **5 I EXPERIENCED TREMENDOUS GROWTH/ADDED GREAT SKILL**
Teamwork "cooperating to support effective teamwork"	**4.41**	**4.22**
Information gathering "analyzing the appropriateness of information before application"	**4.54**	**4.25**
Problem definition "developing problem definitions that consider criteria and constraints"	**4.54**	**4.39**
Idea generation "using techniques within the team to synthesize ideas"	**4.25**	**4.20**
Evaluation and decision making "using testing and prototyping techniques effectively as part of the iterative evaluation process"	**4.03**	**4.00**
Implementation "describing key concepts regarding successful implementation of software"	**4.26**	**4.07**
Communication "presenting design information in individual oral presentations"	**4.16**	**4.25**

Student Outcomes: Flexibility, practical nature of program enhances school-work connections

Like most CAHSI students, nearly all of the software engineering MS students interviewed (n= 12) were employed, and most of those students were working in a software- or computing- related position. Seven students indicated working and going to school simultaneously allowed them to practice and apply skills immediately. Four students further described how the lessons learned in school were improving their work because they are bringing notions of standardization and methodical software development to their work settings. The flexibility of project development[11] allowed five students to blend school and work seamlessly—the capstone projects they are designing have direct applications at work.

> *"I took a parallel programming class- I didn't know about how to do that programming…It helped me a lot to know what was going on when they talk about it in the lab. They talk a lot about parallel programming and now I have a bigger part of that conversation and now I'm in charge of the MPI for the cluster."*

Two students note that the work-school connections they are building are helping them develop skills in communicating technical concepts. In addition, working part-time on campus (such as in research labs, as teaching assistants, as web developers and in site-based internships) allowed students flexibility to complete work and school at their own pace.

> *"As a TA I have more ways of explaining things to the students because of my coursework in the program."*

The software engineering MS program is developing a good record of accomplishment for ensuring students are prepared for industry-grade certifications with the CSDA. Recruitment in years one and two have provided enough student interest to hold core courses for the MSSwE, and the contribution of the systems engineering program to coursework has been beneficial, but for the described gaps in technical content in the area of program management. Students find the program appealing and view the skills and knowledge they are learning relevant to their work and applicable to real world settings. They appreciate the focus on projects so they can practice their skills, and understand the importance of the focus on human-centered learning. They perceive the project management skills they gain as useful, particularly as future software engineering industry professionals. ***The program is on track to graduate 22 students in software engineering over the next two years—the majority of whom are Hispanic.*** To put this number in perspective, 22 Hispanics

[11] Project requirements involve finding a client that cares about the development of a specific software program or product.

earned Master's degrees in Software engineering during the 2010-2011 academic year, out of 990 total graduates (2%).[12]

MSSWE- Implications for CAHSI

The software engineering program at UTEP is one way in which CAHSI institutions are building new pathways towards success in computer science for Hispanic students. The real world applications, knowledge, and skill that are the focus of the MSSWE provide its graduates with marketable abilities sought after in the software engineering field. The opportunity to build a project from a client request necessitates communicative ability vital to success in the business world. Students note they hope the knowledge they gain in the program will allow them to advance beyond entry level programming positions in industry- an important step in diversifying the computing workforce from the ground up.

CASE STUDY: LATINA PROFESSIONALS IN COMPUTING FIELDS-STORIES OF THE "DOUBLE-BIND"

CAHSI evaluators interviewed eight Latina computing professionals as part of the evaluation effort to understand exceptionality in the field, in the case of women of color, dubbed the "double bind" (Malcolm, S., Hall, P., & Brown, J., 1976) All of those interviewed had ties to CAHSI, through Latinas in computing, undergraduate or graduate coursework, or their professional employment. Interviews focused on impressions of the discipline, future aspirations in computing, and perceptions of underrepresentation.

Navigating the dominant computing culture

Throughout our interviews with professional Latinas in computing, participants made clear their awareness of the dominant culture that structures successful entre into their fields of expertise. For some of our participants, navigating the dominant culture involves often conscious decision making regarding whether to follow the dominant culture or follow one's own instincts, passions, or familial culture. In our interviews, participants acknowledge the dominant view of success in computing industry and academia, and at the same time positioned themselves in ways that are in conflict with those views and expectations. When professional obligations, rather, tacitly assumed obligations made clear in the dominant culture of the profession, did not match the professional goals or aspirations for Latinas in computing, our participants described negotiation processes that occur either internally, with one's family, or within one's professional organization. In some cases, women described how their choices were viewed as less desirable, or less in line with the prevailing view of success in industry. For example, Pilar describes how the work she does as a volunteer leads to her be seen as "less serious", or "less technical" in her field.

[12] Institute of Education Statistics, public and private not-for-profit institutions, graduating with CIP code 14.0903 (Computer software engineering)

> *"I worked really hard in 2009, 2010 to support the women at this site. … And, it just seemed like the visibility that I got from doing that was negative because managers see it as fluff, and they don't value it. And, they see it as taking time away from working on my technical skills. So, I think that's the really hard part is for women, it's a double-edged sword. If you want to be like the guys, you have to be like the guys. You have to put in the time like the guys, you have to be, not overly visible in the volunteer side of things because then it means you're not really serious."*

Pilar describes how she has found a way to continue volunteering as a mentor and role model by navigating the dominant culture and its expectations, in which her professional time is spent on technical work and her free time on her professional passion—mentoring underrepresented students and professionals. Pilar's experience of volunteerism in the workplace highlights the low status and gendered interpretation of these helping behaviors and what is valued (or not valued) in the male-dominant culture of computing industry. She has navigated this culture, and found her strengths at the margins of it. Her dedication to the gendered and cultural value of support for others emboldens her to find time to persevere, with or without professional compensation, support, or recognition.

> *"I've got permission to participate at [conference to support underrepresented students and professionals], and I'll need to get permission to take that time off, which is what I have to do. But, you know, I'll do what I have to do. I've got all my vacation days planned for the rest of the year."*

As members of non-dominant groups based on their gender, ethnicity, citizenship, native language, economic background, and/or the educational legacies of their families, interview participants experienced explicit and implicit bias in the workplace and educational settings. In the telling of their career paths, participants alternately described bias they perceived as being related to gender as well as cultural differences, or in some cases did not label the bias they experienced with either categorical label of difference, as expected for those in marginal gender or ethnic groups (Crenshaw, 1991). These biases, felt and heard through actions, through talk and through silence, often veiled means to achieving success for underrepresented individuals, as the knowledge needed to navigate higher education typically passes through the dominant culture. These biases create a need for Latinas in computing to navigate the dominant discourses of success in the field and at the same time constrain their ability to do so. Navigating the dominant culture assumes that one has access to and understanding of metrics of success within the dominant culture.

Our data show that access to dominant cultural pathways of success was delayed and incomplete throughout the Latinas' computing careers. Upon reflection, our interviewees described events where they realized more mentoring would have helped them pursue their goals, or would describe how decisions made were not in line with the prevailing notions of success in computing. Mentoring through formal and informal relationships and experiences were key to the success of the Latinas in our piece. The mentors or mentoring experiences gave Latinas access to dominant views of success in their chosen profession through explicit instruction, dialogue with near peers and mentors, and attendance in specially designed programs that make traditional definitions of success explicit to newcomers. Beatrice describes a program that led to her navigate

the prescribed pathway to success in computing. The experience gave her the knowledge needed to successfully position herself for a role in a sought-after technical firm.

> *"My advisor recommended that I apply for a scholarship …. So, I did, and in that process… they give us money, but they also took us to the offices, and they really made an effort for everybody that was there to meet women engineers. And, I think this was really well thought out… part of the scholarship was just meeting these people and forming this network. They created this mailing list, and they'd send us articles and things about the scholarships recipients. But then, they also made an effort. 'You're going to be meeting these women engineers that work at [company] and they're really excited to meet you. And, you should really try to make an effort to stay in touch with them and email them.' And, one woman in particular said, "Get this book, and you do everything it says, you will do okay in the interview." And so, I did it. And then, I contacted the recruiters and I said, 'Hey, I'm ready to interview.'*

Beatrice's experience illustrates how explicit instruction can provide needed information to those outside of the dominant populations in computing, and give access to pathways for success needed to navigate STEM careers in western academic and industrial contexts.

Traditional and non-traditional definitions of success

Career paths described in our interviews often took into account traditional and non-traditional views of success. While Latinas described how they have navigated the path to traditional success, they also interpreted their own paths as non-traditional. Interview participants described traditional notions of success in their given careers through their description of accomplishments and goals, and in their expressed "next steps" in their careers. The non-traditional views of success in our data included influencing the community, becoming an agent of change in their field, and following personal passions at the workplace.

The majority of our interview participants acknowledged a difference in their definition of success and their peers' (assumed) definitions of success. Participants often juxtaposed who they wanted to be professionally with those in their professional realms of influence. The interviews uncover what Taylor (2006) referred to as "identity trouble" or inconsistency in the telling of one's story. For example, Laura spoke of defining her own success as unique from that of her peers, "my career is definitely not traditional.. I mean, it was traditional when I went from high school to the first university. That would be it." Shortly after this statement, she made the comment that her next step in her career was to receive a promotion for her individual technical performance: This could be considered an example of identity trouble, in which the express goals and aspirations of individuals conflict from a focus on non-traditional paths and values, to more traditional ones.

Rather than focus on the inconsistency, we find the constant comparison between one's chosen career path and the traditional definition of success in the discipline is a negotiation that allows Latinas membership (if marginal) in computing that both counters and conforms to the standards designated by white males in academic and industrial settings. For example, Kayla described her current aspirations: receiving tenure. These aspirations follow traditional standards for success in academia. As she works on her tenure package, she translates the text continuously from her native language into English. This process means that her work

is slow going, taking time away from pursuing grant funding that would support her research efforts. Kayla also worries that the quiet demeanor she embodies, particularly in professional situations with her faculty peers, reflects negatively on her abilities and expertise. She describes how her values and interests help her consider next steps in her career:

> *I just hope I can to make it to tenure. Although it doesn't matter too much to me, I'll go back just to teaching. I know I'm good at teaching. My students have told me and my colleagues have told me that I'm good at teaching. It comes natural to me. I come from a family of teachers. My grandparents were both teachers, and my cousins. So, I grew up in it. I always admired my teachers, even thought they were like gods. …You know, that's the thing. I don't want them to say, 'Oh, you didn't work hard enough.' I don't want to miss tenure because I didn't work hard enough.*

Kayla's response highlights the constant negotiation and re-negotiation of cultural views of success in computing. In describing her aspirations, she suggests an alternative path she would enjoy, one of lesser status in the computing community, and yet with great familial significance. Her confidence in her teaching and her view of herself as a successful educator is gendered, and runs counter to traditional standards for academic success. Yet her need to be perceived as a hard worker also aligns with traditional definitions of success in the western world.

Latinas in Computing: Implications for CAHSI

The narratives of CAHSI Latinas in computing indicate a need for underrepresented students to receive explicit mentoring that highlights the characteristics of graduate students and professionals in the field, that allows for self and perhaps group reflection regarding aspirations and goals, and a safe place to discuss not only what traditional "success" in the field looks like, but also how those ideals might be redefined. FemProf and Mentorgrad have the potential to serve these purposes, and providing annual meeting content around these topics might facilitate dialogue about underrepresentation in computing.

BPC INDICATOR #2: ORGANIZATIONAL CAPACITY

The development of organizational capacity within BPC Alliances is important for engaging all members in the mission of the Alliance and, in the near future, will be crucial for contributing to sustainability of the alliances beyond the life of National Science Foundation funding. Building on research in sustainability and organizational capacity development in the social sciences, the evaluators developed the rubric, below, to measure CAHSI's capacity to support its mission and its sustainability beyond the life of the grant. Research literature indicates that an alliance aiming to increase the number of underrepresented students who earn degrees in computing must have the capacity to do the following:

a) Replenish and fortify the pipeline at each stage through continuous improvement of initiatives and pedagogy (K-12 through graduate education),

b) Train new educators and hold training sessions at sites within and outside CAHSI institutions to inform one another about best practices in supporting students in computing,

c) Develop staff and faculty engagement in new practices and understanding of the mission of CAHSI

d) Engage a cadre of staff and faculty who are aware of CAHSI's goals and take up the new practices.

Research shows the most sustainable models of organizational change include more than just a handful of faculty, but must be infused into common departmental or institutional practice. In addition, fostering connections with common goals, deliverables, and actions (e.g., technical research projects, additional curriculum development projects) beyond the years of the grant will be important to sustain collaboration among alliance members. These tangential or additive programs and projects maintain CAHSI's collaborations and, at the same time, help the alliance grow and create broader impact. Because of this potential to create broader impact, this idea is introduced in the third BPC evaluation metric, alliance impact.

Table 11. Organizational Capacity Rubric

CAHSI Organizational Capacity Rubric: Orange color indicates school or department is achieving the goal, , yellow indicates partial fulfillment; light blue indicates rubric metric not measured; for sustainability: black indicates no additional funding, yellow indicates partial fulfillment via other means, and orange indicates fully "other" funded. Pink indicates the cell is N/A.							
Indicator (colors used to show different types of indicators)	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**
Healthy Pipeline: K12 outreach using CAHSI initiatives (e.g., CS-0)							
Healthy Pipeline: faculty staff or students have continued to innovate in course pedagogy (e.g., experimenting with new initatives, finding new ways to study initiatives underway)							
Healthy Pipeline: graduate school preparation (goal is 15% of departmental students)							
Healthy Pipeline: CAHSI graduate application (as defined by intent, measured across departments, above baseline for 2010 annual meeting rates)							
Healthy Pipeline: CAHSI graduate application (as defined by application to graduate school, measured across departments, above baseline for 2010 annual meeting rates)							
Resource Dev Train: host training in 1 or more CAHSI initiatives							
Resource Dev Train: lead training in 1 or more CAHSI initiatives							
Fac/staff engagement: undergraduate faculty CAHSI awareness measured every other year (75%)fac survey[13]							
Fac/staff engagement: fac CAHSI participation (33%) fac survey							
Fac/Staff engage: undergraduate faculty CAHSI-trained continuously (e.g., every other year participate in training)(25%)PI report							
CAHSI Alliance sustainability: funds for CAHSI supplemented at the department/institutional level-CS0 outreach							
CAHSI Alliance sustainability: funds for CAHSI supplemented at the department/institutional level-CS0 undergrad							
CAHSI Alliance sustainability: funds for CAHSI supplemented at the department/institutional level-PLTL							
CAHSI Alliance sustainability: funds for CAHSI supplemented at the department/institutional level-ARG							
CAHSI Alliance sustainability: funds for CAHSI supplemented at the department/institutional level-mentorgrad/fellownet/femprof							

NURTURING THE PIPELINE

CAHSI schools are continuing their steady support of students at all levels, though improvement is needed in a few areas of the pipeline. Graduate school preparation has declined, though the lack of a CAHSI annual meeting during this evaluation year could be responsible for the poor showing across campuses—often undergraduates receive graduate preparation off-site at the annual conference.

A sustainable alliance must be willing to learn and develop continuously. Faculty at multiple schools are continuing to experiment with curriculum and teaching techniques to support Hispanics in computing. Feeding the pipeline from the bottom up is important for continued recruitment and retention of Hispanics in CAHSI departments—continuing to engage K12 students may help to increase enrollments across CAHSI schools.

EXPANDING THE CAHSI COMMUNITY

Growing the number of CAHSI-trained faculty is imperative for institutionalization and faculty buy-in at the local level. Similarly, continuous professional development is necessary for faculty to improve in their use of learned techniques. While the rate of participation is strong at many schools, continuing training opportunities will be important as CAHSI matures and the number of new faculty increases at each institution. Only one initiative has multiple "levels" of training that engage novice and intermediate practitioners, yet developing continued opportunities for faculty professional development related to all initiatives may enhance student outcomes and lead to greater faculty involvement with CAHSI.

Every other year, CAHSI evaluation targets faculty perceptions of CAHSI and their participation in the network. As CAHSI grows and moves toward sustainability, we directed focus to those who impact departmental culture directly—faculty. For CAHSI to be sustained, the effort must permeate departments, leading to lasting change where change is needed, or lasting positive support for students where department environments may have been positive at the start of CAHSI. This section of the report details results from faculty and Principal Investigator surveys from CAHSI departments. The purpose of the survey was to ascertain the following:

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

This report section summarizes data collected to date from 45 faculty members at CAHSI institutions, and is supplemented with data from PIs regarding CAHSI participation, as a validation check regarding faculty responses. This evaluation data serves to document the ways in which CAHSI is developing organizational capacity at the departmental level that supports student retention and quality instruction.

Faculty Survey Participation

Faculty names were culled independently from CAHSI PIs, through a department search via all ten institution websites. To ensure all currently teaching undergraduate faculty and instructors were contacted, evaluators compared these lists with current academic course offerings in required undergraduate courses, adding any names that were missing from the initial department faculty listings. In all, 170 survey invitations were sent. Two messages were marked undeliverable, leaving 168 potential respondents from ten schools. Respondents were reminded with five additional requests for information following the initial request, only if the respondent had not yet replied to the survey. All PIs completed a related survey, in an effort to triangulate data from multiple department perspectives. See table below. To a certain extent, the variability in departmental response rates reflects differences in the size of CAHSI departments.

Table 12. Faculty survey response rate by institution

School	Number of Faculty survey responses
CSUDH	1
UTEP	7
TAMUCC	6
UPRM	10
NMSU	3
FIU	3
UHD	5
CSUSM	2
MDC	6
UTPA	4

The response rate was not optimal. To understand whether the respondents were more likely to be participants or non-participants in the CAHSI program, Principal Investigators and project leaders were asked to list the faculty and instructors who are participating in the alliance, then compared the participation of those individuals with respondents. P.I.s at each institution were excluded from the survey, and only eight of the forty seven respondents were CAHSI faculty or staff who contributed regularly to CAHSI content or related programming content. For example, four faculty regularly taught CAHSI courses and trained students in PLTL, and three additional faculty were PIs, co-PIs, and program coordinators for related grants that collaborate with CAHSI. This indicates that while the sample was comparatively small, the majority of respondents were not directly affiliated with CAHSI.

Demographics of faculty survey respondents

Faculty respondents came from all ten institutions. We note that SACI institutions have had the least time to garner recognition and awareness for CAHSI. The chart below describes participation throughout the alliance institutions. Over a quarter of respondents who answered the demographic item (10, 28%) indicated they considered themselves Hispanic/Latino/a, a large portion of faculty, compared to the proportion of tenure track faculty in computing nationally who identify as Hispanic (2.1% according to

Zweben & Bizot, 2012). The majority of survey respondents were tenured professors (14 full professors, 8 associate professors) and the next common position held by survey respondents was that of assistant professor (9). A small number of instructors (5) and other professionals (1) participated. One respondent was also department chair.

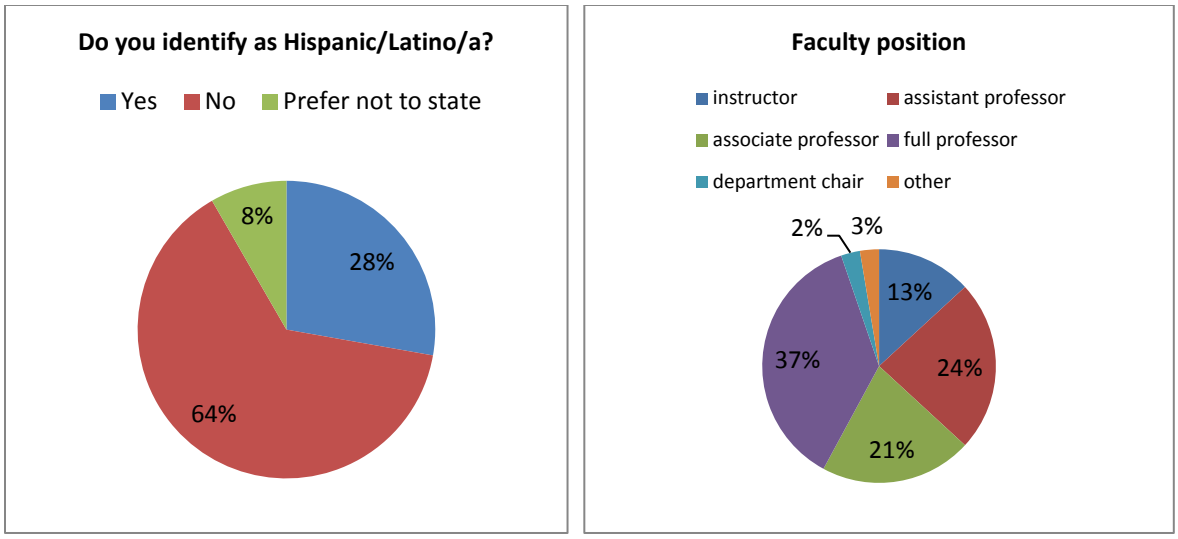


Figure 7,8. Faculty survey demographic information, position in the department

FACULTY BREADTH AND DEPTH OF KNOWLEDGE, EXPERIENCE WITH CAHSI

Over eighty percent of participants who responded to the item regarding CAHSI awareness described knowing of the alliance, and the majority of survey respondents learned about the program between 2 and 5 years ago. A small number of participants learned about the alliance over 5 years ago, and a fifth learned about CAHSI in the last 2 years, most of these coming from SACI schools. These data indicate that CAHSI is permeating departmental culture. In the next section we review faculty participation in CAHSI.

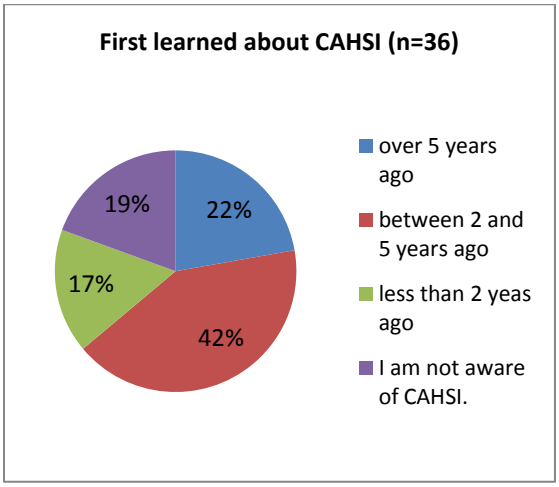


Figure 9. CAHSI faculty awareness, participation in CAHSI

FACULTY PARTICIPATE IN CAHSI THROUGH MENTORING, TEACHING, ORGANIZING EVENTS

Faculty and instructors indicated the CAHSI activities in which they participate. Respondents chose activities from a list. Twenty one participants reported active participation in an average of 4.6 activities per respondent, 97 responses in all. Four additional respondents state that while they do not participate in CAHSI, they know that their students are engaged in the initiative.[14]

CAHSI FACULTY MENTOR STUDENTS, LESS SENIOR FACULTY

About a third of survey respondents across institutions mentor students regarding research, graduate school application, and academic careers, 18 of the 47 respondents (38%) indicated at least one of the mentoring activities they perform through CAHSI. All ten CAHSI and SACI institutions are represented in the "mentoring of students" data.

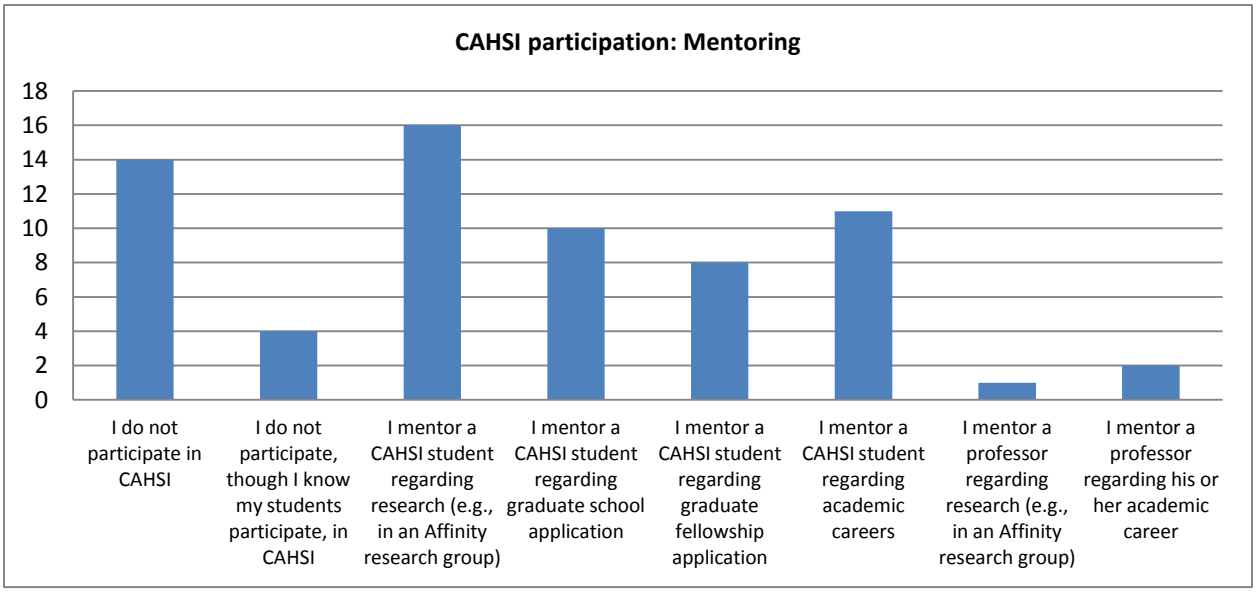


Figure 10. Number of CAHSI faculty participating in mentoring activities

CAHSI FACULTY TEACH, DEVELOP CURRICULUM

Faculty members who participated in the survey were engaged in student teaching or training in CAHSI initiatives, particularly CS0, PLTL and ARG. Thirteen individuals from 7 CAHSI and SACI institutions

[14] One formerly active CAHSI survey participant is no longer affiliated with the university, and so his responses convey his current lack of participation and his recollections of the department from the previous year.

indicate they teach or train students or faculty in CAHSI institutions.[15] This number is expected to be lower than the mentoring number, as fewer faculty take on this type of role within CAHSI.

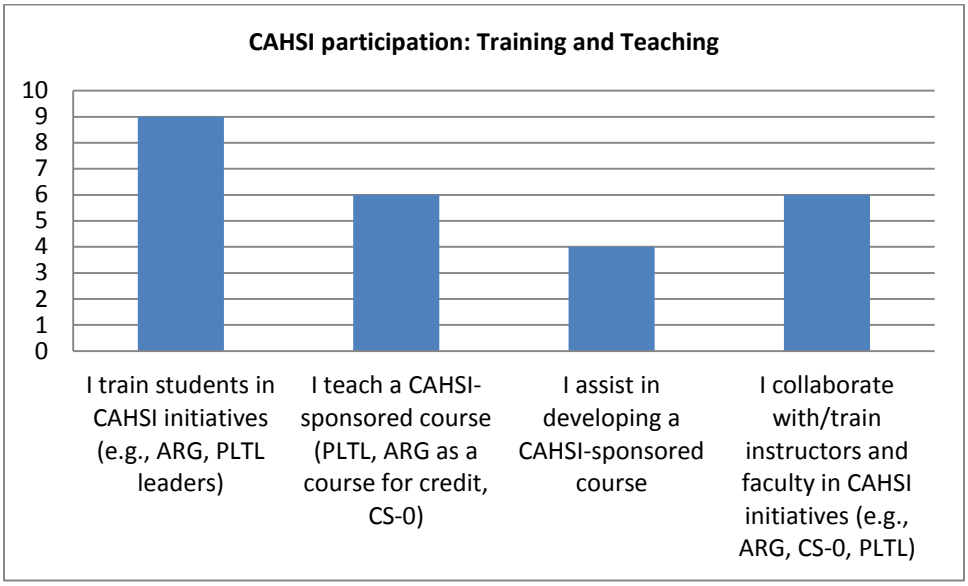


Figure 11. Number of CAHSI faculty participating in training and teaching of CAHSI initiatives

CAHSI FACULTY DEVELOP, PARTICIPATE IN CAMPUS BASED, NATIONAL ACTIVITY

The number of faculty members who engage in the organizational operations of CAHSI are, as expected, smaller than the number of faculty members who participate in the day-to-day operations of CAHSI implementation. CAHSI participation in campus-based events is moderate, according to survey results. CAHSI is, however, represented in national venues by a cohort of faculty core to its operation, though beyond the appointed leadership (P.I.s) at each institution. See table below.

Table 13. Faculty participation in CAHSI activities

Faculty participation in CAHSI Alliance	
I attend CAHSI event(s) on campus (e.g., student workshops, speaker series, recruitment events)	8
I attend CAHSI event(s) off campus, such as workshops, Broadening Participation in Computing conferences, or the CAHSI annual meeting	9

[15] Two of the three schools without representation n the teaching and training category do not participate in course-level CAHSI initiatives during the academic year.

I serve as the appointed CAHSI advocate at my institution	1
I advise faculty regarding CAHSI's mission and goals	3
I represent CAHSI at national or international events	2

FACULTY IMPRESSIONS OF DEPARTMENTAL COMMUNITY

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

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

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

Nearly all faculty aware of CAHSI perceive gain in departmental community

Evaluators looked across related items to ascertain how many faculty members noticed a difference in at least one area of departmental community since CAHSI began. Of the individuals who responded to the change items, 23 (79%) mentioned a positive change in one of the departmental community elements of CAHSI. The specific changes in departmental community are described across CAHSI in the following section.

Increase in undergraduate research on campuses, according to most faculty

Engaging students in on-campus work is thought to increase retention and sense of community for students (Astin, 1987). The majority of faculty state that CAHSI has increased students' participation in computing research (61%) though 39% noted it has not changed students' behavior regarding computing research. Respondents noted in open-ended items that undergraduate students are more involved in their department since CAHSI began, with one faculty member noting that more Hispanics in the department are doing research (whereas before CAHSI researchers tended to be from dominant demographic groups). Of

the respondents indicating no change, two mentioned that they are not sure how to assess change, and one did not understand how CAHSI related to undergraduate research. One faculty member mentioned being unable to assess change as the faculty member joined the department after CAHSI began—indicating a need to address respondents' time in current department in the next variation of the survey.

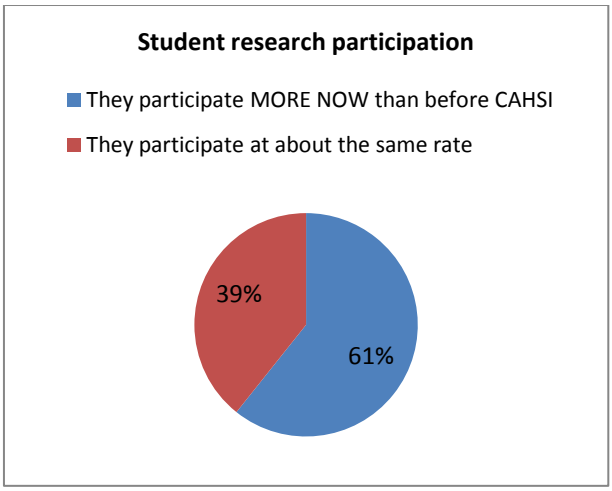


Figure 12: Faculty impressions of students' change in research participation

A slight majority of faculty agreed that students participated more in research since CAHSI began. No one indicated a decrease in student participation in research, which is notable given the current economy and the ways in which budget cuts have affected public universities in the years since the inception of CAHSI. More than half of faculty note the positive impact of CAHSI on student collaboration as well.

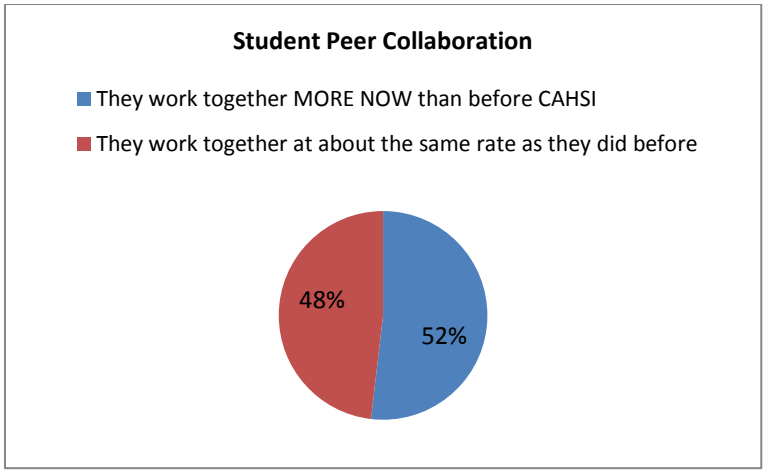


Figure 13: Faculty impressions of change in student collaboration with peers

Some change in faculty interaction perceived by CAHSI faculty

Faculty impressions of student interaction changes were slightly less apparent for CAHSI faculty—a third (34%) state they spend more time interacting with students, and remaining respondents (66%) state they spend the same amount of time interacting with students. Faculty's impressions of their peers' interactions

were slightly more positive— 39% of respondents indicated their colleagues spent more time with students since CAHSI began It is important to note that research shows Hispanic-serving institutions tend towards greater faculty interaction than predominantly white institutions (PWIs) (www.luminafoundation.org; Kuh, et al 2005), and so faculty impressions of a lack of change in this area may indicate that a great deal of faculty interaction with students was already in place when CAHSI began. Two open-ended responses indicate active participation was common in the department prior to the program, and one stated that the change is related to multiple programs that work together in the department to develop more interaction.

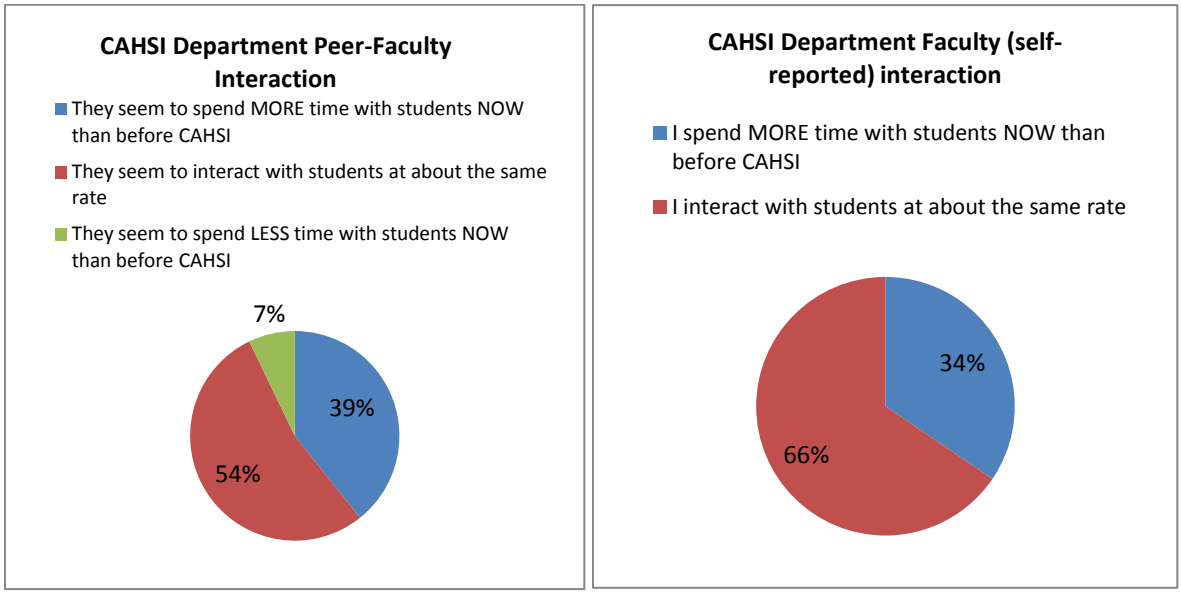


Figure 14,15. Faculty perceived change in interaction with students

CAHSI FACULTY IMPRESSIONS OF DEPARTMENTAL VISIBILITY, REPUTATION CHANGES SINCE CAHSI

Though not one of CAHSI's intended goals, a positive consequence of the CAHSI alliance mentioned by a few PIs and determined anecdotally by evaluators has been the impression that the CAHSI alliance may elevate departmental visibility and reputation. According to faculty survey results, ***nearly a third of respondents described a change in visibility on campus or beyond campus.*** Six note on-campus visibility differences for the increasing number of activities, and eight describe off-campus visibility improvements related to publicity from regional press and through participation in CAHSI conferences.

CAHSI LEADING TO GREATER FACULTY NETWORKING, INCREASED COLLABORATIVE OUTCOMES

This visibility may contribute to increased scholarship and increased faculty network development—16 faculty note they participated in one or more proposals that mentioned CAHSI as relevant prior work. The majority of proposals mentioned CAHSI involvement as evidence of strong student development (via ARG, PLTL strategies) and recruitment and advancement of underrepresented students in computing. In addition, open-ended responses show that faculty are collaborating more often with peers off campus, and their students are also discovering new networking opportunities.

EXTENDING, LEVERAGING CAHSI THROUGH ADDITIONAL PROPOSALS

Fifteen faculty members noted their dissemination of CAHSI-related efforts beyond their institution, in research venues such as Super Computing, ACM conferences, FIE, SACNAS, ITCSE, and disciplinary workshops. In fact, 21 of 35 faculty respondents reported they either disseminated or wrote a proposal that leveraged CAHSI results, indicating departmental investment in the initiative.

SUMMARY OF FACULTY SURVEY ANALYSIS

Many faculty survey respondents at CAHSI institutions are aware of and participate in CAHSI initiatives, activities, and events, though awareness across departments shows room for improvement at the faculty/instructor level. Those aware of CAHSI reported positive elements of departmental change since the beginning of the Alliance, including increased student collaboration, more opportunities for student research, and increased faculty interaction. The notion that CAHSI is creating more visibility for departments is a positive indicator that CAHSI's alliance is viewed as cohesive, and lends support for the potential of sustaining the effort and disseminating it beyond member institutions.

FUNDING AND SUSTAINABILITY

In order for CAHSI to sustain itself beyond the years of the grant, its initiatives must be implemented with new or alternative sources of funding. Course level initiatives continue to be easiest to fund through other means, while direct student initiatives (i.e., paying an undergraduate for work in research labs) remain difficult to fund from outside sources. As CAHSI research grant proposals are submitted and funding allocated reaches undergraduates, it may be more likely that CAHSI students are funded from other sources. A collaborative CAHSI proposal to a not-for-profit organization specifically for student research funds may be in order to sustain undergraduate work beyond CAHSI's final years.

BPC INDICATOR #3: BROADER ALLIANCE IMPACTS

CAHSI aims to broaden its impact beyond its original members, and expand its reach to serve Hispanics in computing at the national level. CAHSI views the issues they address as part of broader societal and educational concerns, and seeks to influence the national conversation regarding Hispanics, higher education attainment, and in particular, Hispanic access to scientific and technical fields. CAHSI has developed goals to broaden its impact, including disseminating proven educational practices beyond the alliance, focusing more attention on cross-institutional technical research innovation and collaboration, and becoming a unified voice for Hispanics in computing with the ability to influence national and local policy and practice. To do this, CAHSI will need to build cooperative agreements with national organizations that promote Hispanics in education, become advocates for CAHSI at regional and national venues for policy and education reform, and strategically align CAHSI educational initiatives with institutional, regional, and national agendas.

The CAHSI Alliance Impact rubric measures the reach of the alliance in its efforts to include new partners and allies, disseminate its work to multiple audiences, elevate its mission to the public consciousness, and create tools for collaboration within and beyond CAHSI. The Alliance Impact rubric is calibrated towards the end of the grant, and as such, the first years will potentially show a need for growth. The intention is for the rubric—which was developed with the input of the CAHSI executive team—to reflect CAHSI's goals for dissemination and expansion, to drive strategic thinking in the alliance, and to potentially shift with the evolving goals of the group.

CAHSI EXPANDS ITS REACH BEYOND ITS ORIGINAL MEMBERS

In this section, we describe CAHSI's progress on the metrics established in the CAHSI Alliance Impact rubric. All rubric categories reflect goals put forth by CAHSI in the renewal proposal to the National Science Foundation, and refined in ongoing discussion among CAHSI members and leadership. In turn, we discuss CAHSI's progress on each rubric category, including funding, social science engagement, policy, cyberinfrastructure, and partnerships. Finally, we discuss findings from a survey of new adopters of CAHSI initiatives.

CAHSI MAKES PROGRESS IN DISSEMINATING ITS INITIATIVES

Overall, CAHSI has made moderate progress on efforts to engage other organizations in mutually beneficial partnerships, broadly disseminate its initiatives, and create tools to establish and sustain productive collaborations. CAHSI is not yet halfway through the final extension grants, so they are where one would expect them to be in terms of broader alliance impact, according to the Alliance Impact metrics. Table 14 displays the CAHSI Alliance Impact rubric metrics. CAHSI has scored "moderate/needs some improvement" on 8 of the indicators, "beginning/needs substantial improvement" on one indicator, and "proficient" on one indicator. Metrics for one indicator are yet to be determined. Thus, CAHSI has scored "moderate" on 80% of established metrics on the Alliance Impact rubric.

Table 14. CAHSI Alliance Impact rubric

IMPACT INDICATOR	Beginning/needs substantial improvement	Moderate/needs some improvement	Proficient
1. CAHSI Alliance impact: CAHSI annual meeting resourced through other organizations/ funding sources	Travel scholarships for some students covered; else CAHSI funded	Site collaborations lead to shared costs for annual meeting site, some travel covered by scholarships, funding from industry	Annual meeting speakers, faculty and student travel scholarships, and site costs covered by non-profits, industry support, endowments, or institutional funds
2. CAHSI Alliance impact: social science engagement	**Evaluation report data** focusing on social science elements of CAHSI disseminated (baseline practice)	**One to two social scientists** well versed in higher education, Hispanics in education, and or STEM education collaborate with CAHSI and produce **1-3 disseminated works**	**Three or more social scientists** well versed in higher education, Hispanics in education, and or STEM education collaborate with CAHSI and **produce 4 or more disseminated works**
3. CAHSI Alliance impact: policy voice [annual activity]	**1-2 national or regional venues**	**Less than 5 national or regional venues**	Multiple CAHSI PIs **served as CAHSI delegates** to higher education and STEM education organizations in leadership roles in 5 or more national or regional venues across a spectrum of organization types. PIs discuss lessons learned from CAHSI rather than focusing on own institution specifically
4. CAHSI Alliance impact: faculty dissemination – education	**0-4 engaged PIs/faculty** publishing or presenting in 1-2 venues	**5-9 engaged PIs faculty** publishing or presenting in two or fewer venues	**10-15 engaged PIs/faculty** publishing or presenting in more than 3 total venues
5. CAHSI Alliance impact: cyber infrastructure to support broader educational impact via web dissemination [CS0 PLTL ARG mentorgrad fellownet =5 initiatives]	**0-40% of initiatives available for deployment** in new settings (0-2)	**41%-99% of initiatives available for deployment** in new settings (3-5)	**100% of initiatives available for deployment in new settings**
6. CAHSI Alliance impact: cyberinfrastructure national impact via web dissemination	**0-14%** of all website downloads/views occur outside of original CAHSI regions	**33-49%** of all website downloads/views occur outside of original CAHSI regions	**50% or more** of all website downloads/views occur outside of original CAHSI regions (website analytic data)
7. CAHSI Alliance impact: cyberinfrastructure to support collaboration	Cyberinfrastructure metric to be determined: focus is on research collaboration, usability, and quality of communication – survey of users to be developed		
8. CAHSI Alliance impact: cross institutional funding-technical/scientific research	**1-3 CAHSI institutions**	**4-6 CAHSI institutions**	**Each CAHSI institution is involved in a collaborative research grant** that supports continued contact and scholarship among students and faculty

9. CAHSI Alliance impact: alignment of initiatives (for this indicator, CS0, PLTL, ARG, mentorgrad, fellownet =5 initiatives)	**0-40% of initiatives**	**41%-99% of initiatives**	**All CAHSI initiatives** have documentation fit for wide distribution showing how they **align to national and local goals in education**
10. CAHSI alliance impact: promoting CAHSI in policy arenas	**0 meetings**	**1 meeting** (e.g., CAHSI collaborates with Excellencia at their conference (fall 2011)	CAHSI **established more than 2 meetings or summits with multiple national stakeholders** and local leaders to describe and promote this alignment
11. CAHSI Alliance impact: collaboration beyond original 7 CAHSI institutions	**8 or fewer departments** with documented implementation of initiatives (baseline is 6 in 2010)	**9-15 departments** with documented implementation of initiatives (baseline is 6 in 2010)	**16 or more departments** with documented implementation of initiatives (baseline is 6 in 2010-2011)

SUSTAINABILITY OF THE ANNUAL MEETING

The 2012 annual meeting will take place in October onsite with the SACNAS conference. This collaboration will serve to expand the reach of CAHSI—nearly 4,000 Hispanics, Chicanos, and Native Americans engaged in science attended the 2011 SACNAS conference—and at the same time will enhance the sustainability of CAHSI, given that the logistics of the meeting will be under the authority of SACNAS. As of this writing, more than 40 CAHSI students plan to contribute to the SACNAS annual meeting, and CAHSI faculty will serve as scientist mentors for the computer science division of SACNAS. In these ways, CAHSI will expand its sphere of influence beyond member institutions to influence students and professionals from across the country. While there was not a CAHSI annual meeting during the past 12 months covered in this annual report, PIs from 5 of the 7 schools stated that they sent students to the 2011 SACNAS meeting using non-CAHSI funds, indicating there is opportunity to continue some presence of CAHSI beyond the years of the grant. The CAHSI project manager and student workers are currently developing systems for integrating the application and funding processes necessary to join SACNAS and CAHSI.

SOCIAL SCIENCE NETWORKS- NEW MODELS FOR COLLABORATION

While no disseminated works have been reported beyond the baseline practice, a new form of collaboration may be worth cultivating to increase the influence of CAHSI efforts in the realm of social science.[16] The recent push from CE-21 towards collaboration with learning scientists, as evidenced in the CE-21 PI meeting agendas from recent years and in the changes to the call for participation, supports interdisciplinary ventures. In this way, CAHSI members might develop new program initiatives, or make changes to current initiatives and simultaneously fund educational researchers to study the development of programs alongside their implementation, as in a design experiment. Four CAHSI PIs indicate engaging in

[16] One social scientist has been advising and consulting with CAHSI throughout the last two years, and multiple social scientists attended the 2011 CAHSI meeting to present their work to CAHSI. However, the goal of increasing alliance impact involves dissemination of social science findings beyond the CAHSI community.

these types of collaborations for recent proposals, with five social scientists and two additional evaluators. These interdisciplinary collaborations show promise for engaging social scientists in the work of CAHSI as well as serving as environments for in-depth study of how students develop technical skill, knowledge, motivation, and interest, beyond baseline practice. Inviting social scientist collaborators to the SACNAS meeting might be useful for deepening connections with social scientists, and as a means for introducing them to the national CAHSI community.

INFLUENCING POLICY THROUGH NATIONAL SERVICE—CAHSI REPRESENTATION

In the past year, CAHSI members have engaged in the policy arena on behalf of CAHSI and to serve the broader needs of Hispanic computer scientists. These activities have engaged multiple communities that support Hispanics/Latinos/as in education, as well as underrepresented communities in the sciences. This year, CAHSI nearly met its annual goal of serving at least 5 external organizations that influence policy. Faculty members from four CAHSI departments noted their service as delegates for educational policy, in venues such as Excelencia in Education and the National Center for Women & Information Technology. In addition, CAHSI contributed to a paper for the Computing Research Association regarding underrepresentation, and met with representatives from the US Department of Education to discuss Hispanics in computing.[17]

EDUCATION DISSEMINATION VIA CAHSI FACULTY

Five CAHSI faculty members participated in educational research dissemination, in some cases in cooperation with the evaluators. Education-focused faculty members come from three institutions, and present/disseminate about outreach, CS-0, and ARG practices. Providing time for instructors and other engaged faculty to collaborate across institutions on dissemination efforts, for example, as professional development during the SACNAS conference, might assist faculty in disseminating collaborative work in ways that do not detract from their professional responsibilities (e.g., presenting at an education-focused professional association, such as ASEE, SIGCSE).

SPREADING INITIATIVES FOR COMPUTER SCIENCE

The CAHSI website is continuously building the set of resources available online. To date, CS-0, PLTL, and ARG are supported on the website to the extent that a professor, instructor, or student leader would be able to download documents and try out the intervention. For example, CS-0 modules are available on the website for download, as are lesson plans for PLTL sessions developed for three computing courses. Affinity Research Group manuals, scripts, and lesson plans that assist faculty in the deliberate mentoring of research students are also available. Additional materials are in the works, such as a video of a successful PLTL session. The website would benefit from additional authors' materials, such as variations of CS-0 and more students' interpretations of an effective PLTL session. As in past years, the difficulty in designing an appropriate template for this information has hampered progress in showcasing all of the variations across CAHSI.

[17] A few mentioned SACNAS as a policy venue, though upon consideration of the main goals of SACNAS, this response was not included in the results.

WHO VIEWS CAHSI WEBSITE MATERIALS? GOOGLE ANALYTICS ANALYSIS

One way to measure the impact of an alliance is through the use of its website. CAHSI Google Analytics were collected from August 2011 through May 2012 in an effort to describe patterns of use across the United States and internationally. The focus of this report is on the use of the website in the United States, specifically. The CAHSI website was viewed 4,664 times in the past 10 months (August-May), with 13,373 page views and an average of two and a half minutes per visit. The most often viewed pages were the home page, opportunities notices, events, the student portal, and news releases regarding CAHSI members.

The map below shows regions of the country in which the website was visited regularly. In other words, states with the darkest shading had at least one visitor to the site in each of the 10 months. While it is unclear whether the same organizations or people are using the site or whether the visits come from different interested parties, the map indicates sustained interest that moves beyond CAHSI boundaries. For instance, interest seems to be sustained in the Midwest and eastern regions, where populations of Hispanic students have been growing in recent years.

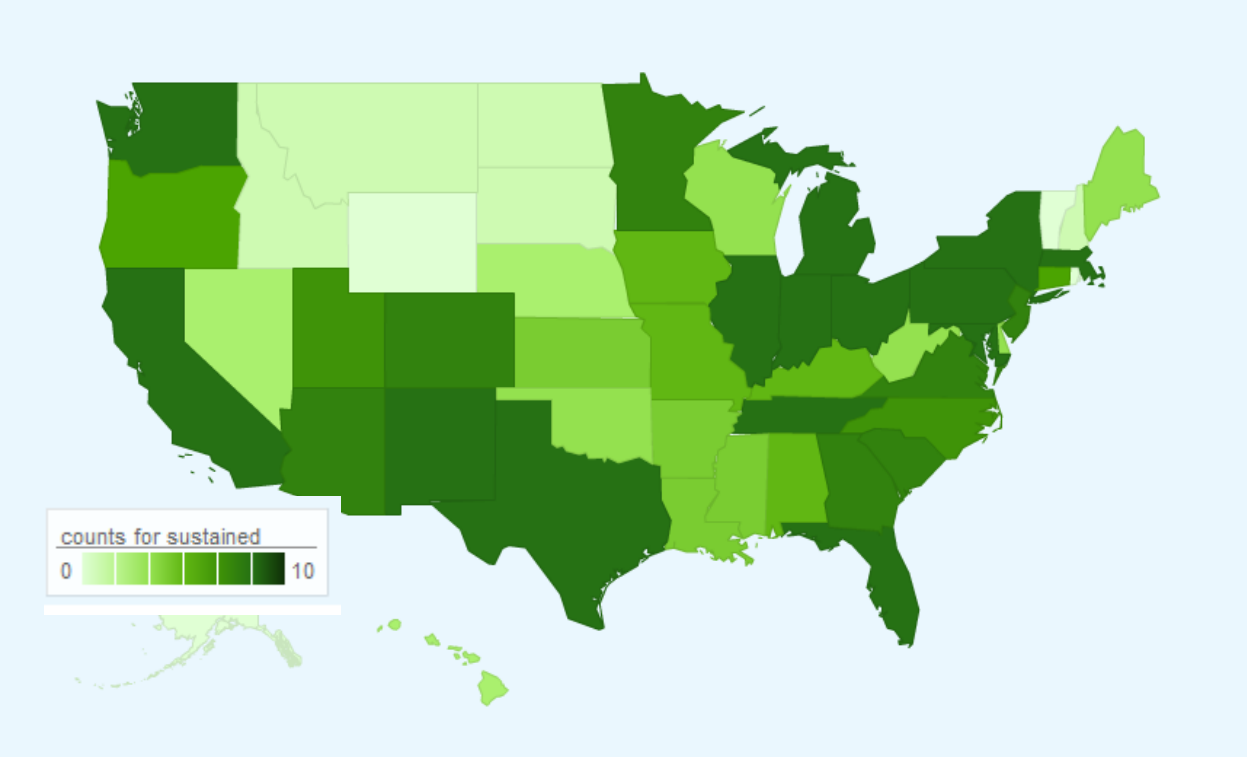


Figure 11. Regional variations in visits to CAHSI website

In an effort to measure regional trends in visits to the website, visits made from the first half of the year (August –December) were subtracted from visits made in the second half of the year (January-May). Darker shading indicates more visits made during the second half of the year (growing trend) and lighter shading

indicates a waning interest in the region. Some of the Midwest and southern states appear to be growing slightly in interest over the year, though most states remain steady regarding interest.

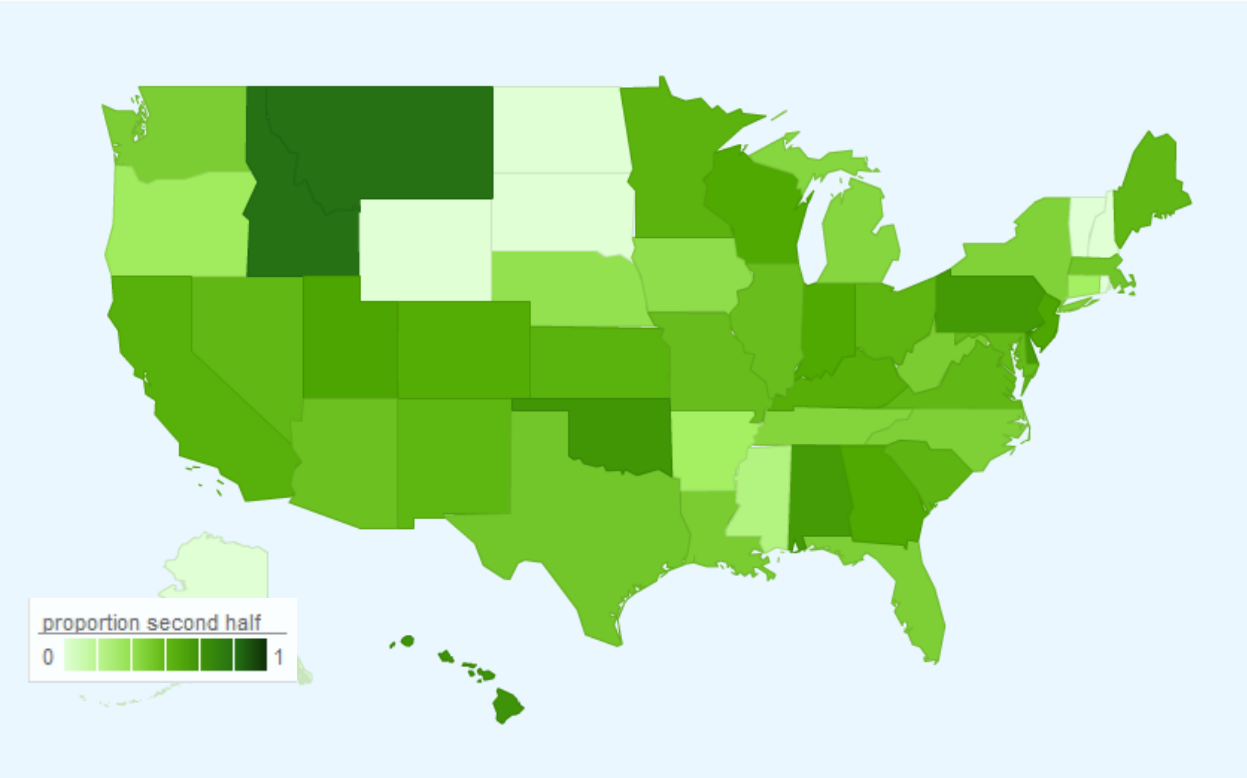


Figure 12. Regional trends in visits to CAHSI website in last five months

From state level data, it was impossible to understand how many web visits were from CAHSI institutions and how many came from outside of CAHSI. With help from the CAHSI administrative team, the evaluators received data from the city level. All web views originating from the cities of the 10 CAHSI institutions were added together, and monthly rates of CAHSI/non-CAHSI traffic were calculated. Page visits ranged from 34-59% CAHSI city generated (e.g., El Paso, Corpus Christi, Miami, Los Angeles, etc.) over 10 months, while site visits ranged from 28-46% CAHSI city generated. We note these are not precise readings, as it is very possible for a Los Angeles viewer to be unaffiliated with CAHSI, and it is possible that a web view from Columbus, Ohio could result from a CAHSI insider at a conference, for example. Page and site visit information appears below.

Table 15. CAHSI page and site visits, August 2011-May 2012

TIME PERIOD	page visits, CAHSI	page visits, total	percent CAHSI visits	site visits, CAHSI	site visits, total	percent visits, CAHSI
August	866	1471	59%	176	416	42%
September	728	1251	58%	187	430	43%
October	854	1505	57%	240	525	46%
November	568	1285	44%	139	426	33%
December	258	663	39%	80	263	30%
January	813	1544	53%	211	490	43%
February	662	1611	41%	198	550	36%
March	719	2087	34%	228	732	31%
April	519	1163	45%	205	495	41%
May	348	793	44%	96	337	28%
AVERAGES ACROSS 10 MONTHS	**633.5**	**1337.3**	**47%**	**176**	**466.4**	**37%**

Site visits averaged slightly over a third from CAHSI constituents, and 63% from outside individuals. The goal for the CAHSI Alliance was to reach 50% outside viewers by 2015. CAHSI has nearly met this goal, and may want to revisit the benchmark to support greater impact.

SUPPORTING COLLABORATION THROUGH CYBER INFRASTRUCTURE

Adoption of new technologies takes time, even in tech-savvy communities. The Lotus Live CAHSI community has been developed, and members have been added to the account. The use of Lotus Live for resources has been very limited to date. The organization is shifting towards using this tool, but not nearly to the extent where an analysis of its use was feasible this year. Two of the current uses are online video conference training and a repository for meeting notes. When additional information is available, evaluators will begin to analyze its use, and garner feedback regarding the tool.

CONTINUING TECHNICAL COLLABORATION ACROSS CAHSI INSTITUTIONS

Five of the founding CAHSI departments engage in technical research in collaboration with one another. This is promising, as sustainability research indicates collaborations are best maintained when collaborators have multiple connections, or multiple reasons to communicate and work together. In addition to these technical collaborations, faculty reported writing 15 grant proposals that mention CAHSI—typically this meant that CAHSI students would be involved in the technical research and/or that educationally focused grants would build on the work of CAHSI to support additional student development activity. Thus, the list of proposals includes technical and educational endeavors, and those that are educational have research components rather than remaining strictly programmatic in nature.

ALIGNING WITH NATIONAL GOALS

This area has been a challenge for CAHSI. At the summer 2011 retreat, the development of materials that show how CAHSI initiatives align with local, regional, or national efforts was listed as a to-do item, and yet it was not clear how to go about doing this, what form these materials would take, and whether a document would need to cover all the initiatives as well as multiple aligned goals, or whether separate materials would be needed. Faculty are beginning to speak about CAHSI achievements in new ways, and are individually beginning to think about the alignment of their work with broader institutional or national goals—for instance, one faculty member described a huge increase in completions in computing in his department in terms of his university's "time to graduation" initiative. Another CAHSI faculty member noted that CAHSI is mentioned in her university's strategic plan. Creating sample handouts, or a template for developing local materials might assist CAHSI in making progress in this area. Although CAHSI has made steps towards supporting the national STEM agenda, a more unified effort could be made to align key activities with institutional, state, regional, or national initiatives.

CAHSI SERVING AS A UNIFIED POLICY VOICE

As CAHSI moves into the area of policy, the need to collaborate with policy professionals and hold conferences for extending the CAHSI educational agenda is more vital to success. In the fall of 2011, CAHSI participated in the Excelencia in Education award ceremony, provided panelists on STEM education and the Latino community, and co-hosted the CAHSI advisory board meeting at the event on Capitol Hill in Washington, D.C. Continuing the relationship built with Excelencia, a policy organization with similar goals, will be an important way to increase connections with policy makers in the United States, while continuing to focus efforts locally to support Hispanic student advancement.

NEW ADOPTERS SPREAD CAHSI PRACTICES AND STRATEGIES

New adopters of CAHSI initiatives have spread CAHSI philosophies and practices beyond the original alliance. Faculty members at outside institutions and K-12 educators have adopted and adapted several of CAHSI's initiatives, including ARG, PLTL, and CS-0. A few of these adopters have even begun to disseminate CAHSI practices themselves. Adoption ranges from a single faculty member implementing aspects of a single initiative to entire departments adopting all of CAHSI's educational practices.

In spring 2012, adopters of core CAHSI initiatives (e.g., ARG, PLTL, and CS-0) and participants in CAHSI-led workshops were surveyed to assess the extent to which they have implemented CAHSI initiatives. In all, 19 out of 62 new adopters completed the survey, for a response rate of 31%. The survey sample was representative of the larger population of adopters in terms of demographics and initiatives adopted. Survey respondents represented 11 higher education institutions and 2 K-12 schools. Respondents also represented 9 academic disciplines, including Teacher Education, Nutritional Science, English, Nursing, Geography, and campus administration.

The majority of survey respondents were ARG adopters, with three PLTL adopters and four CS-0 adopters. Four of the 16 respondents (25%) are implementing multiple CAHSI initiatives. One department has adopted ARG and PLTL on a large-scale and is considering how to integrate CS-0 into their curriculum. The rest of the Adopters are working individually.

CAHSI has disseminated its practices most effectively through personal and professional networks of Computer Science and STEM educators, both in the higher education and K-12 arenas. Half of the survey respondents learned about CAHSI initiatives through a CAHSI member or another colleague. In fact, five of these respondents learned about CAHSI through a colleague external to CAHSI, indicating that the CAHSI network is spreading beyond its original participants. Additionally, three respondents learned about CAHSI through a conference, such as Grace Hopper or SACNAS. Two respondents received e-mail invitations to attend CAHSI workshops and three received word about CAHSI from their institution. These results suggest that CAHSI has been successful in disseminating its initiatives through a variety of venues, and that members of the CAHSI network beyond the original PIs are beginning to spread the word about CAHSI and its educational initiatives.

In the past year, 62 new individuals from outside the alliance have adopted CAHSI initiatives.

New adopters represent:
21 colleges and universities
10 K-12 schools
25 departments

New adopters have engaged:
500 students in PLTL,
338 students in ARGs, and
20 students in CS-0

New adopters reported a strong belief in the efficacy of CAHSI educational practices, yet some respondents were still naïve in their pedagogical understanding of CAHSI initiatives. In an open-ended question, new adopters were asked why they had adopted CAHSI initiatives. ARG adopters noted that ARGs are beneficial for faculty-student interaction and team communication. PLTL and CS-0 adopters generally mentioned that both initiatives are effective for student learning and engagement, but did not comment on *why* they believe those practices enhance student learning. A majority of adopters also want to improve outcomes for Hispanic students or other underserved student populations. In addition, CAHSI is spreading

beyond Hispanic-Serving Institutions. An adopter at a predominantly white university with many first-generation college students commented:

> *"I wanted to create a bridge to build the capacity of Hispanics in students in computing to do research and have successful careers. Although in the area there is not a large population of Hispanics, the problems faced by the Hispanics seemed similar to the students at my institution."*

Adopters were in various stages of implementation. Half of the survey respondents reported that they had partially adopted a CAHSI initiative. Other respondents were further along in the process. Three adopters are implementing the ARG model in a course. The respondents who have more fully adopted CAHSI initiatives reported positive outcomes for students, including improved student learning and improved performance on course assessments. A faculty member who has implemented ARG in her courses commented:

> *The difference in critical thinking has been noticed through discussions, literature search and analysis, and general test score results.*

Faculty also reported increased student confidence, and creating a community of learners. One respondent also noted that the culture of her department had changed since her adoption of the ARG model. She commented on outcomes for students and her department at large:

> *The first result was building students' confidence and ability to succeed in applying to REUs and presenting at conferences. There was a radical change in the culture of undergraduate students as their posters were showcased in the department and a newsletter featured the students' success. The culture of the department has changed and students are organizing groups for competition. ARG is a powerful model that goes beyond the research towards generating a community of students and faculty who share the same values and interests.*

Additionally, a few of the new adopters themselves are starting to spread CAHSI practices. In particular, the ARG hub leaders, a part of ARG dissemination efforts, have begun to train non-CAHSI faculty in the ARG model. In the past year, ***ARG hub leaders trained an additional 36 faculty from 10 departments at their home institutions*** in using the ARG model.

Adopters generally have received the support they need to implement CAHSI initiatives; in fact 14 out of 16 adopters (88%) were satisfied with the resources, materials, and ongoing support that they had received to adopt CAHSI initiatives. However, a few adopters felt they needed more support to fully implement CAHSI practices. For instance, two adopters suggested they needed more support in adapting CAHSI models for their particular institutional contexts or student populations. As an example, an ARG adopter noted that he would like more information about adopting the ARG model for a short-term 8-10 week REU. Two adopters also noted that they could use more materials, resources, or general information about CAHSI initiatives.

Unfortunately, CAHSI members have little control over the largest obstacles faced by CAHSI adopters—lack of time and money, and lack of institutional support. Several adopters mentioned that they would need funding in order to implement CAHSI practices on a larger scale. Sustainability is clearly a challenge for new adopters. Another faculty member noted that the tenure and promotion system typically does not reward educational innovation, and three adopters mentioned that they generally need more support from their chairs or university administration. One department that is implementing CAHSI initiatives on a large-scale commented that they would benefit from becoming a more formal member of the CAHSI alliance.

> *"Without external funding or other ideas, our implementation of PLTL won't get enough institutional support. In general our department would benefit with more contact with other CAHSI institutions and with being a regular member of the alliance."*

On the other hand, six adopters commented on the mentoring, support, and materials they had received from CAHSI. An ARG adopter noted that CAHSI faculty members have shared resources and access to CAHSI student networks. One adopter also noted that CAHSI had helped him to reach Hispanic populations for recruiting students into a summer REU program. Several adopters referred to the "personal contact and mentoring" they had received from CAHSI faculty.

Finally, new adopters had several suggestions of ways that CAHSI could better disseminate their activities. Several adopters suggested a newsletter that would report about CAHSI students and faculty, and highlight the successes of new adopters. One adopter suggested a stronger social networking presence and one adopter recommended more online resources. Three adopters suggested that CAHSI continue to disseminate their practices at national conferences.

In conclusion, CAHSI new adopters have demonstrated that CAHSI is reaching new faculty and K-12 teachers in a variety of institutional contexts, disciplines, and venues. CAHSI new adopters are reaching sizeable numbers of students and their reports indicate that at least half of them are fully implementing CAHSI initiatives, while the other half are partially implementing CAHSI models. A few of the new adopters have begun to disseminate CAHSI practices themselves. Most of all, CAHSI adopters report positive student outcomes, such as improved learning, increased confidence, and the creation of learning communities. The largest obstacles for new adopters are not under the control of CAHSI, but are structural in nature. New adopters could benefit from more time, funding, institutional support, and integration with the CAHSI alliance. Nevertheless, the majority of adopters reported that they received mentoring from CAHSI faculty and sufficient resources and materials to successfully implement CAHSI initiatives.

CONCLUSION

Overall, CAHSI is consistently graduating high numbers of Hispanics at all levels, particularly compared to graduation rates across the nation. A significant portion of Hispanic graduate students in computing disciplines in the nation earn their degrees from CAHSI institutions. The non-traditional pathways created in CAHSI departments have contributed to their success in college and graduate school completion

rates. CAHSI is becoming a policy advocate for Hispanics in STEM education, but creating a targeted plan to continue this work in a more coordinated manner is needed. CAHSI is also making headway in funding their initiatives to increase the sustainability of their efforts. Future sustainability will depend on continuing and expanding faculty engagement with CAHSI at the departmental level. CAHSI has been successful at disseminating its initiatives to a broad base of institutions and STEM departments. CAHSI will need to continue to build and expand their cyberinfrastructure to support the efforts of new adopters. As the number of new adopters increases along with the scope of their activities, CAHSI will need to think strategically about how to best support membership at many levels, (e.g., individual, departmental, institutional).

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