CAHSI Year Three Annual Evaluation Report

Recruiting, Retaining, and Advancing Hispanics in Computing

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1 Introduction

1.1 Program Overview

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

- California State University at Domingo Hills (CSU-DH)
- Florida International University (FIU)
- New Mexico State University (NMSU)
- Texas A&M University at Corpus Christi (TAMU-CC)
- University of Puerto Rico at Mayaguez (UPR-M)
- University of Houston-Downtown (UHD)
- University of Texas at El Paso (UTEP)

1.2 Goals of the Alliance Interventions

The evaluation assesses the degree to which the Alliance's interventions are individually successful in their goals of recruiting, retaining, and advancing students in computer science.

Recruitment through CS-0: **Increasing student familiarity with and motivation to study computer science, provide confidence and encouragement for pursuing a computing major**. CS-0 is a three-unit course in introduction to computer programming and concepts designed to better prepare students for success in computer science. The CS-0 courses are realized differently at each institution implementing the course, which will permit comparative analysis of methods and produce ideas for customizing or adapting for other universities. Generally speaking, students with little to no prior background in computing enroll in the course. They are provided with the opportunity to learn the basics of programming concepts and develop problem solving and systematic reasoning skills while becoming familiar with a programming environment.

Retention through Peer-Led Team Learning: **Developing a sense of community and belonging among students while providing meaningful, timely academic support**. PLTL provides academic and social support to CS students in gatekeeper courses, or the courses that tend to deter students from remaining in the major. As a part of PLTL, peer leaders provide timely assistance to students for concepts that the students have identified as unclear or difficult. The process requires the instructor to adjust lectures accordingly and the peer leader to conduct a session to address the concerns. Peer tutoring consists of faculty-supervised, one-on-one tutoring by students who have successfully completed and excelled in the course. Peer tutors provide direct assistance with the course concepts, programming, and other assignments in a manner accessible to the student.

Affinity Research Groups: Engendering understanding of research and research careers as well as a sense of belonging in a research community. Affinity Research Groups (ARGS) are a model for undergraduate research development that provides both undergraduate and graduate students with opportunities to learn, use, and integrate the knowledge and skills required for research with those required for cooperative work.

Development Workshops: **Supporting graduate studies, completion of the Ph.D. and promotion and tenure for junior faculty.** Development workshops are designed to provide graduate students and faculty with effective skills to succeed in their careers and studies. Development workshops provide opportunities: (a) to disseminate information about "survival in graduate school and academe," (b) for discussion of critical issues to career success, (c) for creating mentoring communities, and (d) for establishing cohorts of students and faculty with common goals.[1]

1.3 Purpose of Evaluation

The purpose of the evaluation is five-fold:

- To inform the ongoing work of the Alliance so that year-to-year improvements can be made and to support the development of model programs for adoption by other higher education institutions;
- To determine the extent to which the short and long-term goals of the Alliance's four main interventions have been achieved;
- To establish short- and long-term tracking of student outcomes (completion of CS undergraduate and graduate degrees, tracking of students throughout intervention courses and experiences, commitment to research careers);
- To provide an evaluation model which can be used by other institutions who adopt these interventions in the future; and
- To provide information that supports the success of the Alliance as a partnership.

This evaluation addresses the five distinct components of the Alliance described above:

- CS-0 (Intervention 1)
- PLTL (Intervention 2)

[1] Development Workshops occurred in mid to late January. Data will be reported in a separate document in the spring of 2009, along with complete data on overall enrollment and graduation trends in CAHSI computer science programs.

- ARGs (Intervention 3)
- Development workshops (Intervention 4)

This report focuses on student outcomes following the establishment of CAHSI interventions in institutions. The more comprehensive report, which describes initiative-specific results, is provided as Appendix A.

2 Evaluation Procedures: Data Gathered and Analytical Methods

2.1 Evaluation Methods

Evaluation methods include observation, interviews (individual and group), surveys, and participation in Alliance meetings. Database analysis, in which student information is analyzed from the fall of 2003 through the spring of 2008, informs the evaluation, and describes the effectiveness of the CAHSI interventions for recruiting and retaining students within computer science. Qualitative data support more nuanced interpretation of survey results. Participation in Alliance meetings allows evaluators to better understand goals and processes and permits sharing of findings from social science and educational research and from other projects the evaluators have contact with. The specific data collections for CAHSI interventions are as follows:

- CS-0: Pre-post student survey and course observations at two institutions
- PLTL: End-of-semester survey for students in PLTL courses and peer leaders, as well as observation in one institution
- ARG: End-of-academic year survey administered to ARG students in April 2008, observation at two institutions
- Development workshop: Survey for all participants, observation, informal interviews

Survey instruments were adapted from existing, reliable and valid instruments when available, though the needs and interests of the CAHSI stakeholders required development of additional measurement tools, specifically for the Peer-Led Team Learning initiative. Also, for comparison purposes, the CAHSI evaluation team was asked to use the survey developed at Georgia Tech to evaluate the CS-0 courses. All fixed response survey items were scored using a 4 point scale, in which 1=strongly disagree, 2= disagree, 3= agree, and 4= strongly agree. Responses indicating that a student was “unsure” or “did not know” were not assigned a score, and the response was dropped from analysis.

Specific research questions regarding ***CAHSI initiative’s effectiveness at recruiting and retaining students, particularly Hispanic students, in computing*** include the following:

1. What are the overall undergraduate computer science/engineering enrollment patterns at CAHSI institutions?

2. Do students who take CS-0 courses later enroll (or concurrently enroll) in CS-1? Do these enrollment and completion patterns indicate any differences by ethnicity, school, major, gender?

3. Are students who successfully complete CS-0 more likely to succeed in CS-1 during their first enrollment? Do these enrollment and completion patterns indicate any differences by ethnicity, school, major, or gender (comparing overall CS-1 one time enrollment success rates with CS-0 students' one time enrollment success rates)?

4. Are students enrolled in PLTL-targeted courses more likely to succeed during their first enrollment after the institution of CAHSI than before CAHSI existed [comparing course success rates for one-time enrollees pre intervention (2004-2005) and post intervention (2006-2007)]?

5. Are students involved in Affinity Research Groups or Affinity Research Group courses exhibiting professional computer scientist behaviors related to their scientific field, e.g. attending professional conferences, presenting original work, publishing in journals)?

Additional research questions specific to ***student experiences in CAHSI initiatives*** include the following:

6. How are students experiencing the CS-0 intervention as a learning environment? Does the course increase or maintain student self efficacy, aspirations, interest, career or academic goals in computing? If so, to what do students attribute the success of CS-0 (e.g. professor, assignments, structure of course, collaboration with peers)? Do any of these impacts differ by gender, ethnicity, school, or student major?
7. How are students experiencing PLTL courses? Does the PLTL intervention increase student (leader and student) self-efficacy, aspirations, interest, career or academic goals in computing? If so, to what do students and leaders attribute the success of PLTL?
8. How are students experiencing ARG? Does the ARG model sustain or influence student interest, self-efficacy, self-reported ability, career or academic goals in computing? If so, to what do students and leaders attribute the success of ARG?
9. How are students and faculty experiencing Development Workshops?

2.2 Data Collection and Analysis

Student database information was collected from Institutional Research Offices of the five institutions currently providing standard CS-0 (UHD, NMSU, UTEP, CSUDH, TAMUCC) and PLTL computing course interventions (UTEP, CSUDH, TAMUCC).[2] All offices were given the same spreadsheet to fill out for each student, including

"student identifier",
"student ethnicity"
"student gender"
"student major as of 2003 or first major",
"student major as of 2008 or graduating major",

[2] NMSU includes a different, voluntary version of PLTL, while UHD has PLTL in their math courses rather than in their computing courses.

“course A enrollment (semester/semesters enrolled or Not Applicable)”
“course A completion (semester/semesters successfully completed or Not Applicable”
(repeated for courses B, C, etc.)

Requests were made in May and June of 2008 and took from three weeks to six months to collect from various institutions. Some institutions did not provide all requested major data, and so documentation of students who switch majors between 2003 and 2008 (or upon first and last enrollment in targeted courses) is incomplete at this time. Requests of overall student enrollment and graduation demographics institution-wide and in computer science were requested in May and again in November of 2008, when the majority of Institutional Research Offices state this information is available. The data from 5 of the 7 schools has been received to date. The trends report will be developed in spring of 2009 when all data become available, though undergraduate enrollment data from the 5 schools are reported below.

Survey data were collected online via the Survey Monkey tool. Instructors administered the survey during their course time. The surveys were reviewed by the CAHSI executive team, a team of experts in the interventions. This review was done to establish content validity and face validity, to ensure that the surveys were measuring what they intend to measure. The quantitative data were entered into the statistical package SPSS where descriptive statistics were computed. Means, standard deviations, and frequencies are reported in the full report, Appendix A. To test for statistically significant differences among various subgroups of the sample, t-tests, one-way analysis of variance (ANOVA), and repeated measures tests were used. Further explanation of quantitative measures and discussion of reliability tests of survey instruments can be found in Appendix C as well. Briefly, student survey reliability measures Cronbach’s Alpha scores are PLTL student = 0.892; PLTL leader=0.792, and ARG= range of 0.69-0.87 on subscales, indicating that the quality of the surveys is strong (0.70 is considered good to excellent in social science research). The CS-0 survey was developed by others, and no published reliability information is available. Evaluators may need to modify this instrument to improve the survey with key indicators for comparison to Georgia Tech considered. Survey instruments may be found in Appendix B.

Write-in responses to open-ended survey questions were entered into a spreadsheet and coded. Each new idea raised in a response was given a unique code name. As later respondents raised these same ideas, a tally was added to an existing code reflecting that idea. At times the write-in answers were brief and counted within one category, but more frequently, responses contained ideas that fit under multiple categories, and these ideas were coded separately. For instance, students may have listed more than one favorite element about the CS-0 course (e.g., completing a course project and working in a group), and these were each counted. Codes were collapsed into broader categories when applicable.

3 CAHSI Initiative Evaluation Results: Student Impact

This section describes the impact of CAHSI initiatives on student enrollment and course completion in computer science/engineering. Specifically, it addresses the following research questions:

- What are the overall undergraduate computer science/engineering enrollment patterns at CAHSI institutions?
- Do students who take CS-0 courses later enroll (or concurrently enroll) in CS-1? Do these enrollment and completion patterns indicate any differences by ethnicity, school, major, gender?
- Are students who successfully complete CS-0 more likely to succeed in CS-1 during their first enrollment? Do these enrollment and completion patterns indicate any differences by ethnicity, school, major, or gender (comparing overall CS-1 one time enrollment success rates with CS-0 students' one time enrollment success rates)?
- Are students enrolled in PLTL-targeted courses more likely to succeed during their first enrollment after the institution of CAHSI than before CAHSI existed [comparing course success rates for one-time enrollees pre intervention (2004-2005) and post intervention (2006-2007)]?
- Are students involved in Affinity Research Groups or Affinity Research Group courses exhibiting professional computer scientist behaviors related to their scientific field, e.g. attending professional conferences, presenting original work, publishing in journals)?

3.1 Overall Undergraduate Enrollment

CAHSI Institutions are not seeing the large declines in enrollment described in the 2008 Computer Research Association Taulbee Survey (Zweben, 2008) of PhD-granting institutions. While the report notes an 18% decline in BA enrollment for computer science and computer engineering, data collected to date from 5 institutions shows that CAHSI schools enrolled 1,106 students in 2006 and 1,088 students in 2007, representing a 1.7% decline in enrollment. When looking only at CAHSI's PhD granting institutions, we find an increase in student enrollment, from 856 to 883 students—a 3.2% increase in enrollment. Schools saw a very modest decline in 2008. While it is unclear why students are enrolling in similar and in some cases greater numbers at CAHSI institutions while numbers are declining elsewhere, CAHSI initiatives that retain students as well as the explosive growth in the number of Hispanic citizens of college age who enroll in HSIs may be contributing factors. See table 1.

School	Year	Total	Gender M	Gender F	White M	White F	African-American M	African-American F	Hispanic M	Hispanic F	Asian-American M	Asian-American F	Native American M	Native American F	Mexican M	Mexican F	Other Internat'l M	Other Internat'l F	Other/unknown M	Other/unknown F
BA COMPUTER SCIENCE ENROLLMENT 2006																				
NMSU	2006	166	142	24	78	13	4	1	50	8	4	0	6	2	NA	NA	NA	NA	NA	NA
UTEP	2006	195	164	31	15	0	1	1	105	20	1	0	0	0	37	9	5	1	0	0
CSUDH	2006	141	119	22	13	1	35	8	15	4	16	2	1	0	24	4	7	0	8	3
UHD	2006	109	87	22	28	1	17	6	17	8	13	1	0	0	1	1	11	5	NA	NA
FIU	2006	495	X	X	35	0	47	6	179	24	15	1	0	0	1	0	187		NA	NA
Total BA Enroll		1106			169	15	104	22	366	64	49	4	7	2	63	14	210	6	8	3
BA COMPUTER SCIENCE ENROLLMENT 2007																				
NMSU	2007	170	145	25	86	9	4	1	43	13	6	0	6	2	NA	NA	NA	NA	NA	NA
UTEP	2007	185	156	29	9	1	3	0	108	21	1	1	0	0	27	4	7	2	1	0
CSUDH	2007	94	25	11	4	29	7	14	3	14	5	0	0	20	4	1	0	5	2	0
UHD	2007	109	93	16	32	1	18	5	15	7	16	1	0	0	1	1	11	1	NA	NA
FIU	2007	530	X	X	35	0	47	7	193	19	16	2	0	0	0	0	223		NA	NA
Total BA Enroll		1088			166	40	79	27	362	74	44	4	6	22	32	6	241	8	3	0
BA COMPUTER SCIENCE ENROLLMENT 2008																				
NMSU	2008	172	151	21	90	10	5	0	47	11	4	0	5	0	NA	NA	NA	NA	NA	NA
UTEP	2008	191	152	39	11	2	3	0	110	29	0	2	0	0	0	0	5*	19*	NA	NA
CSUDH	2008	87	18	11	2	25	7	10	2	15	3	0	1	14	1	6	1	6	1	0
UHD	2008	112	96	16	30	5	19	3	17	4	17	2	0	0	1	1	12	1	NA	NA
FIU	2008	486	X	X	31	2	44	5	189	18	16	2	1	0	3	0	175		NA	NA
Total BA Enroll		1048			164	44	78	18	365	77	40	6	7	14	5	7	188	7	1	0

Table 1: CAHSI Institution Undergraduate Computer Science/Computer Engineering Enrollment

3.2 CS-0 enrollment

Five schools currently hold CS-0 courses. In the four schools with current data available, nine hundred and ninety five students have enrolled in CS-0 since 2003, and 865 completed the course. It is important to note that 702 of these students attended UHD, and the majority of these (approximately 565) were receiving dual course credit as high school students. Because of their non-traditional enrollment status, only those who continue at UHD as undergraduates can be tracked into Computer Science 1 courses. Overall, in the four schools with available data, 57 of the students who were successful in CS-0 courses also continued through CS-1 and completed the course. In the next section, student course enrollment and completion patterns are described in detail by school.

Looking at schools other than UHD where student tracking is most difficult, we find 240 students who have completed CS-0, 51 of whom enroll in CS-1 (21% of those who complete CS-0). Of these students, 39 were successful in CS-1 (76%), a rate that exceeds the same four schools' average rate of course success for CS-1 (63.5%). While 65% (156 of 240) of the students who completed CS-0 in this group were Hispanic, 59% of the students who successfully completed CS-1 were Hispanic. This difference was not statistically significant at the 95% confidence level, indicating a near equivalent proportion of Hispanic students continued through CS-0 into CS-1 at these three schools.

3.3 CS-0 Students Recruited into/Retained in Computer Science

3.3.1 CS-0 at CSUDH

Eighty seven students enrolled in CS-0 since 2003, and seventy students completed the course at CSUDH. Over one third of the students were Hispanic (37 of those enrolled, 29 of those completing CS-0) and nearly one quarter were African American (21 of those enrolled, 15 of those completing CS-0). About one third were female (26 of those enrolled, 22 of those completing CS-0), and just over one third were declared computer science majors (35 of those enrolled, 26 of those completing CS-0). The following figure describes the pattern of student recruitment, retention and advancement from CS-0 through CS-1.

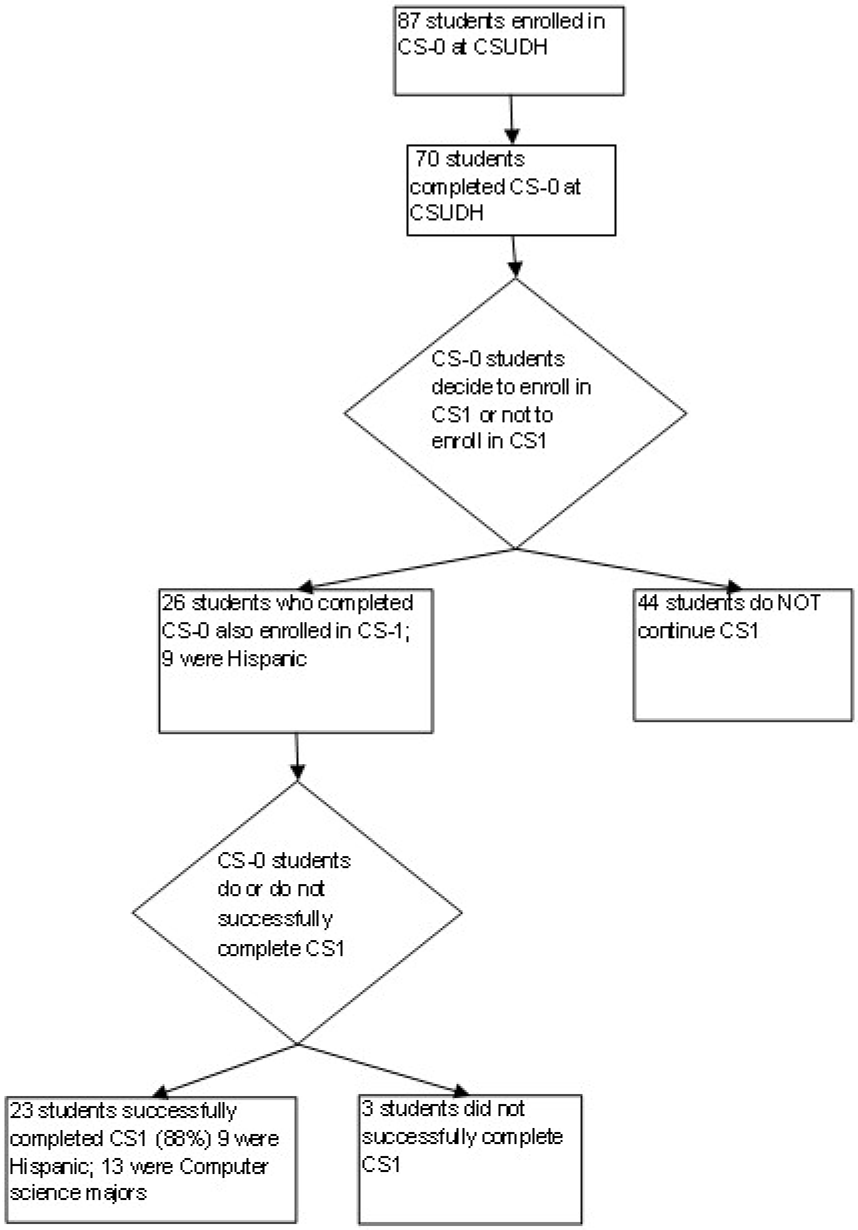

Figure 1: CS-0/CS-1 Course Enrollment and Completion for CSUDH

The figure shows that of the 70 students who completed CS-0, 26 students later enrolled in CS-1, and 23 passed CS-1. This pass rate exceeded the average pass rate for students in CS-1 (56 of 91, or 62%) calculated over 4 semesters pre-CAHSI (fall 2004, spring 2004, fall 2005, and spring 2005). This difference in proportions is significant at the .02 confidence level (z= 2.348), meaning the likelihood that this difference in rate of completion is due to chance is 2%.

In addition to preparing computer science students for higher level programming work in CS-1, the CS-0 course may also be recruiting students into the field. Ten of those students who have completed CS-1 following CS-0 enrollment are from majors other than computer science.

3.3.2 CS-0 at UHD

The University of Houston, Downtown has enrolled the largest number of CS-0 students, the majority of whom took the course through dual enrollment at the high school level. Since 2003, 702 students have enrolled in the course, and 625 students completed it. Following their experiences in CS-0, 29 students continued at UHD in the CS-1 course, and 18 successfully completed the course. Data show that Hispanic students at UHD who enrolled in CS-1 were less successful (40%) than the average completion rate for this group of CS-0 students who continued their computer science studies (62%). It is unclear why that is the case.

The majority of the students who continued from CS-0 into CS-1 were non-computer science majors, indicating that the course had a modest impact on student recruitment into the computing field. Three percent of all students who completed CS-0 also completed CS-1 successfully. The fact that many of these students were high school students at the time of their enrollment in CS-0 makes tracking them through their college experiences very difficult—we have no way of knowing whether students who went to other colleges after graduating high school continued their efforts in computer science. See figure 2 below.

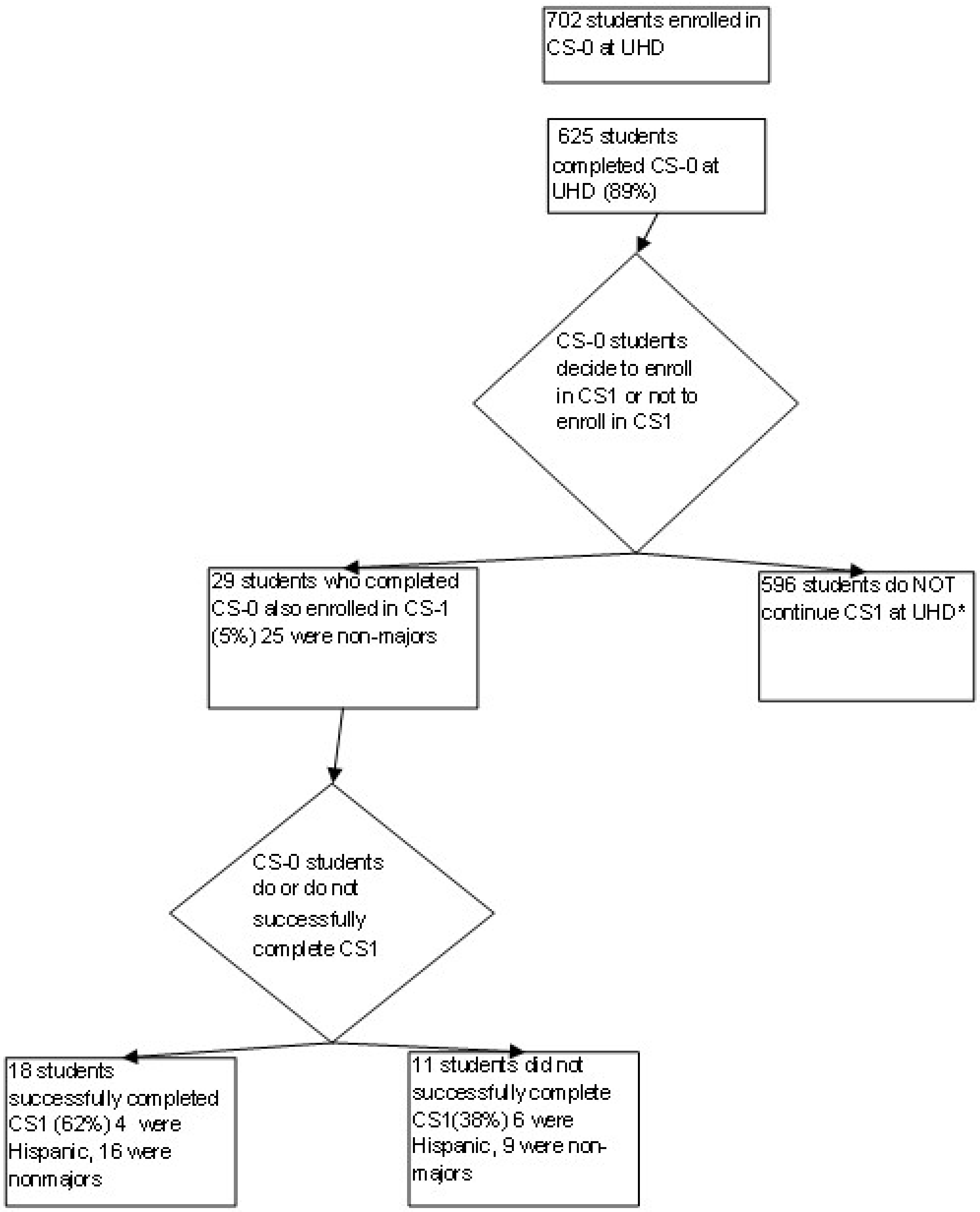

Figure 2: CS-0/CS-1 Course Enrollment and Completion for UHD

3.3.3 CS-0 at UTEP

One hundred seventy four students have enrolled in CS-0 courses at UTEP since 2003, and 147 completed the course, the majority of those completing CS-0 were Hispanic non-computer science majors (109,74%). Of these, 21 (14% of those completing CS-0) students enrolled in CS-1 following their efforts in CS-0. Fourteen of the students completed CS-1 successfully, as of the spring 2008 semester, and 12 of these students were Hispanic. The rate of completion for CS-0 students engaged in CS-1 courses (67%) was similar to the average baseline rate of CS-1 course success determined over four pre-CAHSI semesters (212 of 312, or 68%). While this seems to suggest that CS-0 did not assist students in succeeding in CS-1, it is important to note that all but one (8 of 9) of the computer science majors successfully passed CS-1 following CS-0. Also, four non-majors succeeded in CS-1. We will follow these students to see if they were successfully recruited into computer science.

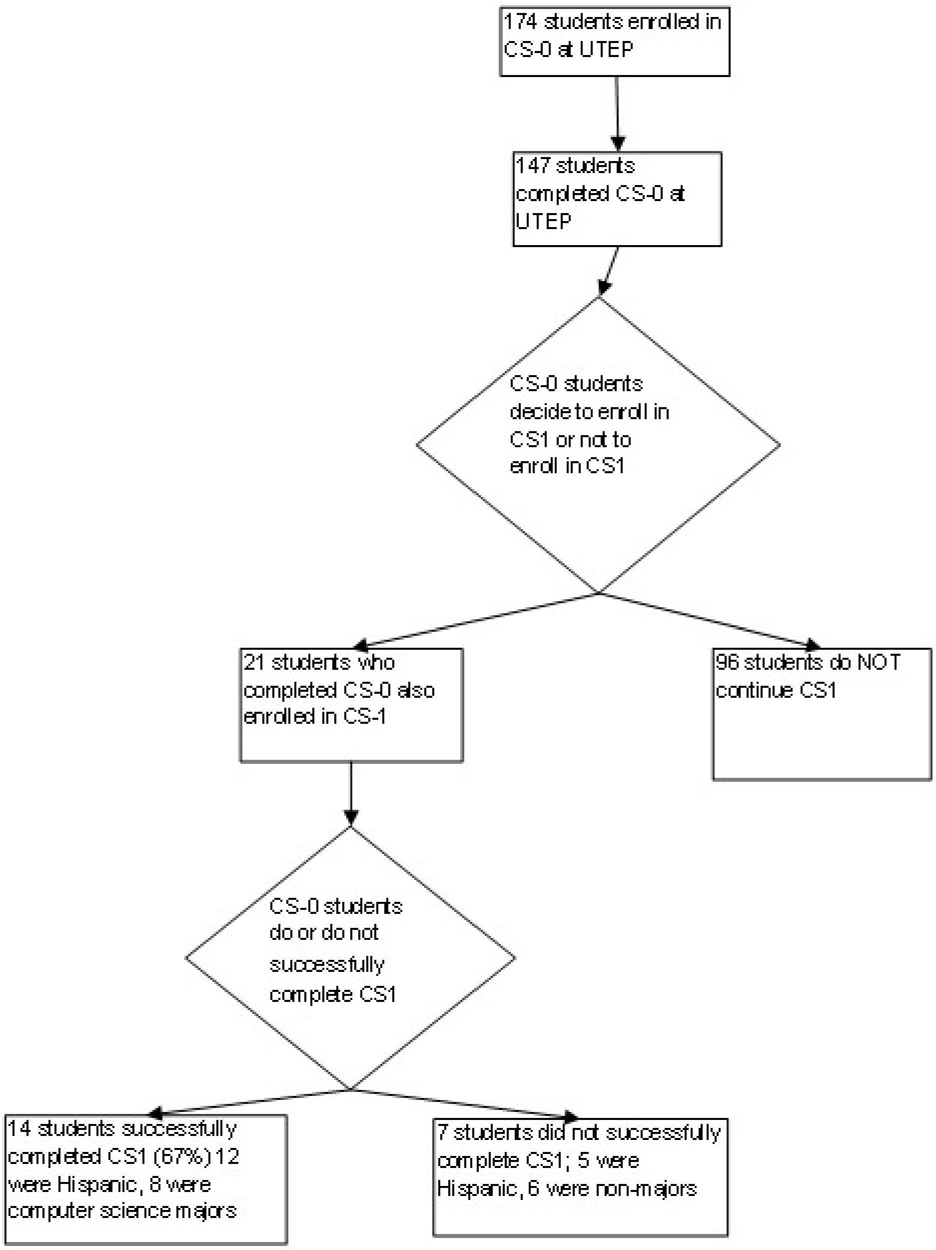

Figure 3: CS-0/CS-1 Course Enrollment and Completion for UTEP

3.3.4 CS-0 at NMSU

New Mexico State University has implemented CS-0 into their curriculum as an elective for students from all majors. Billed as an animation course, the class has enrolled students from art, business, computer science, liberal arts, and science backgrounds. The course is labeled CS 209, a special topics in computing designation. Unfortunately, CS 209 is a course designation given to other computer science courses. For example, during semesters when CS-0 was instituted, the courses “Online Communities” and “Media Literacy” were also offered with the same course number. At present, it is impossible to discern from our data which course students took, CS-0 or another computing course. We are working with the Institutional Research Office at NMSU to clarify the data. Focus group and interview data suggests that 2 to 3 students may have completed CS-1 concurrently with CS-0. This information will be added to our report when available.

3.3.5 CS-0 at TAMUCC

Texas A& M University, Corpus Christi is the latest school to adopt CS-0 into the curriculum. To date, 32 students have enrolled in CS-0, and 23 completed the course, 12 of the students were Hispanic. Of them, 4 enrolled in CS-1 since their experience in CS-0. Note that these four come from one section of CS-0, taught in the fall of 2007, as they are the only students for whom we have an additional semester of course data beyond their CS-0 enrollment. Of these students, 2 successfully completed CS-1 to date, and both were Hispanic males. See figure 4 below. We will continue to track those students who have completed CS-0 into their future semesters, to see if they later enroll and succeed in CS-1.

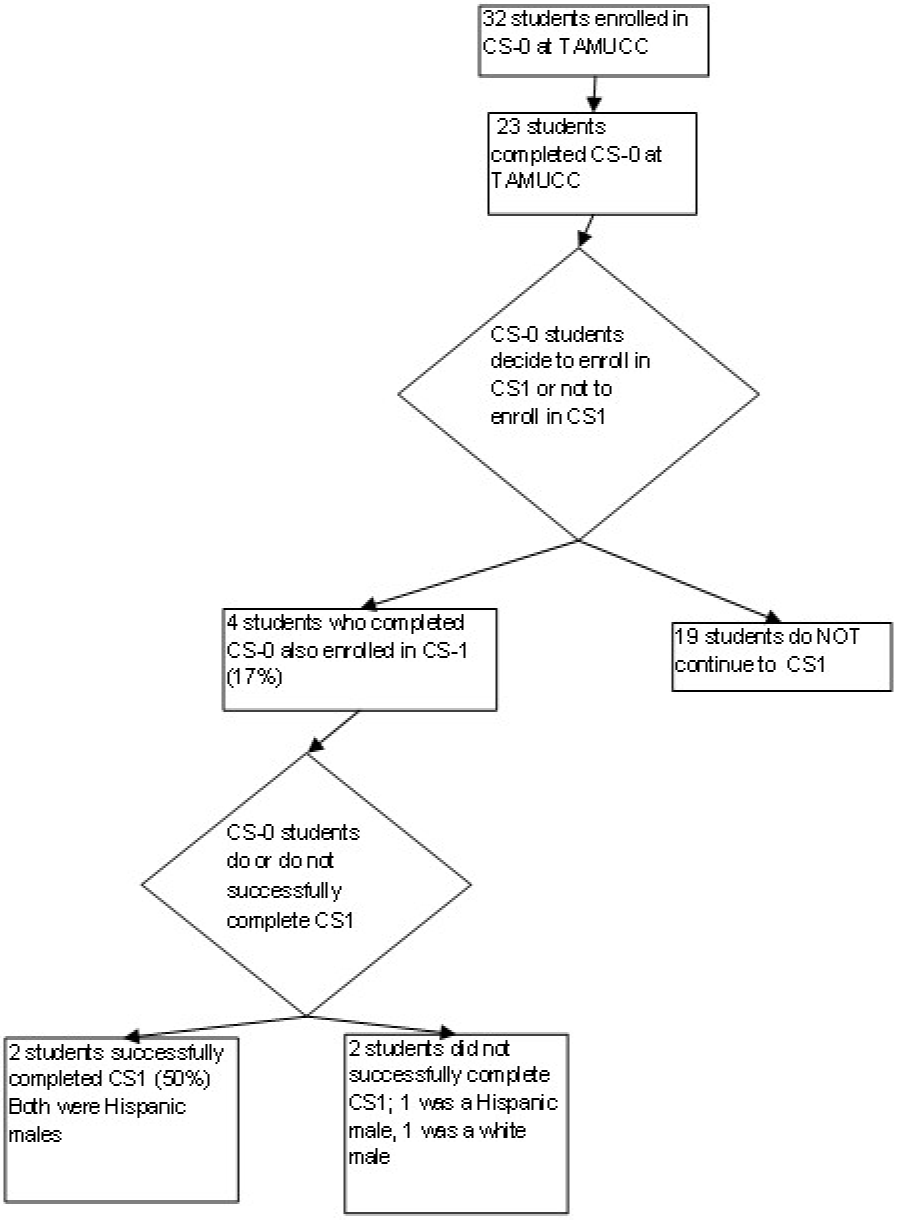

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Figure 4: CS-0/CS-1 Course Enrollment and Completion for TAMUCC

3.4 Discussion of CS-0 evaluation results, challenges, and next steps

CS-0 varies widely across CAHSI institutions, perhaps the most of all CAHSI interventions. The role the course plays at an institutional level varies from an enrichment elective, to a recommended pre-requisite for computer science 1, to a dual enrollment course for high school students, to a core course for all students at an institution. It is unclear what an acceptable or "good" rate of recruitment into computer science would be, and it is evident that we do not have access to all of the data necessary to measure recruitment into CS-1 (e.g. students who leave institutions for other institutions, high school students who enroll in new colleges upon graduation). As more students are added to the data base, and as students have more opportunities to take CAHSI intervention courses, we will know more about the impact of these interventions on recruitment and retention within computer science/engineering.

One avenue for future data collection is the rate at which students from CS-0 enroll in computing majors outside of CAHSI departments, such as electrical engineering, computer engineering (when CAHSI departments are computer science), computer science (when CAHSI departments are computer engineering) and information systems. Adding the introductory courses in these computing fields to our database may indicate that CS-0 students remain in computing fields at a higher rate than is indicated by the current CS-0 data. According to UTEP faculty, the CS-0 course at their institution includes a career advising component, in which students may be directed towards information systems degrees. Currently, we are not capturing the success of those students in computing. As the BPC alliances are focusing on computing careers more generally than in the field of computer science alone, the addition of underrepresented students in these courses would also signify an increase in the computing talent pool.

3.5 PLTL Intervention: Retaining students through peer teaching, learning

The primary goal of Broadening Participation in Computing (BPC) Alliances like CAHSI is to increase or contribute to the increase of students obtaining computing degrees and the number of students pursuing advanced degrees in computing fields. This section explores the ways the PLTL intervention is assisting students in their computing studies. Data reported here cover three institutions, and pertain only to computing courses that fulfill requirements for the computer science major at the institutions. PLTL is offered in some institutions for math courses for computer science majors. This data was not included in this report, because the mathematics department is not directly involved in CAHSI.[3]

3.5.1 PLTL and first time enrollments- Improving successful completion of computing courses

In this section, we explore the success of students who enroll one time in CAHSI target courses. The students described in this section either complete the computer science course successfully in the first attempt or they are unsuccessful (meaning they drop the course or fail the course) and they do not reenroll.[4] This second group of students is a selection of students lost to other majors, or other interests. The table indicates the number and proportion of students who have successfully completed PLTL targeted courses before and after the CAHSI intervention.[5]

[3] The evaluators acknowledge the importance of success in mathematics courses, particularly calculus based courses, for success in the computing major, and feel further study of this practice in mathematics may be an essential addition to future CAHSI efforts.

[4] The students who do in fact reenroll in the course are described in following sections of the report
[5] Asterisks * indicate the difference from 2004 to 2007 was statistically significant

	2004			2005			2006			2007		
	number successful	number enrolled	success ratio	number successful	number enrolled	success ratio	number successful	number enrolled	success ratio	number successful	number enrolled	success ratio
US Hispanic females first enrollment	42	55	76%	35	43	81%	56	73	77%	64	73	88%
US Hispanic males first enrollment	126	171	74%	130	177	75%	164	198	83%	161	198	81%
US Hispanic student total	168	226	74%*	165	220	75%	220	271	81%	225	271	83%*
Non-Hispanic females first enrollment	42	54	78%	36	49	73%	36	52	69%	31	43	72%
Non-Hispanic males first enrollment	148	195	76%	166	202	82%	166	194	86%	119	148	80%
Non Hispanic student total	190	249	76%	202	251	80%	202	246	82%	150	191	79%
All students first enrollment	358	475	75%*	367	471	78%	422	517	82%	375	462	81%*

Table 2: CAHSI Institution Student Course Completion Rates for One-Time Enrollees

The proportion of students who enrolled once in CAHSI target courses and were successful upon their first enrollment increased from 2004 to 2007. This difference was significant for Hispanic students (z=2.135) and for all student groups, though differences among non-Hispanic students were not statistically significant. This information indicates that PLTL interventions are particularly supportive of Hispanic students' achievement in computer science. In other words, more Hispanic students are passing computer science major courses upon first enrollment since the inception of CAHSI than before CAHSI.

3.5.2 Multiple enrollment students- How are struggling students faring in CS courses?

The above data took into account all students who enrolled one time in a CAHSI course. Not all computer science students complete or drop their courses after one semester—it is common for students to drop or fail a course and reenroll in the same course later in their academic careers. In order to compare the rates, pre and post CAHSI, at which students successfully complete courses for which they enrolled multiple times, students were separated into three groups. The numbers indicate numbers of students who were enrolling in a single target course multiple semesters during pre-CAHSI semesters, students enrolling before and after CAHSI's inception in 2006, and students enrolling in CAHSI target courses multiple times since 2006. Each student enrolled in targeted CAHSI courses for 2 to 5 semesters, though each student is counted only once in these figures. See Figure 5 below.

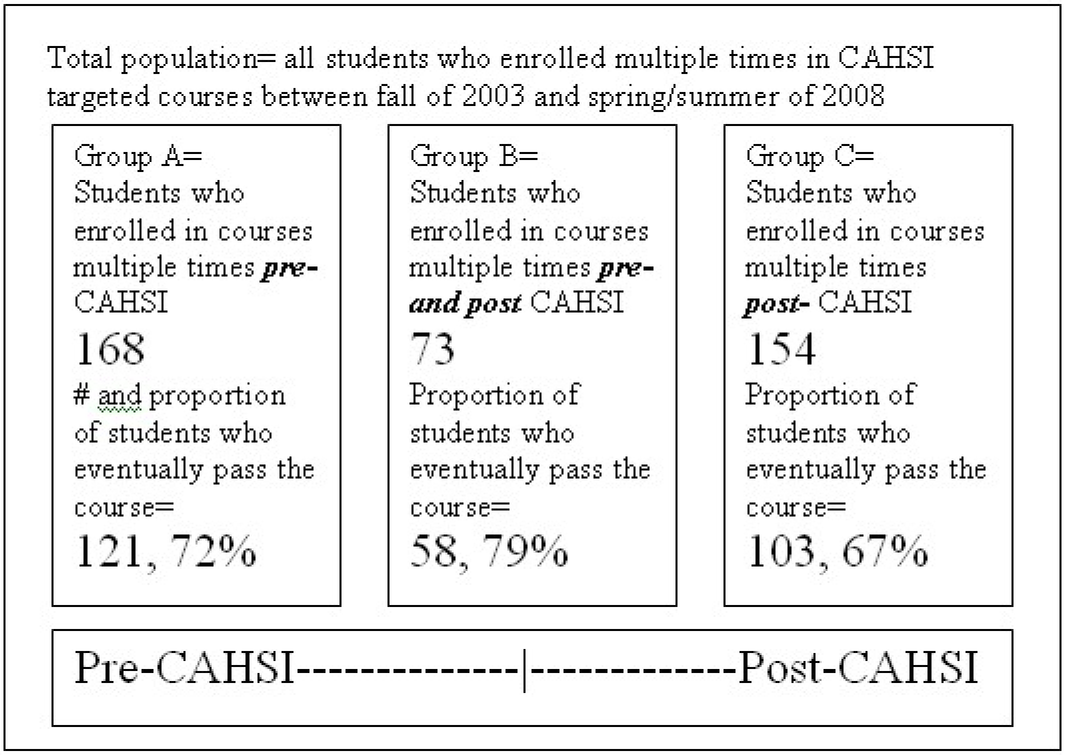

Figure 5: Multiple Enrollment Students' Eventual Success in Targeted CAHSI Courses

These data indicate that students who enrolled in CAHSI target courses multiple times before the CAHSI initiative had a 72% eventual success rate, meaning that 121 of the 168 students who enrolled multiple times in a course were able to pass it between 2003 and 2005. As CAHSI interventions took hold, the rate of student success increased to 79% for group B students, who enrolled and passed target courses between 2003 and 2008. This indicates that CAHSI interventions may have boosted student achievement for those who needed extra opportunities to learn the material in target courses. For students enrolling during CAHSI years, the data reflect a slightly lower rate of completion; though time is a factor in viewing these figures, as is the relative success of students who enroll one time in CAHSI interventions (see above section). Students who enrolled in a course in fall of 2007 and spring of 2008 may reenroll and succeed in the fall of 2008, for example, and thus be included in the number of successful students. In other words, the proportions for Groups B and C are dynamic, and may increase in future semesters. Note that these differences in proportions are not statistically significant, meaning these differences may be due to chance. Continuous monitoring of students who enroll multiple times in courses is essential to the evaluation of CAHSI.

3.5.3 PLTL and Student Retention: Patterns of Student Success

The CAHSI initiative is increasing the number and proportion of students successfully completing the target computer science courses at CAHSI institutions. While first time enrollees, particularly Hispanic enrollees, are more successful completing courses, those who take additional course time to succeed are progressing at a similar rate than in pre-CAHSI years according to data collected to date. As students in groups B and C continue to enroll and succeed in targeted courses, we may see an increase in the rate at which multiple enrollment students complete computer science coursework. This data will be collected again in the summer of 2009. As additional institutions and courses adopt CAHSI interventions, and as the PLTL leaders, faculty, and staff become more comfortable with the intervention, we may see greater impact on student success.

3.6 ARG Students' Apprenticeship in the Field of Computing

Affinity Research Groups are affording students opportunities to join in behaviors associated with high-level, scientific research practice. Through their collaborative work with more experienced researchers (other undergraduates, graduate students, staff, and faculty), ARG students have access to *legitimate peripheral participation*; in essence, they get a glimpse into the lives and work of research scientists as they perform some of the important tasks of research (Lave & Wenger, 1991). This report highlights the demographic and experiential details of ARG students, and the activities they engage in that display their apprenticeship into scientific research. For more details on students attitudes and aspirations in computer science, please see the full report in Appendix A.

Overall, 98 Affinity Research Group (ARG) students completed a survey about their personal, professional and intellectual gains from participation in research: 32 students in spring 2008, 34 students in summer 2008, and 32 students from the research course at University of Puerto Rico, Mayaguez. Survey responses were received from UTEP (34% of student participants), TAMU-CC (9%), UHD (2%), CSU-DH (12%), NMSU (7%), and UPRM (36%--all but three of these students participated in the research course).

ARG students were primarily undergraduates, with a few graduate student participants. Undergraduate students tended to be upperclassmen. Only 2% of ARG students were 1st year students, 9% were 2nd year students, 16% were 3rd year students, 26% were fourth year students, and 34% were 5th year undergraduates. In addition, 10% were master's students, and 3% were Ph.D. students.

Many ARG students were relatively inexperienced researchers. Two-thirds of students had only completed 1-2 semesters or summers of research. A little less than one-quarter of students had completed 3-4 semesters or summers of research, and the remainder had completed 5 or more semesters or summers of research.

ARG students were predominantly Hispanic (76% of students). The remainder was Caucasian (11%), Asian (6%), mixed race/ethnicity (4%) or African-American (3%). ARG students were also predominantly male (77% of students). The gender representation of ARG students is consistent with the national average: in 2005, 22% of bachelor's degrees in computer science were awarded to women (NSF, 2006). Finally, 61% of students were computer science majors, while the rest were computer engineering majors.

Most ARG students had the opportunity to participate in professional forums in their field of interest. Over two-thirds of students attended a professional conference within the past year. Less often, students had the opportunity to present or publish their results; however, our prior research on UR has shown that these accomplishments are rare for undergraduates (Hunter et al., 2007; Seymour et al., 2004). Nevertheless, over one-third of ARG students presented a poster at a conference in the past year, 18% of students authored or co-authored a journal manuscript, and 10% presented a conference paper. Therefore, ARG students seemed to have had ample opportunities to engage in authentic research that led to publishable results. Access to "real-world" research is essential for socializing students into the profession and producing the strongest intellectual and professional gains (Thiry et al., 2009). See Table 3 below.

Professional activity undertaken in the past year (n=98)	Number of students	Percentage of students
Attended a professional conference	64	65%
Authored or co-authored a journal paper	18	18%
Presented a conference paper	10	10%
Presented a poster at a professional conference	37	38%

Table 3: ARG Students' Achievements in Scientific Research

4 Discussion

According to institution-level data, CAHSI interventions are increasing the number of students retained in computer science courses specific to the major. The modest but statistically significant rise in one-time enrollment student success rates in CAHSI targeted courses indicate that the CAHSI practices have impact in the CAHSI institutions. The stable enrollment of students in CAHSI institutions, in a time when PhD granting universities saw an 18% drop in enrollment is encouraging. While CS-0 impact appears low at this time, an expansion of data collection to include all computing fields may show a greater number of students recruited into computing fields. ARG students appear to be advancing their scientific careers through participation in conferences and through dissemination of their work. This is significant, as most undergraduate researchers do not have these high-level participation opportunities.

CAHSI's multiple pronged strategy of a) mainstreaming mentoring opportunities through ARG and PLTL b) easing students into programming via visual, project-based programming curricula in CS-0 and c) developing students' career and academic readiness through workshops is impacting the number of students, particularly Hispanic students, who are succeeding in computing courses. As we continue to follow students throughout their academic careers, we will ascertain whether the number of students pursuing and completing the computer science degree does in fact increase over time. The goals of the next funding cycle include expanding the number of CAHSI institutions as well as outside institutions utilizing the CAHSI model.

The evaluation of such a widespread, diverse program as CAHSI faces many challenges. Obtaining data from 7 institutions regarding student course enrollment requires many person-hours, and requires much turn around time, as offices vary in staff, funding, and numbers of requests. In some cases, evaluators receive data 5-6 months after it was requested. Involving P.I.s from institutions has helped in getting this data expediently, though each institutional research office has a unique method for collecting and presenting data (even in cases such as these where the format is prescribed by the evaluators), and much data cleaning is necessary before data can be analyzed.

A tension faced by the evaluation team is that between formative and summative assessment of the CAHSI program. The goals of the evaluation team include collecting, analyzing, and presenting CAHSI with data to inform their current practice, as well as evaluating the ways in which the interventions impact student behavior and outcomes. This tension may be alleviated somewhat with the addition of an internal evaluator to the CAHSI team, and with the addition of BPC common core indicators, currently being developed by a team of BPC evaluators in collaboration with Daryl Chubin of the American Association for the Advancement of Science (AAAS).

5 References

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

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

Bransford, J.D., Brown, A., & Cocking, R. (2000) (Eds.), *How People Learn: Mind, Experience and School, Expanded Edition.* Washington, D.C: National Academies Press.

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

Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *Journal of Higher Education*, 69(6), 589-504.

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

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

Lent, Robert W.; Hackett, Gail; Brown, Steven D.(1999). A Social Cognitive View of School-to-Work Transition. *Career Development Quarterly, v47 n4* p297-311.

Lent, Robert W.; Brown, Steven D.; Sheu, Hung-Bin; Schmidt, Janet; Brenner, Bradley R.; Gloster, Clay S.; Wilkins, Gregory; Schmidt, Linda C.; Lyons, Heather; Treistman, Dana (2005) Social Cognitive Predictors of Academic Interests and Goals in Engineering: Utility for Women and Students at Historically Black Universities. *Journal of Counseling Psychology*. *Vol 52(1)*, p 84-92.

Margolis, Jane (2008). *Stuck in the Shallow End: Education, Race, and Computing.* MIT Press: Cambridge, MA.

Margolis, Jane, & Fisher, Allan (2003). *Unlocking the Clubhouse: Women in Computing.* MIT Press: Cambridge, MA.

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

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

National Science Foundation (2006). Women, minorities, and persons with disabilities in science and engineering. NSF 4-311, Arlington, VA: NSF.

Olson, D. & Torrance, N. (1998) (Eds.) *The Handbook of Education and Human Development.* Blackwell Publishers: Malden, MA.

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

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57(1)*, p.1-22.

Steele, C. & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69(5),* p 797-811.

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

Thiry, H. Hunter, A-B. & Laursen, S.L. (2009). Where do students become scientists? A comparative study of research and other sources of personal and professional gains for STEM undergraduates, manuscript submitted to the *Journal of Higher Education*.

Appendix A:
CAHSI Full Evaluation Report

CAHSI Year Three Annual Evaluation Report

Recruiting, Retaining, and Advancing Hispanics in Computing

January 30, 2009

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University of Colorado, Boulder

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CAHSI Year Three Annual Evaluation Report

Recruiting, Retaining, and Advancing Hispanics in Computing

1 Introduction

1.1 Program Overview

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

- California State University at Domingo Hills (CSU-DH)
- Florida International University (FIU)
- New Mexico State University (NMSU)
- Texas A&M University at Corpus Christi (TAMU-CC)
- University of Puerto Rico at Mayaguez (UPR-M)
- University of Houston-Downtown (UHD)
- University of Texas at El Paso (UTEP)

1.2 Goals of the Alliance Interventions

The evaluation assesses the degree to which the Alliance's interventions are individually successful in their goals of recruiting, retaining, and advancing students in computer science.

Recruitment through CS-0: **Increasing student familiarity with and motivation to study computer science, provide confidence and encouragement for pursuing a computing major**. CS-0 is a three-unit course in introduction to computer programming and concepts designed to better prepare students for success in computer science. The CS-0 courses are realized differently at each institution implementing the course, which will permit comparative analysis of methods and produce ideas for customizing or adapting for other universities. Generally speaking, students with little to no prior background in computing enroll in the course. They are provided with the opportunity to learn the basics of programming concepts and develop problem solving and systematic reasoning skills while becoming familiar with a programming environment.

Retention through Peer-Led Team Learning: **Developing a sense of community and belonging among students while providing meaningful, timely academic support**. PLTL provides academic and social support to CS students in gatekeeper courses, or the courses that tend to deter students from remaining in the major. As a part of PLTL, peer leaders provide timely assistance to students for concepts that the students have identified as unclear or difficult. The process requires the instructor to adjust lectures accordingly and the peer leader to conduct a session to address the concerns. Peer tutoring consists of faculty-supervised, one-on-one tutoring by students who have successfully completed and excelled in the course. Peer tutors provide direct assistance with the course concepts, programming, and other assignments in a manner accessible to the student.

Affinity Research Groups: Engendering understanding of research and research careers as well as a sense of belonging in a research community. Affinity Research Groups (ARGS) are a model for undergraduate research development that provides both undergraduate and graduate students with opportunities to learn, use, and integrate the knowledge and skills required for research with those required for cooperative work.

Development Workshops: **Supporting graduate studies, completion of the Ph.D. and promotion and tenure for junior faculty.** Development workshops are designed to provide graduate students and faculty with effective skills to succeed in their careers and studies. Development workshops provide opportunities: (a) to disseminate information about "survival in graduate school and academe," (b) for discussion of critical issues to career success, (c) for creating mentoring communities, and (d) for establishing cohorts of students and faculty with common goals.[1]

1.3 Purpose of Evaluation

The purpose of the evaluation is five-fold:

- To inform the ongoing work of the Alliance so that year-to-year improvements can be made and to support the development of model programs for adoption by other higher education institutions;
- To determine the extent to which the short and long-term goals of the Alliance's four main interventions have been achieved;
- To establish short- and long-term tracking of student outcomes (completion of CS undergraduate and graduate degrees, tracking of students throughout intervention courses and experiences, commitment to research careers);
- To provide an evaluation model which can be used by other institutions who adopt these interventions in the future; and
- To provide information that supports the success of the Alliance as a partnership.

This evaluation addresses the five distinct components of the Alliance described above:

- CS-0 (Intervention 1)
- PLTL (Intervention 2)

[1] Development Workshops occurred in mid to late January. Data will be reported in a separate document in the spring of 2009, along with complete data on overall enrollment and graduation trends in CAHSI computer science programs.

- ARGs (Intervention 3)
- Development workshops (Intervention 4)

This report focuses on student outcomes following the establishment of CAHSI interventions in institutions. The more comprehensive report, which describes initiative-specific results, is provided as Appendix A.

2 Evaluation Procedures: Data Gathered and Analytical Methods

2.1 Evaluation Methods

Evaluation methods include observation, interviews (individual and group), surveys, and participation in Alliance meetings. Database analysis, in which student information is analyzed from the fall of 2003 through the spring of 2008, informs the evaluation, and describes the effectiveness of the CAHSI interventions for recruiting and retaining students within computer science. Qualitative data support more nuanced interpretation of survey results. Participation in Alliance meetings allows evaluators to better understand goals and processes and permits sharing of findings from social science and educational research and from other projects the evaluators have contact with. The specific data collections for CAHSI interventions are as follows:

- CS-0: Pre-post student survey and course observations at two institutions
- PLTL: End-of-semester survey for students in PLTL courses and peer leaders, as well as observation in one institution
- ARG: End-of-academic year survey administered to ARG students in April 2008, observation at two institutions
- Development workshop: Survey for all participants, observation, informal interviews

Survey instruments were adapted from existing, reliable and valid instruments when available, though the needs and interests of the CAHSI stakeholders required development of additional measurement tools, specifically for the Peer-Led Team Learning initiative. Also, for comparison purposes, the CAHSI evaluation team was asked to use the survey developed at Georgia Tech to evaluate the CS-0 courses. All fixed response survey items were scored using a 4 point scale, in which 1=strongly disagree, 2= disagree, 3= agree, and 4= strongly agree. Responses indicating that a student was “unsure” or “did not know” were not assigned a score, and the response was dropped from analysis.

Specific research questions regarding ***CAHSI initiative’s effectiveness at recruiting and retaining students, particularly Hispanic students, in computing*** include the following:

1. What are the overall undergraduate computer science/engineering enrollment patterns at CAHSI institutions?

2. Do students who take CS-0 courses later enroll (or concurrently enroll) in CS-1? Do these enrollment and completion patterns indicate any differences by ethnicity, school, major, gender?

3. Are students who successfully complete CS-0 more likely to succeed in CS-1 during their first enrollment? Do these enrollment and completion patterns indicate any differences by ethnicity, school, major, or gender (comparing overall CS-1 one time enrollment success rates with CS-0 students' one time enrollment success rates)?

4. Are students enrolled in PLTL-targeted courses more likely to succeed during their first enrollment after the institution of CAHSI than before CAHSI existed [comparing course success rates for one-time enrollees pre intervention (2004-2005) and post intervention (2006-2007)]?

5. Are students involved in Affinity Research Groups or Affinity Research Group courses exhibiting professional computer scientist behaviors related to their scientific field, e.g. attending professional conferences, presenting original work, publishing in journals)?

Additional research questions specific to ***student experiences in CAHSI initiatives*** include the following:

6. How are students experiencing the CS-0 intervention as a learning environment? Does the course increase or maintain student self efficacy, aspirations, interest, career or academic goals in computing? If so, to what do students attribute the success of CS-0 (e.g. professor, assignments, structure of course, collaboration with peers)? Do any of these impacts differ by gender, ethnicity, school, or student major?
7. How are students experiencing PLTL courses? Does the PLTL intervention increase student (leader and student) self-efficacy, aspirations, interest, career or academic goals in computing? If so, to what do students and leaders attribute the success of PLTL?
8. How are students experiencing ARG? Does the ARG model sustain or influence student interest, self-efficacy, self-reported ability, career or academic goals in computing? If so, to what do students and leaders attribute the success of ARG?
9. How are students and faculty experiencing Development Workshops?

2.2 Data Collection and Analysis

Student database information was collected from Institutional Research Offices of the five institutions currently providing standard CS-0 (UHD, NMSU, UTEP, CSUDH, TAMUCC) and PLTL computing course interventions (UTEP, CSUDH, TAMUCC).[2] All offices were given the same spreadsheet to fill out for each student, including

"student identifier",
"student ethnicity"
"student gender"
"student major as of 2003 or first major",
"student major as of 2008 or graduating major",

[2] NMSU includes a different, voluntary version of PLTL, while UHD has PLTL in their math courses rather than in their computing courses.

“course A enrollment (semester/semesters enrolled or Not Applicable)”
“course A completion (semester/semesters successfully completed or Not Applicable”
(repeated for courses B, C, etc.)

Requests were made in May and June of 2008 and took from three weeks to six months to collect from various institutions. Some institutions did not provide all requested major data, and so documentation of students who switch majors between 2003 and 2008 (or upon first and last enrollment in targeted courses) is incomplete at this time. Requests of overall student enrollment and graduation demographics institution-wide and in computer science were requested in May and again in November of 2008, when the majority of Institutional Research Offices state this information is available. The data from 5 of the 7 schools has been received to date. The trends report will be developed in spring of 2009 when all data become available, though undergraduate enrollment data from the 5 schools are reported below.

Survey data were collected online via the Survey Monkey tool. Instructors administered the survey during their course time. The surveys were reviewed by the CAHSI executive team, a team of experts in the interventions. This review was done to establish content validity and face validity, to ensure that the surveys were measuring what they intend to measure. The quantitative data were entered into the statistical package SPSS where descriptive statistics were computed. Means, standard deviations, and frequencies are reported in the full report, Appendix A. To test for statistically significant differences among various subgroups of the sample, t-tests, one-way analysis of variance (ANOVA), and repeated measures tests were used. Further explanation of quantitative measures and discussion of reliability tests of survey instruments can be found in Appendix C as well. Briefly, student survey reliability measures Cronbach’s Alpha scores are PLTL student = 0.892; PLTL leader=0.792, and ARG= range of 0.69-0.87 on subscales, indicating that the quality of the surveys is strong (0.70 is considered good to excellent in social science research). The CS-0 survey was developed by others, and no published reliability information is available. Evaluators may need to modify this instrument to improve the survey with key indicators for comparison to Georgia Tech considered. Survey instruments may be found in Appendix B.

Write-in responses to open-ended survey questions were entered into a spreadsheet and coded. Each new idea raised in a response was given a unique code name. As later respondents raised these same ideas, a tally was added to an existing code reflecting that idea. At times the write-in answers were brief and counted within one category, but more frequently, responses contained ideas that fit under multiple categories, and these ideas were coded separately. For instance, students may have listed more than one favorite element about the CS-0 course (e.g., completing a course project and working in a group), and these were each counted. Codes were collapsed into broader categories when applicable.

3 CAHSI Initiative Evaluation Results: Student Impact

This section describes the impact of CAHSI initiatives on student enrollment and course completion in computer science/engineering. Specifically, it addresses the following research questions:

- What are the overall undergraduate computer science/engineering enrollment patterns at CAHSI institutions?
- Do students who take CS-0 courses later enroll (or concurrently enroll) in CS-1? Do these enrollment and completion patterns indicate any differences by ethnicity, school, major, gender?
- Are students who successfully complete CS-0 more likely to succeed in CS-1 during their first enrollment? Do these enrollment and completion patterns indicate any differences by ethnicity, school, major, or gender (comparing overall CS-1 one time enrollment success rates with CS-0 students' one time enrollment success rates)?
- Are students enrolled in PLTL-targeted courses more likely to succeed during their first enrollment after the institution of CAHSI than before CAHSI existed [comparing course success rates for one-time enrollees pre intervention (2004-2005) and post intervention (2006-2007)]?
- Are students involved in Affinity Research Groups or Affinity Research Group courses exhibiting professional computer scientist behaviors related to their scientific field, e.g. attending professional conferences, presenting original work, publishing in journals)?

3.1 Overall Undergraduate Enrollment

CAHSI Institutions are not seeing the large declines in enrollment described in the 2008 Computer Research Association Taulbee Survey (Zweben, 2008) of PhD-granting institutions. While the report notes an 18% decline in BA enrollment for computer science and computer engineering, data collected to date from 5 institutions shows that CAHSI schools enrolled 1,106 students in 2006 and 1,088 students in 2007, representing a 1.7% decline in enrollment. When looking only at CAHSI's PhD granting institutions, we find an increase in student enrollment, from 856 to 883 students—a 3.2% increase in enrollment. Schools saw a very modest decline in 2008. While it is unclear why students are enrolling in similar and in some cases greater numbers at CAHSI institutions while numbers are declining elsewhere, CAHSI initiatives that retain students as well as the explosive growth in the number of Hispanic citizens of college age who enroll in HSIs may be contributing factors. See table 1.

School	Year	Total	Gender		White		African-American		Hispanic		Asian-American		Native American		Mexican		Other Internat'l		Other/ unknown	
			M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
BA COMPUTER SCIENCE ENROLLMENT 2006																				
NMSU	2006	166	142	24	78	13	4	1	50	8	4	0	6	2	NA	NA	NA	NA	NA	NA
UTEP	2006	195	164	31	15	0	1	1	105	20	1	0	0	0	37	9	5	1	0	0
CSUDH	2006	141	119	22	13	1	35	8	15	4	16	2	1	0	24	4	7	0	8	3
UHD	2006	109	87	22	28	1	17	6	17	8	13	1	0	0	1	1	11	5	NA	NA
FIU	2006	495	X	X	35	0	47	6	179	24	15	1	0	0	1	0	187		NA	NA
Total BA Enroll		1106			169	15	104	22	366	64	49	4	7	2	63	14	210	6	8	3
BA COMPUTER SCIENCE ENROLLMENT 2007																				
NMSU	2007	170	145	25	86	9	4	1	43	13	6	0	6	2	NA	NA	NA	NA	NA	NA
UTEP	2007	185	156	29	9	1	3	0	108	21	1	1	0	0	27	4	7	2	1	0
CSUDH	2007	94	25	11	4	29	7	14	3	14	5	0	0	20	4	1	0	5	2	0
UHD	2007	109	93	16	32	1	18	5	15	7	16	1	0	0	1	1	11	1	NA	NA
FIU	2007	530	X	X	35	0	47	7	193	19	16	2	0	0	0	0	223		NA	NA
Total BA Enroll		1088			166	40	79	27	362	74	44	4	6	22	32	6	241	8	3	0
BA COMPUTER SCIENCE ENROLLMENT 2008																				
NMSU	2008	172	151	21	90	10	5	0	47	11	4	0	5	0	NA	NA	NA	NA	NA	NA
UTEP	2008	191	152	39	11	2	3	0	110	29	0	2	0	0	0	0	5*	19*	NA	NA
CSUDH	2008	87	18	11	2	25	7	10	2	15	3	0	1	14	1	6	1	6	1	0
UHD	2008	112	96	16	30	5	19	3	17	4	17	2	0	0	1	1	12	1	NA	NA
FIU	2008	486	X	X	31	2	44	5	189	18	16	2	1	0	3	0	175		NA	NA
Total BA Enroll		1048			164	44	78	18	365	77	40	6	7	14	5	7	188	7	1	0

Table 1: CAHSI Institution Undergraduate Computer Science/Computer Engineering Enrollment

3.2 CS-0 enrollment

Five schools currently hold CS-0 courses. In the four schools with current data available, nine hundred and ninety five students have enrolled in CS-0 since 2003, and 865 completed the course. It is important to note that 702 of these students attended UHD, and the majority of these (approximately 565) were receiving dual course credit as high school students. Because of their non-traditional enrollment status, only those who continue at UHD as undergraduates can be tracked into Computer Science 1 courses. Overall, in the four schools with available data, 57 of the students who were successful in CS-0 courses also continued through CS-1 and completed the course. In the next section, student course enrollment and completion patterns are described in detail by school.

Looking at schools other than UHD where student tracking is most difficult, we find 240 students who have completed CS-0, 51 of whom enroll in CS-1 (21% of those who complete CS-0). Of these students, 39 were successful in CS-1 (76%), a rate that exceeds the same four schools' average rate of course success for CS-1 (63.5%). While 65% (156 of 240) of the students who completed CS-0 in this group were Hispanic, 59% of the students who successfully completed CS-1 were Hispanic. This difference was not statistically significant at the 95% confidence level, indicating a near equivalent proportion of Hispanic students continued through CS-0 into CS-1 at these three schools.

3.3 CS-0 Students Recruited into/Retained in Computer Science

3.3.1 CS-0 at CSUDH

Eighty seven students enrolled in CS-0 since 2003, and seventy students completed the course at CSUDH. Over one third of the students were Hispanic (37 of those enrolled, 29 of those completing CS-0) and nearly one quarter were African American (21 of those enrolled, 15 of those completing CS-0). About one third were female (26 of those enrolled, 22 of those completing CS-0), and just over one third were declared computer science majors (35 of those enrolled, 26 of those completing CS-0). The following figure describes the pattern of student recruitment, retention and advancement from CS-0 through CS-1.

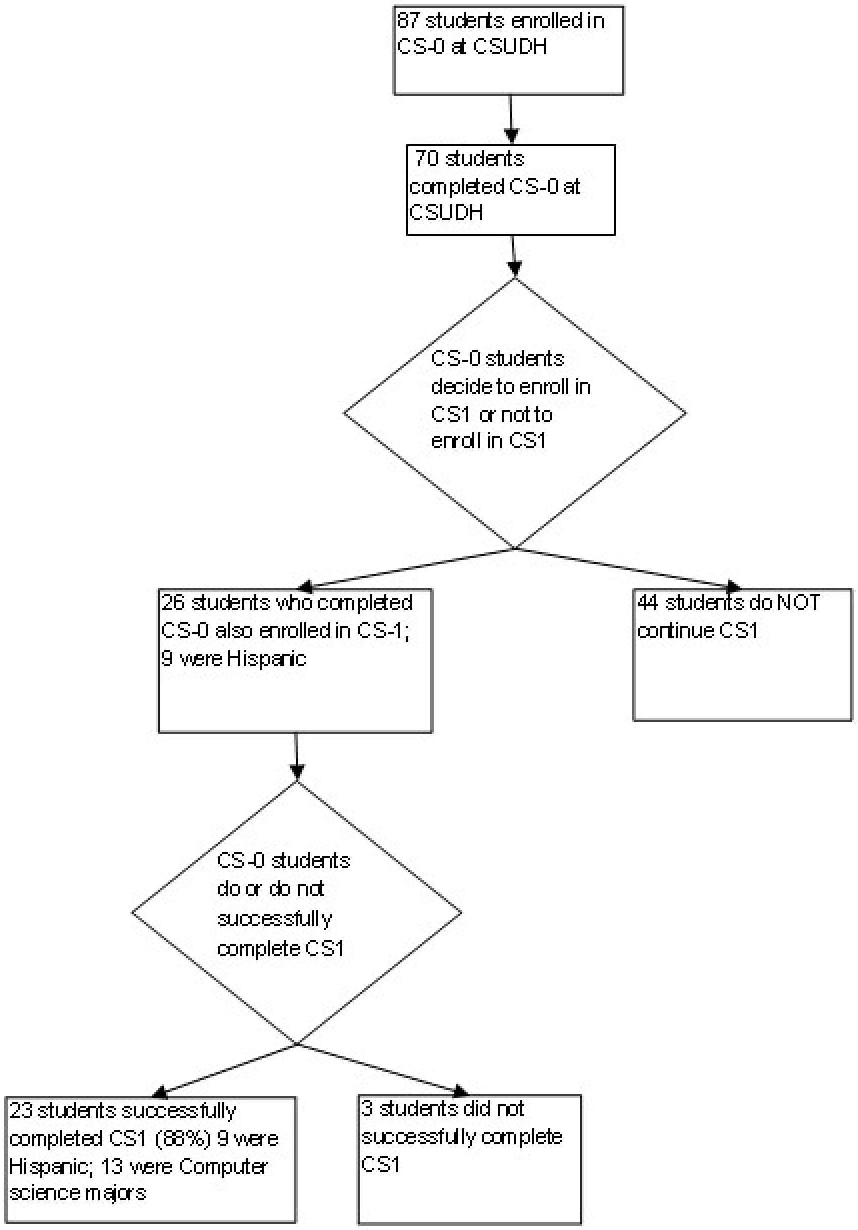

Figure 1: CS-0/CS-1 Course Enrollment and Completion for CSUDH

The figure shows that of the 70 students who completed CS-0, 26 students later enrolled in CS-1, and 23 passed CS-1. This pass rate exceeded the average pass rate for students in CS-1 (56 of 91, or 62%) calculated over 4 semesters pre-CAHSI (fall 2004, spring 2004, fall 2005, and spring 2005). This difference in proportions is significant at the .02 confidence level (z= 2.348), meaning the likelihood that this difference in rate of completion is due to chance is 2%.

In addition to preparing computer science students for higher level programming work in CS-1, the CS-0 course may also be recruiting students into the field. Ten of those students who have completed CS-1 following CS-0 enrollment are from majors other than computer science.

3.3.2 CS-0 at UHD

The University of Houston, Downtown has enrolled the largest number of CS-0 students, the majority of whom took the course through dual enrollment at the high school level. Since 2003, 702 students have enrolled in the course, and 625 students completed it. Following their experiences in CS-0, 29 students continued at UHD in the CS-1 course, and 18 successfully completed the course. Data show that Hispanic students at UHD who enrolled in CS-1 were less successful (40%) than the average completion rate for this group of CS-0 students who continued their computer science studies (62%). It is unclear why that is the case.

The majority of the students who continued from CS-0 into CS-1 were non-computer science majors, indicating that the course had a modest impact on student recruitment into the computing field. Three percent of all students who completed CS-0 also completed CS-1 successfully. The fact that many of these students were high school students at the time of their enrollment in CS-0 makes tracking them through their college experiences very difficult—we have no way of knowing whether students who went to other colleges after graduating high school continued their efforts in computer science. See figure 2 below.

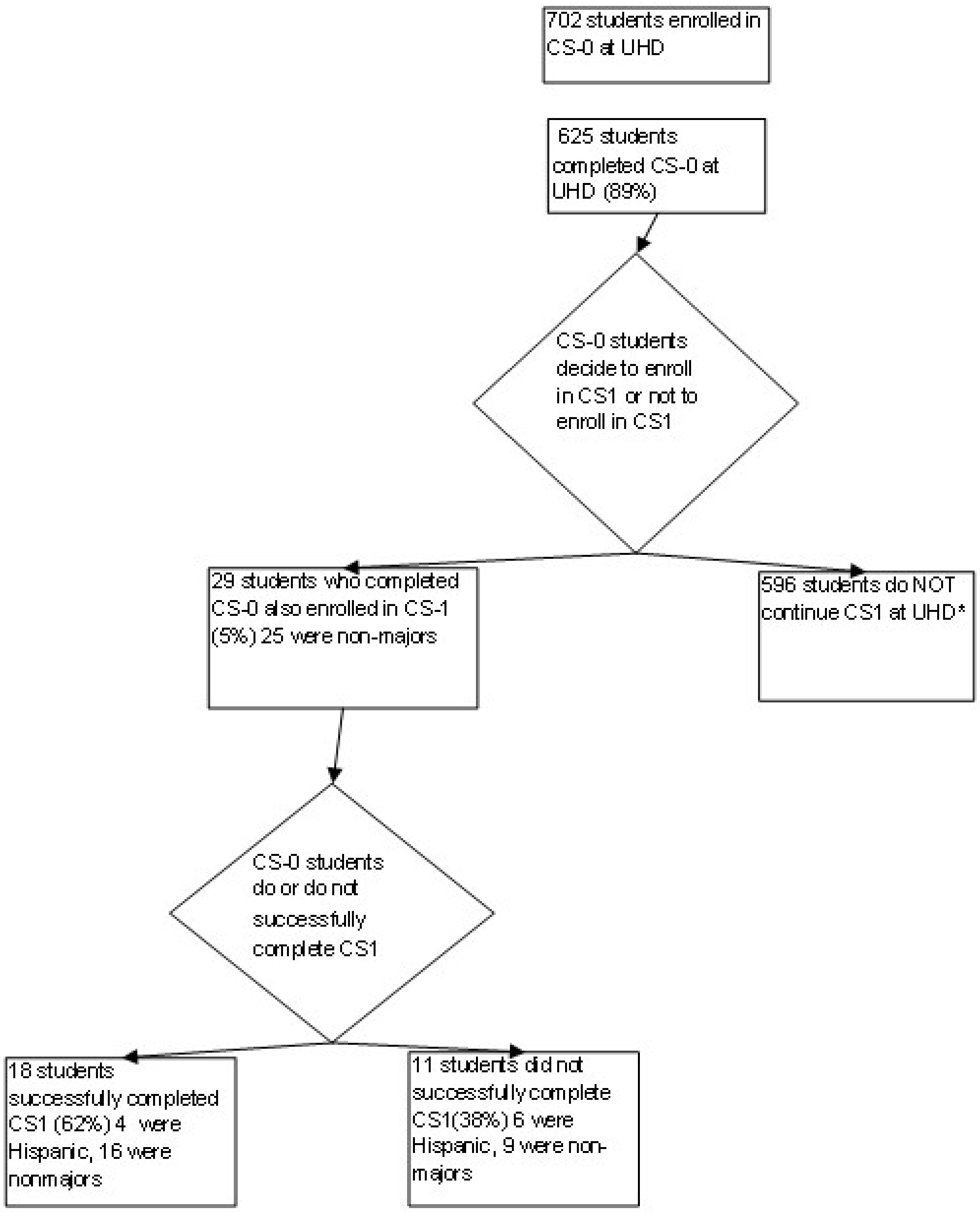

Figure 2: CS-0/CS-1 Course Enrollment and Completion for UHD

3.3.3 CS-0 at UTEP

One hundred seventy four students have enrolled in CS-0 courses at UTEP since 2003, and 147 completed the course, the majority of those completing CS-0 were Hispanic non-computer science majors (109,74%). Of these, 21 (14% of those completing CS-0) students enrolled in CS-1 following their efforts in CS-0. Fourteen of the students completed CS-1 successfully, as of the spring 2008 semester, and 12 of these students were Hispanic. The rate of completion for CS-0 students engaged in CS-1 courses (67%) was similar to the average baseline rate of CS-1 course success determined over four pre-CAHSI semesters (212 of 312, or 68%). While this seems to suggest that CS-0 did not assist students in succeeding in CS-1, it is important to note that all but one (8 of 9) of the computer science majors successfully passed CS-1 following CS-0. Also, four non-majors succeeded in CS-1. We will follow these students to see if they were successfully recruited into computer science.

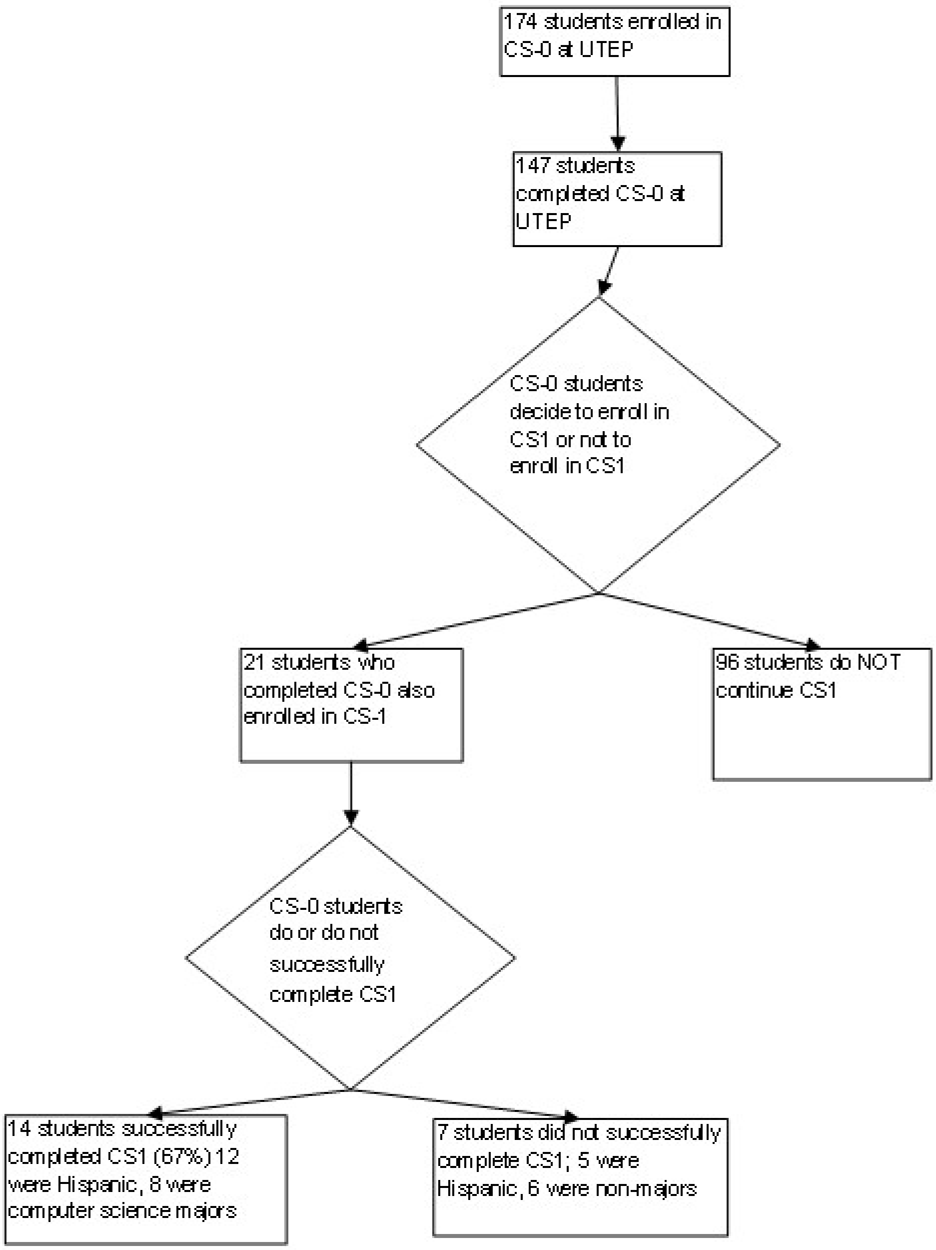

Figure 3: CS-0/CS-1 Course Enrollment and Completion for UTEP

3.3.4 CS-0 at NMSU

New Mexico State University has implemented CS-0 into their curriculum as an elective for students from all majors. Billed as an animation course, the class has enrolled students from art, business, computer science, liberal arts, and science backgrounds. The course is labeled CS 209, a special topics in computing designation. Unfortunately, CS 209 is a course designation given to other computer science courses. For example, during semesters when CS-0 was instituted, the courses “Online Communities” and “Media Literacy” were also offered with the same course number. At present, it is impossible to discern from our data which course students took, CS-0 or another computing course. We are working with the Institutional Research Office at NMSU to clarify the data. Focus group and interview data suggests that 2 to 3 students may have completed CS-1 concurrently with CS-0. This information will be added to our report when available.

3.3.5 CS-0 at TAMUCC

Texas A& M University, Corpus Christi is the latest school to adopt CS-0 into the curriculum. To date, 32 students have enrolled in CS-0, and 23 completed the course, 12 of the students were Hispanic. Of them, 4 enrolled in CS-1 since their experience in CS-0. Note that these four come from one section of CS-0, taught in the fall of 2007, as they are the only students for whom we have an additional semester of course data beyond their CS-0 enrollment. Of these students, 2 successfully completed CS-1 to date, and both were Hispanic males. See figure 4 below. We will continue to track those students who have completed CS-0 into their future semesters, to see if they later enroll and succeed in CS-1.

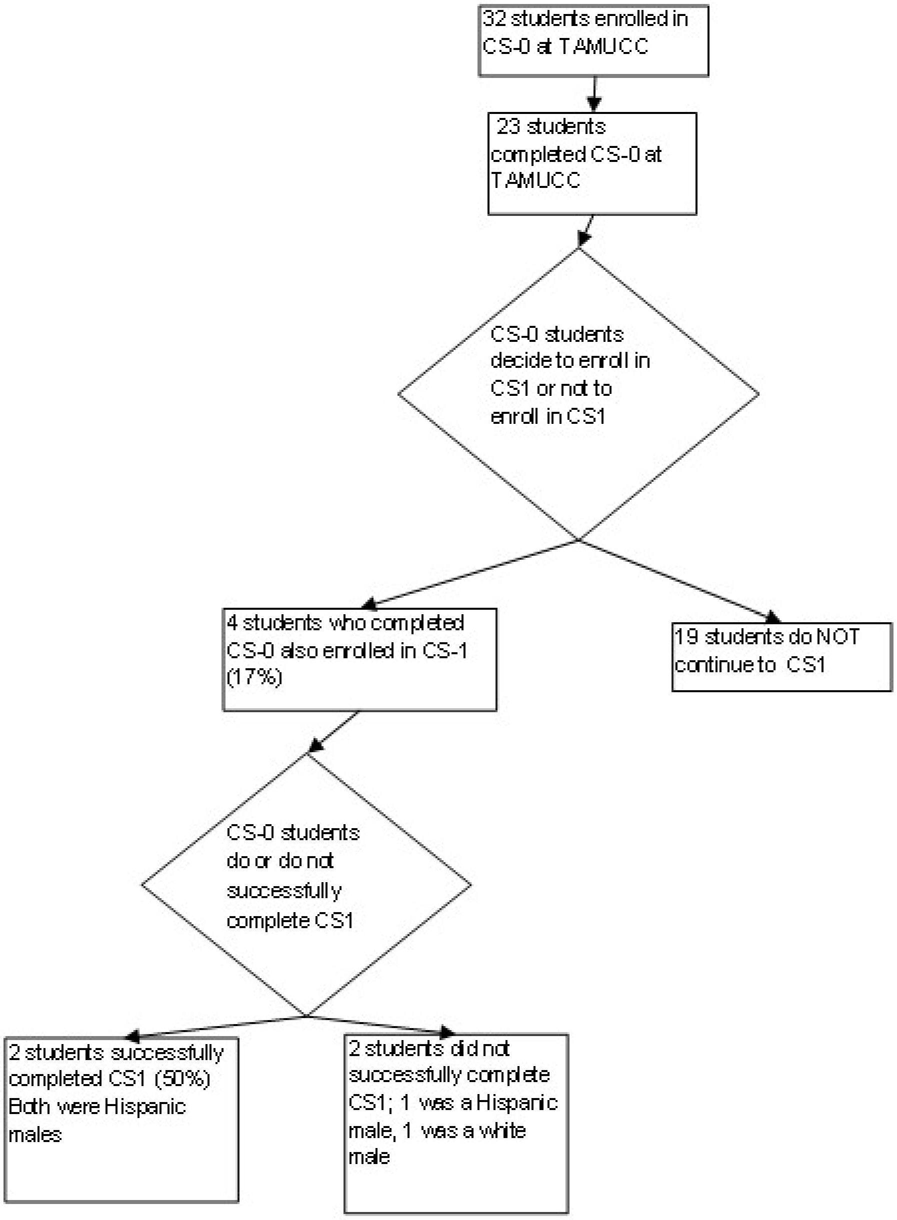

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Figure 4: CS-0/CS-1 Course Enrollment and Completion for TAMUCC

3.4 Discussion of CS-0 evaluation results, challenges, and next steps

CS-0 varies widely across CAHSI institutions, perhaps the most of all CAHSI interventions. The role the course plays at an institutional level varies from an enrichment elective, to a recommended pre-requisite for computer science 1, to a dual enrollment course for high school students, to a core course for all students at an institution. It is unclear what an acceptable or "good" rate of recruitment into computer science would be, and it is evident that we do not have access to all of the data necessary to measure recruitment into CS-1 (e.g. students who leave institutions for other institutions, high school students who enroll in new colleges upon graduation). As more students are added to the data base, and as students have more opportunities to take CAHSI intervention courses, we will know more about the impact of these interventions on recruitment and retention within computer science/engineering.

One avenue for future data collection is the rate at which students from CS-0 enroll in computing majors outside of CAHSI departments, such as electrical engineering, computer engineering (when CAHSI departments are computer science), computer science (when CAHSI departments are computer engineering) and information systems. Adding the introductory courses in these computing fields to our database may indicate that CS-0 students remain in computing fields at a higher rate than is indicated by the current CS-0 data. According to UTEP faculty, the CS-0 course at their institution includes a career advising component, in which students may be directed towards information systems degrees. Currently, we are not capturing the success of those students in computing. As the BPC alliances are focusing on computing careers more generally than in the field of computer science alone, the addition of underrepresented students in these courses would also signify an increase in the computing talent pool.

3.5 PLTL Intervention: Retaining students through peer teaching, learning

The primary goal of Broadening Participation in Computing (BPC) Alliances like CAHSI is to increase or contribute to the increase of students obtaining computing degrees and the number of students pursuing advanced degrees in computing fields. This section explores the ways the PLTL intervention is assisting students in their computing studies. Data reported here cover three institutions, and pertain only to computing courses that fulfill requirements for the computer science major at the institutions. PLTL is offered in some institutions for math courses for computer science majors. This data was not included in this report, because the mathematics department is not directly involved in CAHSI.[3]

3.5.1 PLTL and first time enrollments- Improving successful completion of computing courses

In this section, we explore the success of students who enroll one time in CAHSI target courses. The students described in this section either complete the computer science course successfully in the first attempt or they are unsuccessful (meaning they drop the course or fail the course) and they do not reenroll.[4] This second group of students is a selection of students lost to other majors, or other interests. The table indicates the number and proportion of students who have successfully completed PLTL targeted courses before and after the CAHSI intervention.[5]

[3] The evaluators acknowledge the importance of success in mathematics courses, particularly calculus based courses, for success in the computing major, and feel further study of this practice in mathematics may be an essential addition to future CAHSI efforts.

[4] The students who do in fact reenroll in the course are described in following sections of the report

[5] Asterisks * indicate the difference from 2004 to 2007 was statistically significant

	2004			2005			2006			2007		
	number successful	number enrolled	success ratio	number successful	number enrolled	success ratio	number successful	number enrolled	success ratio	number successful	number enrolled	success ratio
US Hispanic females first enrollment	42	55	76%	35	43	81%	56	73	77%	64	73	88%
US Hispanic males first enrollment	126	171	74%	130	177	75%	164	198	83%	161	198	81%
US Hispanic student total	168	226	74%*	165	220	75%	220	271	81%	225	271	83%*
Non-Hispanic females first enrollment	42	54	78%	36	49	73%	36	52	69%	31	43	72%
Non-Hispanic males first enrollment	148	195	76%	166	202	82%	166	194	86%	119	148	80%
Non Hispanic student total	190	249	76%	202	251	80%	202	246	82%	150	191	79%
All students first enrollment	358	475	75%*	367	471	78%	422	517	82%	375	462	81%*

Table 2: CAHSI Institution Student Course Completion Rates for One-Time Enrollees

The proportion of students who enrolled once in CAHSI target courses and were successful upon their first enrollment increased from 2004 to 2007. This difference was significant for Hispanic students (z=2.135) and for all student groups, though differences among non-Hispanic students were not statistically significant. This information indicates that PLTL interventions are particularly supportive of Hispanic students' achievement in computer science. In other words, more Hispanic students are passing computer science major courses upon first enrollment since the inception of CAHSI than before CAHSI.

3.5.2 Multiple enrollment students- How are struggling students faring in CS courses?

The above data took into account all students who enrolled one time in a CAHSI course. Not all computer science students complete or drop their courses after one semester—it is common for students to drop or fail a course and reenroll in the same course later in their academic careers. In order to compare the rates, pre and post CAHSI, at which students successfully complete courses for which they enrolled multiple times, students were separated into three groups. The numbers indicate numbers of students who were enrolling in a single target course multiple semesters during pre-CAHSI semesters, students enrolling before and after CAHSI's inception in 2006, and students enrolling in CAHSI target courses multiple times since 2006. Each student enrolled in targeted CAHSI courses for 2 to 5 semesters, though each student is counted only once in these figures. See Figure 5 below.

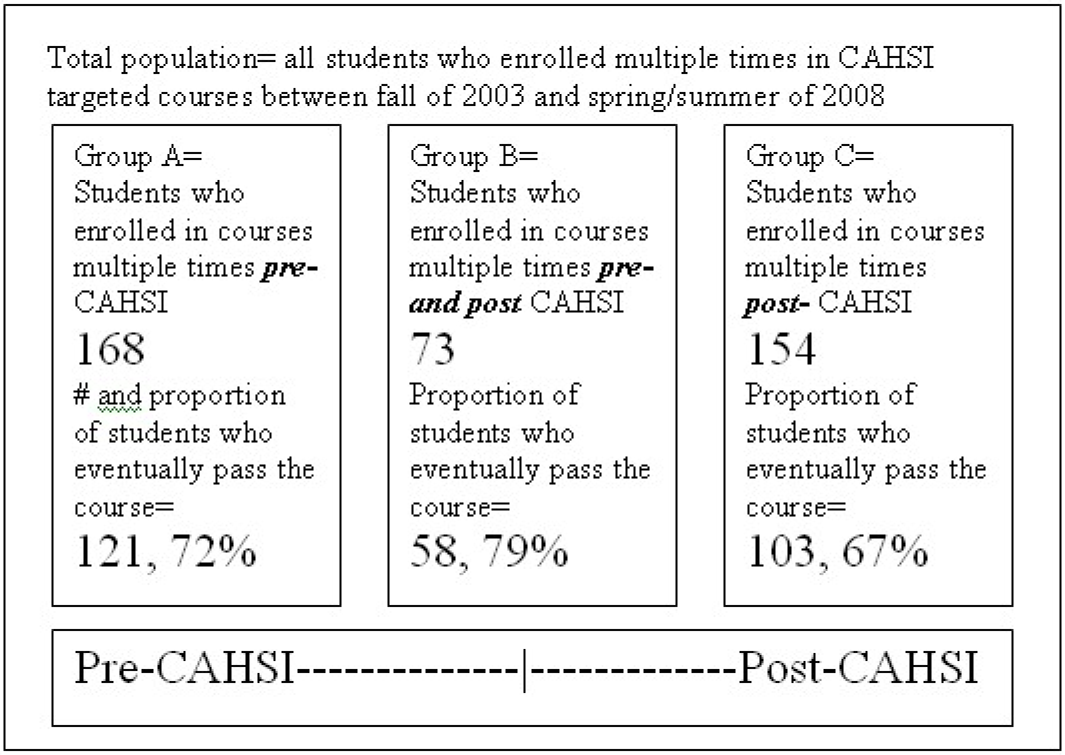

Figure 5: Multiple Enrollment Students' Eventual Success in Targeted CAHSI Courses

These data indicate that students who enrolled in CAHSI target courses multiple times before the CAHSI initiative had a 72% eventual success rate, meaning that 121 of the 168 students who enrolled multiple times in a course were able to pass it between 2003 and 2005. As CAHSI interventions took hold, the rate of student success increased to 79% for group B students, who enrolled and passed target courses between 2003 and 2008. This indicates that CAHSI interventions may have boosted student achievement for those who needed extra opportunities to learn the material in target courses. For students enrolling during CAHSI years, the data reflect a slightly lower rate of completion; though time is a factor in viewing these figures, as is the relative success of students who enroll one time in CAHSI interventions (see above section). Students who enrolled in a course in fall of 2007 and spring of 2008 may reenroll and succeed in the fall of 2008, for example, and thus be included in the number of successful students. In other words, the proportions for Groups B and C are dynamic, and may increase in future semesters. Note that these differences in proportions are not statistically significant, meaning these differences may be due to chance. Continuous monitoring of students who enroll multiple times in courses is essential to the evaluation of CAHSI.

3.5.3 PLTL and Student Retention: Patterns of Student Success

The CAHSI initiative is increasing the number and proportion of students successfully completing the target computer science courses at CAHSI institutions. While first time enrollees, particularly Hispanic enrollees, are more successful completing courses, those who take additional course time to succeed are progressing at a similar rate than in pre-CAHSI years according to data collected to date. As students in groups B and C continue to enroll and succeed in targeted courses, we may see an increase in the rate at which multiple enrollment students complete computer science coursework. This data will be collected again in the summer of 2009. As additional institutions and courses adopt CAHSI interventions, and as the PLTL leaders, faculty, and staff become more comfortable with the intervention, we may see greater impact on student success.

3.6 ARG Students' Apprenticeship in the Field of Computing

Affinity Research Groups are affording students opportunities to join in behaviors associated with high-level, scientific research practice. Through their collaborative work with more experienced researchers (other undergraduates, graduate students, staff, and faculty), ARG students have access to *legitimate peripheral participation*; in essence, they get a glimpse into the lives and work of research scientists as they perform some of the important tasks of research (Lave & Wenger, 1991). This report highlights the demographic and experiential details of ARG students, and the activities they engage in that display their apprenticeship into scientific research. For more details on students attitudes and aspirations in computer science, please see the full report in Appendix A.

Overall, 98 Affinity Research Group (ARG) students completed a survey about their personal, professional and intellectual gains from participation in research: 32 students in spring 2008, 34 students in summer 2008, and 32 students from the research course at University of Puerto Rico, Mayaguez. Survey responses were received from UTEP (34% of student participants), TAMU-CC (9%), UHD (2%), CSU-DH (12%), NMSU (7%), and UPRM (36%--all but three of these students participated in the research course).

ARG students were primarily undergraduates, with a few graduate student participants. Undergraduate students tended to be upperclassmen. Only 2% of ARG students were 1st year students, 9% were 2nd year students, 16% were 3rd year students, 26% were fourth year students, and 34% were 5th year undergraduates. In addition, 10% were master's students, and 3% were Ph.D. students.

Many ARG students were relatively inexperienced researchers. Two-thirds of students had only completed 1-2 semesters or summers of research. A little less than one-quarter of students had completed 3-4 semesters or summers of research, and the remainder had completed 5 or more semesters or summers of research.

ARG students were predominantly Hispanic (76% of students). The remainder was Caucasian (11%), Asian (6%), mixed race/ethnicity (4%) or African-American (3%). ARG students were also predominantly male (77% of students). The gender representation of ARG students is consistent with the national average: in 2005, 22% of bachelor's degrees in computer science were awarded to women (NSF, 2006). Finally, 61% of students were computer science majors, while the rest were computer engineering majors.

Most ARG students had the opportunity to participate in professional forums in their field of interest. Over two-thirds of students attended a professional conference within the past year. Less often, students had the opportunity to present or publish their results; however, our prior research on UR has shown that these accomplishments are rare for undergraduates (Hunter et al., 2007; Seymour et al., 2004). Nevertheless, over one-third of ARG students presented a poster at a conference in the past year, 18% of students authored or co-authored a journal manuscript, and 10% presented a conference paper. Therefore, ARG students seemed to have had ample opportunities to engage in authentic research that led to publishable results. Access to "real-world" research is essential for socializing students into the profession and producing the strongest intellectual and professional gains (Thiry et al., 2009). See Table 3 below.

Professional activity undertaken in the past year (n=98)	Number of students	Percentage of students
Attended a professional conference	64	65%
Authored or co-authored a journal paper	18	18%
Presented a conference paper	10	10%
Presented a poster at a professional conference	37	38%

Table 3: ARG Students' Achievements in Scientific Research

4 CAHSI Initiative Evaluation Results: Student Experiences

In this section, we detail formative assessment data regarding students' experiences in CAHSI initiatives. Specifically, we address the following research questions:

- How are students experiencing the CS-0 intervention as a learning environment? Does the course increase or maintain student self efficacy, aspirations, interest, career or academic goals in computing? If so, to what do students attribute the success of CS-0 (e.g. professor, assignments, structure of course, collaboration with peers)? Do any of these impacts differ by gender, ethnicity, school, or student major?
- How are students experiencing PLTL courses? Does the PLTL intervention increase student (leader and student) self-efficacy, aspirations, interest, career or academic goals in computing? If so, to what do students and leaders attribute the success of PLTL?
- How are students experiencing ARG? Does the ARG model sustain or influence student interest, self-efficacy, self-reported ability, career or academic goals in computing? If so, to what do students and leaders attribute the success of ARG?

4.1 CS-0 Recruiting and Retaining Students in Computer Science

4.1.1 Overview

The Computer Science Zero (CS-0) course is designed to introduce students to computer science in a relaxed, collaborative environment, utilizing visual, incremental programming languages to stimulate creativity and interest in the computing discipline. Students enrolled in this course at CAHSI institutions are asked to take pre and post course surveys focusing on student attitudes, interests, aspirations, and behaviors regarding computing and computing-related activities. The data described in this report include data from 321 students who completed the CS-0 course in the spring of 2008 and fall of 2008. There were a total of 145 matched cases, in which data was available from both pre and post tests. It is unclear why so many students were lost from the data set, though courses do tend to get smaller as students solidify their schedules from the beginning to the end of the course, and students may choose after taking the first survey that they would prefer not to take the post-survey.

4.1.2 Social Cognitive Career Theory- A Framework for understanding the CS-0 intervention

The purpose of the CS-0 intervention is to increase or contribute to the increase of the number of individuals earning computing degrees, with an emphasis on increasing diversity among computing professionals. Lent, Brown and Hackett (1993) explored individuals' career aspirations and attitudes, and found that a variety of interconnected factors influence the careers individuals ultimately choose.[6] Evaluators collect data regarding student factors (gender, ethnicity) and background/contextual affordances (student experiences in computing, parental education attainment). In order to measure the effect of CS-0 we ask students about the following factors in career choice behavior, particularly how these factors change or are maintained during the course:

The quality of their ***learning experiences*** in CS-0,

Their ***self efficacy*** (or feelings of capability and confidence) in computing,

Students' reported ***interest*** in computing and computing activities,

Students' self reported ***choice goals*** regarding computing careers (e.g. intent to major, intent to minor in computing)

And

Students' ***computing performance*** in the course.

[6] SCCT is a tested model used to describe career choice; all factors in the listed model have been shown in previous educational and psychological literature to be statistically significant factors in career decision making and related behaviors (e.g. choice of major) (Lent, Brown, & Hackett, 1993; 2000; Lent & Brown, 1996)

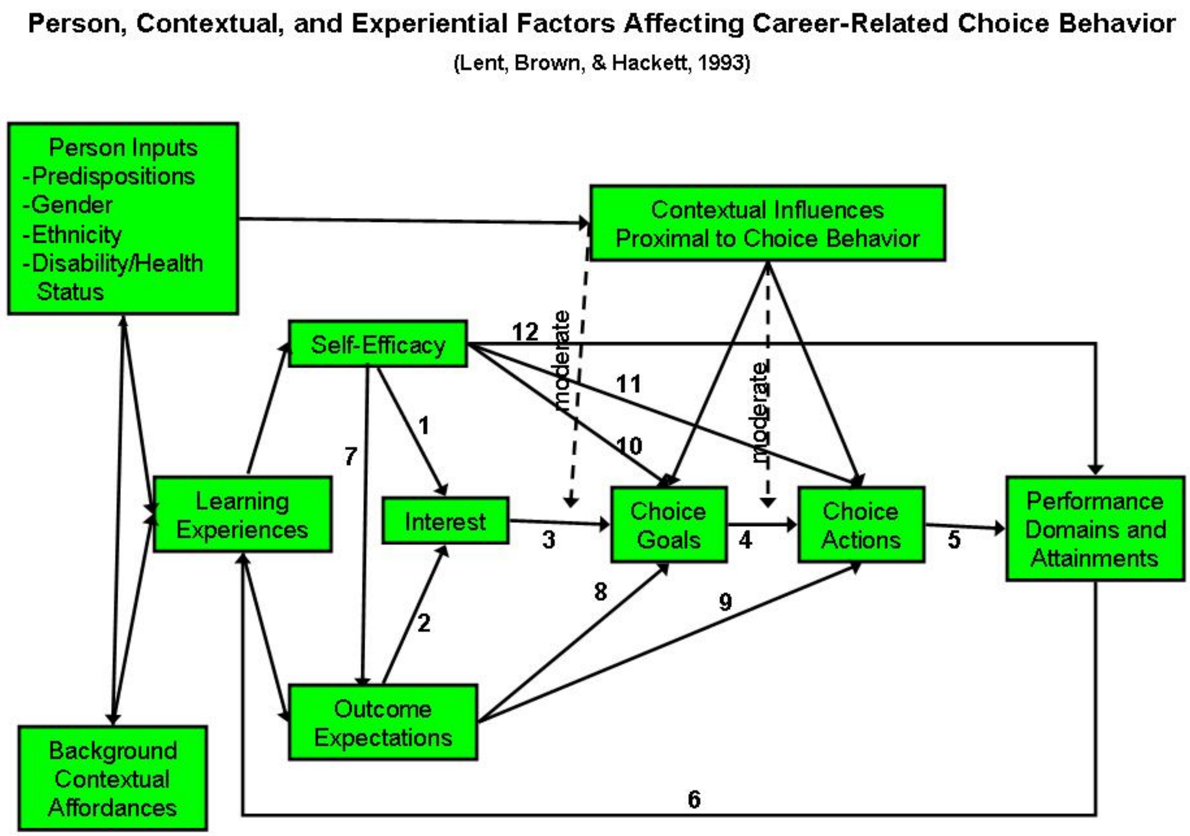

Figure 6: Social Cognitive Career Theory map of Career-Related Choice Behavior (Lent, Brown, & Hackett, 2005)

The figure above describes the factors that influence individual's choice goals and choice actions regarding careers. The arrows indicate the direction of influence; for example, the theory postulates that background contextual factors (such as high school experiences) affect a person's learning experiences, which in turn shape student self confidence in the target career field and expectations of doing well in the career field. The next sections describe student experiences and background with computing, then focus on the ways in which CS-0 influences students' career-related choice behaviors.

4.1.3 Student factors

Survey respondents represented 5 CAHSI institutions (UTEP, TAMUCC, NMSU, CSUDH, and UHD). This demographic data is based on pre-survey responses, as it gives a more complete picture of the students who enroll in CS-0. A significant majority attended UTEP (65). This is not surprising, as UTEP holds multiple sessions of CS-0 each semester, while other schools hold only one. Most of the students were underclassmen (129 freshmen, 76 sophomores), and only one third of CS-0 students were in their third, fourth, or fifth year of undergraduate studies, and two students were earning graduate degrees. Just over half of the 321 pre-survey respondents for CS-0 in 2008 were Hispanic (50.3%), and nearly two-thirds are male (192, 63%). Nearly half of the students were computer science majors (144, 45%).

4.1.4 Background/Contextual Affordances

In high school, only one fifth of students took a calculus course (n= 65). This is significant because mathematics background is vital to computer science success in college. Similarly, only one fifth of the students in CS-0 took a computer programming course in high school (n=66, 21%), though nearly three quarters took a course that had to do with technology (e.g. keyboarding, web design, Microsoft Office) (n=238, 74%). These data correspond with Margolis' recent findings regarding the notion that students from underrepresented ethnic groups are granted fewer opportunities to study computer science in high school (Margolis, 2008).

Despite their lack of high school programming options, 22% (n= 72) of the CS-0 students had programmed a computer at the time of the CS-0 pre-test, predominantly java and C/C++. Besides those who learned to program in high school, this discrepancy could be due to college experiences before CS-0, or to student-initiated learning. More than half of students did have experience editing video, music, and images, however. CS-O builds on these interests in multimedia to create avenues for student programming exploration.

New items were added to the post-survey in the fall semester regarding students' parental education and students' affiliation with a family member who is an engineer. Only 73 responses were recorded for this report, though these items will be collected each semester in 2009. Over half of students' mother and father figures attended some college (36 of 70 fathers, 47 of 72 mothers described by students). Similarly, nearly half of the students had family members working in engineering—thirty four of the 73 respondents (47%), according to survey results.

Background and context data supports the notion that students enrolled in CS-0 may be ill-prepared for formal college computer science 100 level courses. Students overall do not have the mathematical or programming experience to succeed in CS-1, and so CS-0 seems to be the appropriate placement for this group of less prepared students. As CS-0's goals include recruitment and retention, it will be important to not only measure computer science students' enjoyment of the course, but also to monitor non-majors' changes in attitude toward the computer science discipline.

4.1.5 Contextual Influences Proximal to Choice Behavior

Over half of the students in CS-O work outside of school commitments (n=188 of 306 responding to this item, or 61%), most of them work off campus and nearly one-fifth of those who work do so at least 31 hours per week. Students also report multiple obligations outside of school, such as familial responsibilities, military duties, church, club, and sports commitments, and entrepreneurial ventures.

This information supports the CAHSI initiative's hypothesis that the students enrolled in their schools would benefit from much in-class time for programming, as students' time outside of class is so limited. These external obligations may hinder student success in a demanding major, particularly in programs where obsessive programming and many hours spent in computer labs is the norm (Margolis & Fisher, 2002).

4.1.6 Student Learning Experiences

CS-0 survey respondents described their learning experience, particularly their comfort with their instructor, the extent to which aspects of the class assisted their learning, and their engagement in different activities. This and the following sections describe data collected from matched pairs of survey respondents, as they focus on experiences in the course, and in many cases are compared before and after they complete the course. See Table 4.

CS-0 Students Rate Their Learning Experience	
Survey Item	**Number of Students who Agree or Strongly Agree (n=146)**
The professor increased my interest in this course.	**126(86%)**
The class environment was conducive to asking questions.	**134(92%)**
Attending lectures helped me learn in this course.	**134(92%)**
Doing homework helped me learn in this course.	**132(90%)**

Table 4: CS-0 Students' Perceptions of their Learning Experience

Students found the course engaging—they mention that their professors increased their interest in the subject matter, and that the lectures and homework helped students learn course material. They also felt comfortable asking questions about the course material.

The survey asked students to rate the difficulty of different elements of the course. Student responses centered in the middle (around the "easy" and "difficult" selections, rather than "very easy" and "very difficult"), with a slight majority stating the course labs, exams, homework, and quizzes were easy. This is significant in a difficult discipline, in that it is encouraging for students with insubstantial computing background. However, the ease of the course may inflate student confidence in continued computer science study.

CS-0 Students' Course Content Preferences			
	I would prefer MORE of this	**No change**	**I would prefer LESS of this**
Manipulation/creation of graphics and sounds	67 (53%)	52 (41%)	7 (6%)
Designing and modifying of programs	49(39%)	68 (54%)	9 (7%)
Relevance of these projects to my intended career	57(46%)	64 (51%)	4 (3%)

Table 5: Students' Course Content Preferences

According to survey results, CS-0 students couldn't get enough of media manipulation—they would prefer even more opportunities to create novel graphics and sounds. Similarly, few course takers would have decreased the amount of programming presented in CS-0 courses, and many would have appreciated more chances to program. See Table 5.

Students would also like to see more connections between what they are learning and their intended careers. Students may not recognize the application of computer science in their chosen areas of interest. CS-0 might introduce interdisciplinary careers that are highly technical while intersecting with other fields (e.g. bioinformatics, artificial intelligence) to show students how they might pursue their passions and computer science simultaneously.

4.1.7 Computer Science Related Self-efficacy

The best way we have to measure students' developing computer science self efficacy, or his or her belief about his or her computing capability, is to compare their pre and post-survey scores on confidence-related items. Matched scores indicate that students who took both surveys experienced a *statistically significant increase* in confidence in their computer programming ability and their mathematics ability. See Table 6.

Comparison of Students' Pre-test and Post-test Ratings of Confidence				
Survey Item (n=145 matched tests)	**Pre-test mean**	**Post-test mean**	**T-score**	**Significance (2-tailed)** [* indicates statistically significant differences]
I am confident in my computer programming ability	**2.53 (disagree/agree)**	**3.10 (agree)**	**7.39**	**0.000..***
I am confident in my math ability	**2.88 (disagree/agree)**	**3.06 (agree)**	**2.95**	**0.001***

Table 6: Comparison of Pre test and Post test Ratings of Student Confidence

4.1.8 Gendered Differences in Reported Self Efficacy—CS-0 Shrinks a Gap

Women and men scored differently on both of these confidence, or efficacy, measures in the beginning of the course, but following CS-0 women and men did not differ significantly in their computer programming confidence, or computing self-efficacy. See Table 7, in which tests with asterisks indicate differences are statistically significant.

Gender Differences in Pre and Post-survey Self-Efficacy Ratings				
Survey Item (n=145 matched tests)	**Mean score for Males (85 responses)**	**Mean score for Females (45 responses)**	**T-score**	**Significance (2-tailed)** [* indicates statistically significant differences]
PRETEST				
I am confident in my computer programming ability	**2.76**	**2.24**	**4.428**	**0.000…***
I am confident in my math ability	**3.02**	**2.75**	**2.656**	**0.008***
POSTEST				
I am confident in my computer programming ability	**3.11**	**2.98**	**1.146**	**0.254**
I am confident in my math ability	**3.21**	**2.82**	**2.93**	**0.004***

Table 7: Gender Differences in Pre and Post-survey Self-Efficacy Ratings

Students in the post-survey were also asked to report if the CS-0 course affected their confidence in computing. Seventy percent (102 of 143) of the students who responded to this item said that the course did affect their confidence. While a small number of students mentioned that the course experience decreased their confidence, the remaining students explained in open-ended items how the course positively impacted their computing self-efficacy. Additionally, some of the students who said the course did NOT affect their confidence reported that they already exhibited high confidence in this area.

An important element for success in computing academic programs is confidence—student confidence is a better predictor of retention in the major than GPA (Margolis & Fisher, 2003). CS-0 courses positively impact student confidence in computer science for most students. According to survey results, 70% of respondents (78 students) said that the course affected their confidence in using computers. Open-ended responses indicate that many of those whose confidence was not affected by the course already had high confidence in their computing abilities.

4.1.9 Student interest in computing

In the post-survey, students were asked to describe their change in interest in a variety of computing-related activities. See Table 8.

CS-0 Students' Change in Computing Activity Interest			
	I am more/much more interested now	**No change**	**I am less/much less interested now**
Writing computer programs	65 (53%)	42 (34%)	15 (12%)
Using computer applications to do work	72 (59%)	42 (34%)	8 (7%)

Assembling, configuring, or diagnosing computers and their installations	57 (48%)	54 (45%)	8 (7%)
Using computer applications to edit multimedia	87 (71%)	27 (22%)	8(7%)
Specifying what a computer program will do	74 (61%)	34 (28%)	11 (9%)

Table 8: CS-0 Students Change in Computing Activity Interest

As is evident in the data above, students became increasingly interested in computing activities, including programming, following their experiences in CS-0. This is indeed significant because student interest in related activities is imperative for choosing a career in a given discipline. The data also support the notion that editing multimedia is an engaging way to introduce computer science to students—87 of those who took CS-0 were more interested in this activity after the course.

Students were also asked to rate their interest in careers that had computing-related characteristics. While no differences among Hispanics and non-Hispanics were detected, women and men differed significantly on one measure of career interest. Women were more likely to state they would like to "have the flexibility to 'design your own solutions' to problems" (mean score for men= 3.34, mean score for women 3.64, alpha level =0.019).

CS-0 Student Interest in Computing Career Elements		
Item Description	**Number of respondents**	**Mean score (out of 4)**
Having constructed and completed the project	143	3.50
Analyzing the principles required to solve the problems	143	3.31
Having the flexibility to "design your own" solutions	142	3.44
Recognizing how the solutions you developed could be helpful to others (as appropriate to the project)	140	3.37
Focusing on the details necessary to perfect your solutions	142	3.40
Directing others in completing the project	131	3.27
Writing computer programs	122	3.53
Using computer applications to do work	122	3.68

Assembling, configuring, or diag2sing computers and their installations	119	3.58
Using computer applications to edit multimedia (sounds, pictures, video, animations)	122	3.98
Playing games with computers	120	3.93
Specifying what a computer program will do (e.g. designing the characters or storyline of a game)	119	3.79

Table 9: CS-0 Student Interest in Computer Career Elements

Describing computation as a means to design your own solutions may be an effective recruiting message for women, as following CS-0, women responded more positively to this computing career characteristic.

4.1.10 Choice goals in computing

Students' aspirations in computing stayed nearly the same from the beginning to the end of the course. Paired t-tests with students' pre and post test scores showed no statistically significant differences between pre and post test goals to major in computing, take more computing courses, or to earn a graduate degree in computing. In other words, the variation in the average scores of pretest and posttest items was not statistically significant. Differences were detected, however, between males and females. See Tables 10 and 11, below.

Student responses regarding choice goals in computing in Pre and Post-surveys				
Survey Item	**PRETEST**	**POSTTEST**	**T-score**	**Significance (2-tailed)** [* indicates statistically significant differences]
How likely are you to major in computing?	**2.72**	**2.63**	**1.26**	**.211**
How likely are you to take more computing courses?	**3.18**	**3.08**	**1.30**	**0.20**
How likely are you to pursue a graduate degree in computing?	**2.60**	**2.54**	**0.74**	**0.46**

Table 10: Student responses regarding choice goals in computing in Pre and Post-surveys

Male and Female student responses regarding choice goals in computing				
Post Test Survey Item	**Mean score for Males**	**Mean score for Females**	**T-score**	**Significance (2-tailed)** [* indicates statistically significant differences]
How likely are you to major in computing?	**2.86**	**2.16**	**3.19**	**0.002***
How likely are you to take more computing courses?	**3.25**	**2.74**	**2.62**	**0.010***
How likely are you to pursue a graduate degree in computing?	**2.79**	**2.07**	**3.42**	**0.001***

Table 11: Male and Female student responses regarding choice goals in computing

Hispanic students had aspirations that were in line with students of other ethnicities- these differences were not significant before or after the course at the alpha .05 level. While the fact that student aspirations did not change after CS-0 may seem to be negative results, the fact that students are still engaged in computing following their first programming course is significant, as it implies students are being retained in the subject.

Females rated significantly lower than males in their intention to pursue a degree in computing before and after the intervention. This is the case even though their rating scores for nearly all interest, experience of the learning environment, and other computer science-related items on the survey did not show significant differences. In other words, it seems the intervention is experienced similarly by males and females, but that the *impact* of the experience does not lead women to become as interested in computing choice goals as men.

4.1.11 Student Performance

Student performance is measured in CAHSI evaluations of CS-0 through students' self-report of skill attainment as well as through student level data collection regarding student successful completion of future computer science courses. See Section 3 fro more information on student course success. In the survey, students reported that they learned skills from the course that will be useful to them later in life (n=141, mean= 3.17 out of 4), that they learned technical skills from CS-0 (n=143, mean=3.24 out of 4), and that they developed problem solving abilities in the course (n=143, mean = 3.08 out of 4). These average scores correspond to an "agree" response. There were no statistically significant differences by gender or ethnicity. See Table 12.

Student Responses to Post-survey Items Regarding Computing Performance			
Item Description	**N**	**Mean**	**Number and Percent who Agree or Strongly agree**
I learned skills from this class that will be useful in other areas of my life.	141	3.17	124 (88%)
I learned technical skills from this class.	143	3.24	133 (92%)
I developed my problem solving abilities in this course.	143	3.08	124 (87%)

Table 12: Student Responses to Post-survey Items Regarding Computing Performance

4.1.12 CS-0 conclusions

Data indicate that students enter CS-0 ill-prepared for the mathematical and computational demands of a CS-1 course, as is apparent in their lack of math and computer programming preparation. However, many students come from college-educated family backgrounds, and a significant number have engineers in their familial network. Most students of CS-0 work, and have multiple obligations that demand extensive amounts of time.

Survey results suggest that CS-0 is a positive learning environment for students—work was not too difficult, lectures helped students learn, and the classroom environment promoted asking for assistance. A significant minority of students (25 to 40) would have preferred the CS-0 course to have been more relevant to their intended careers. In other words, a large number of students come into CS-0 courses with set expectations for studying in a different field.

These figures suggest matters for discussion. The first concern is that for some students, CS-0 may be recruiting too late, when potential computer scientists have already decided upon an intended career. CAHSI is addressing this issue by provided CS-0 as outreach to prospective college students and to high school students enrolled in a college bridge program. The second issue is that students may not recognize the application of computer science in their chosen areas of interest. CS-0 might introduce interdisciplinary careers that are highly technical while intersecting with other fields (e.g. bioinformatics, artificial intelligence) to show students how they might pursue their passions and computer science simultaneously.

Students’ confidence in their computer programming and mathematical ability significantly increased over the course of CS-0—in fact, females “caught up” up to masculine levels of confidence in computer programming by the end of the course. Hispanic student confidence scores were on par with non-Hispanic students before and after the course.

Students’ stated choice goals (e.g. computing aspirations) stayed steady throughout the course, with females consistently scoring below male students on these measures. Surprisingly, graduate school aspirations in computing are quite high- nearly even with computing major aspirations. It is unclear why this is the case, though graduate school participation patterns in the computing boom years may indicate to students that they might earn an undergraduate degree in a non-computing field, and then attend graduate school in computer science. Alternatively, students who consider majoring in computing may be receiving advice about graduate school through other related CAHSI initiatives.

Overall, it seems the CS-0 intervention is impacting students’ interest in computing, as well as their self-efficacy (feelings of capability and confidence) in computing. Female students are less likely to major, take additional courses, or pursue graduate studies in computing following the course, despite similar interest and experiences in the course. Students’ learning environment is conducive to learning, according to survey results. Respondents describe gains in performance outcomes as well. Students have no overall change in their choice goals following their course, indicating students are not dissuaded from computing in their initial programming course.

4.2 CAHSI Student Impressions of PLTL Practices

4.2.1 Student Demographics

In the spring of 2008, 158 students from CAHSI institutions responded to the spring 2008 PLTL survey. Two thirds (103) of the students indicated they were Hispanic/Latino/a, while one quarter stated they were Caucasian (40). Forty-four students were female, and 28 of the women were Latinas. In the spring 2008 semester, three fourths of the respondents were computer science and engineering majors (75%, 104 students). The overall average self-reported GPA was 3.05. The following semester, 112 students from CAHSI institutions responded to the survey, of whom just over half (55%, 59 students) were Hispanic or Latino/a, and nearly three fourths were male (73%, 80 students). Seventeen students were Latinas. Reported GPAs averaged 3.08. Two thirds of the students were computer science/computer engineering students (65%, 71 students).

4.2.2 General Survey Results – All PLTL Students

Overall, students responding to this survey are pleased with the PLTL intervention, noting that PLTL sessions increase their understanding of computer science concepts, increase test performance, increasing their confidence in their computing ability and knowledge, and assisting in their development of problem solving strategies. See Table 13.

Students' Responses to PLTL Survey Items	
Survey Item (mean for all students in parentheses)	**Number of Students who Agree or Strongly Agree (n=271)**
I study with people from my PLTL session on my own time. (2.49)	144 (53%)
My participation in the PLTL sessions showed me that I could succeed in computing.(2.92)	205 (76%)
My participation in the PLTL sessions increased my confidence in computing. (2.90)	209 (77%)
I would like PLTL in my other computing courses. (3.01)	211 (78%)
The activities in PLTL sessions helped me to learn how to solve problems. (3.06)	221 (82%)
My professor took extra time in class to review material that students had difficulty understanding.(3.09)	221 (82%)
The activities in PLTL sessions prepared me for tests. (3.04)	225 (83%)
The activities in PLTL sessions helped me understand course material. (3.16)	234(86%)
The PLTL sessions helped me to understand difficult computing concepts.(3.18)	235(87%)
I feel comfortable asking my PLTL leader for individual help. (3.31)	239 (88%)
I had confidence that my peer leader could help me. (3.29)	241 (89%)

Table 13: Students' Responses to PLTL Survey Items

Open-ended items confirm the positive responses to PLTL interventions. Specifically, students mentioned that PLTL leaders and sessions increased their confidence in computing (n=46), their interest in computing or computing careers (n=66), and increased their ability or understanding of computing (n= 74), increased course or test grades (n=9). PLTL sessions in which students collaborate with peers also expanded students' social *computing* networks (n=14). See Table 14 for sample student quotations.

Students' Open-ended Responses Regarding PLTL Impact	
Student-described impact of PLTL	**Student Sample quotation**
Increase confidence (n=46)	"I learned that I'm capable of computing, I gained confidence in my knowledge in this subject."
Increase computing interest/career interest (n=66)	"Taking this course showed me that I have enough interest in this field to carry on throughout future semesters."
Increase course/test grades (n=9)	"Mostly, PLTL sessions helped me prepare for the midterm exams. The sessions clarified some of the information (about which) I had doubts."
Increase ability/understanding (n=74)	"I've received a deeper understanding of the material through specific questions asked during the PLT sessions."
Increase social computing network (n=14)	"Being in a group makes learning the material much easier both in giving each student the security that they are not on their own with their problems and in reinforcing communication in problem solving."

Table 14: Students' Open-ended Responses Regarding PLTL Impact

4.2.3 Hispanic Student Perspectives—Does Gender Interact with Ethnicity re: PLTL Satisfaction?

Hispanic students were compared with non-Hispanic students on the PLTL survey items. Differences between the two groups were not statistically significant, indicating that overall, students of Hispanic and non-Hispanic ethnicities see PLTL as similarly beneficial. However, when Hispanic students were also broken down by gender, the data revealed a possible difference among students worthy of further study. See Table 15.

Survey Item (overall mean in parentheses)	Hispanic Males (n=117)	Hispanic Females (n=45)	Non Hispanic Males (n=75)	Non Hispanic Females (n=29)
I study with people from my PLTL session on my own time. (2.49)	2.46	2.33	2.42	3.03
My participation in the PLTL sessions showed me that I could succeed in computing.(2.92)	3	2.78	2.77	3.1
My participation in the PLTL sessions increased my confidence in computing. (2.90)	3.03	2.64	2.92	2.83
I would like PLTL in my other computing courses. (3.01)	3.11	2.96	2.93	3
The activities in PLTL sessions helped me to learn how to solve problems. (3.06)	3.16	2.93	3.07	3
The activities in PLTL sessions prepared me for tests. (3.04)	3.12	3.09	3.03	2.83
The activities in PLTL sessions helped me understand course material. (3.16)	3.24	2.98	3.19	3.17
The PLTL sessions helped me to understand difficult computing concepts.(3.18)	3.21	3.02	3.2	3.24
I feel comfortable asking my PLTL leader for individual help. (3.31)	3.37	3.13	3.26	3.46
I had confidence that my peer leader could help me. (3.29)	3.36	3.13	3.27	3.31

Table 15: Survey Responses By Gender, Ethnicity

Across all gender and ethnicity boundaries, it seems PLTL may be rated higher for nearly all survey items by Hispanic males than by other categories of students (Hispanic females, non-Hispanic males, or non-Hispanic females). At the same time, Hispanic females tended to rate PLTL lower than both Hispanic males and than non-Hispanic students. For example, while 90% of the Hispanic males stated that PLTL increased their confidence in their computing ability, only 80% of Hispanic females felt this way about PLTL. These differences are highlighted here because they are a distinct pattern, where as in other comparisons in which differences may be due to chance the average scores vary from item to item.

At this time, these differences are not statistically significant; meaning these small differences in survey scores may be due to chance. It is important to note that the possible difference among male and female Hispanic students may mask a more positive impact of PLTL for Hispanic males and for non-Hispanic females, who scored PLTL activities more positively than did Non-Hispanic males. The relatively low numbers of Hispanic females taking these surveys also dilute the statistical power of our survey analysis. As we continue to gather data, we will be able to monitor these possible differences. Focus groups with Hispanic females enrolled in PLTL courses may also provide more information.

4.2.4 Underrepresented Minorities' Perspectives

In the CAHSI population, nearly all students who are from underrepresented ethnic groups are in fact Hispanic. While analyses were run on underrepresented minorities (Hispanics, Native Americans, African Americans/Blacks) in comparison to Asians and Caucasians, these student groups were nearly identical to the "Hispanic/NonHispanic" groups, and similarly showed no statistically significant differences from gender and ethnic subgroups of students with substantial representation in computing.

4.2.5 Overall Gender Differences—Females May Rate PLTL Slightly Lower than Males Do

As stated previously, the females' average PLTL scores for the intervention are slightly less than males' responses on each survey item, except for one. According to female PLTL students, they may be a bit more likely to study with their peers outside of class time than males in PLTL courses (2.61 compared with 2.45). Again, these differences may be due to chance, as they are not statistically significant. Both genders average between 2.80 and 3.20 on all survey items, which correspond to an "agree" response. These overall gender differences are evident because of the relatively high portion of Hispanic females in this sample (45 Hispanic females compared with 29 non-Hispanic females). As stated previously, non-Hispanic females scored the intervention more positively than non-Hispanic males (though not to a statistically significant degree) on nearly all items.

4.2.6 Semester Differences—Do PLTL Ratings Improve Over Time?

Differences between spring 2008 and fall 2008 course takers are not statistically significant, meaning that benefits of the intervention do not seem to be varied over the two semesters. Average scores appear slightly higher for the most recent semester, though these differences may be due to chance. A small increase in scores would be a positive sign—indicating that PLTL was becoming more valued by students, student resistance to the changes were weakening, or that PLTL leaders were becoming more skilled at assisting their near-peers. PLTL ratings are already quite positive, and survey analyses may experience a "ceiling effect", in which scores become sufficiently high as to mask PLTL improvements—in other words, scores do not have enough room to expand.

4.2.7 GPA and PLTL Participation Frequency Do Not Seem to Impact PLTL Satisfaction

To test the hypothesis that students who are already do well in school may be less satisfied with the PLTL intervention, we compared student scores for those who reported GPAs lower than 2.67 (a B-minus grade point average) to those who reported a higher GPA. These students showed no significant differences in scores on the PLTL survey, indicating that the intervention may be equally important or positive for students indiscriminate of their current grades. A caveat to these results is that not all students reported their GPAs in the survey. It may be that those with lower GPAs skipped this item, or it may be that students reported inflated grade point averages, even though the surveys were anonymous and could not be tied to the individual students.

In an effort to capture differences by PLTL participation frequency (i.e. the fraction of PLTL sessions students report attending), we compared students who attended 90-100% of the total PLTL sessions (198 students) with those who attended less often (69 students). No statistically significant differences were measured between these groups.

No pattern of scoring was discerned in these categories, indicating that frequency of PLTL participation and GPA did not impact students' impressions of the intervention. In other words, unlike the differences by gender and ethnicity which show regular though slight differences (e.g. Hispanic males nearly always having higher averages than other groups of students), student results regarding GPA and participation frequency did not vary with any regularity.

4.2.8 Exploring What Makes PLTL Effective for Students

Survey data indicate that students find the PLTL intervention successful at increasing their knowledge and skills in computer science. Open-ended items revealed the ***teaching strategies*** and ***learning conditions*** students describe as the most effective elements of PLTL sessions.

4.2.8.1 Effective computer science learning conditions evident in PLTL

Students mentioned characteristics of their experiences in PLTL sessions that led to their positive regard for the intervention and also led to their increased confidence, interest, and understanding of computing concepts. PLTL sessions were described as:

- Supporting collaboration among students (n=43)
- Developing a comfortable, safe environment (n=22)
- Giving students an opportunity to have fun (n=29)

These learning conditions were reported in open-ended items. They support the data described from forced choice responses. Educational researchers across disciplines and age groups describe the need for students to view one another and themselves as resources for learning, and tout creating a safe classroom environment essential for student learning (Olson & Torrance, 1998, Bransford, Brown, & Cocking, 2000) Classrooms that lower students' affective filter, or decrease student anxiety, may be particularly fruitful for students who are underrepresented in computing, since stereotype threat (Steele &Aronson, 1995) might otherwise impede student performance.

Besides creating comfortable, fun, collaborative opportunities for student learning, peer leaders were described by their students as more accessible than professors (n=13). Students reported that the peer leader perspective was an essential aspect of their improved performance (n=65). This was described in two related ways. Survey respondents mentioned that peer leaders provided an *alternative perspective* regarding computing concepts, meaning that being privy to multiple points of view (e.g. the professor, TA, and peer leader) was beneficial. Similarly, students said that peer leaders had a *more relatable perspective* regarding computing concepts, meaning that peer leaders were more closely aligned intellectually with PLTL students. The reality of peer leaders completing only a few additional courses than PLTL students made their explanations more relevant to students.

4.2.8.2 PLTL teaching strategies students find essential for learning computing

As described above, it seems that peer leaders bring an alternative perspective to explaining computer science concepts—in many instances hearing a second version or alternative answer to a student-posed question was essential for student understanding. PLTL survey respondents also indicated that PLTL leaders were increasing their understanding of computer science through the following means:

- Providing individualized help to students inside and outside of PLTL session time (n=57)
- Engaging students in structured test review activities, such as jeopardy, etc. (n=33)
- Utilizing active learning pedagogy, in which students solved problems, built models, discussed programs, etc. (n=33)
- Discussing computer science applications, or using context to explain abstract ideas (n=10)
- Assisting students or facilitating student group work on course assignments/labs (n=9)

According to PLTL students, the structure of PLTL sessions allowed for greater depth of discussion than was generally experienced in a lecture based class (n=46). This focus on depth rather than breadth of coverage in college courses is an important one—in fact, research on pedagogy and learning across subjects highlights the benefits of increasing course depth in an effort to teach for understanding (Shulman, 1987) The structure of PLTL sessions may be a good model for regular course design in the computer science curriculum. See Table 16 for sample student responses.

Students' Open-ended Responses Regarding Effective PLTL Strategies	
Student-described effective PLTL strategies	**Student Sample quotation**
Providing individualized help to students (n=57)	"(My peer leader) encouraged me to try things I thought I could not do plus any time I struggled in class he let me know I can ask him for help." "The sessions added an outside resource other than class time to work on difficult concepts and receive help."
Engaging students in structured test review (n=33)	"They go over information that wasn't covered in the lessons that would be on tests or reviews." "(Both peer leaders) went well out of their way and way above the call of duty to ensure that we had ample times to meet for study sessions before tests."
Utilizing active learning pedagogy (n=33)	"(the best part of PLTL was) the way the activities made the concepts discussed in class make sense." "(the best part of PLTL was) playing games that involved what we were learning during in class."
Discussing computer science applications/applying computer science concepts (n=10)	"I got to apply what I had learned in the lecture and the lab to solve the problems the peer leader presented to us." "(My peer leader) would share with us experiments he has done in the past and (let us know) that writing a program is actually doing something, its not a bunch of words just being put into the computer."
Assisting students on course assignments/labs (n=9)	"There were some times when I would struggle with assignments, and I would get help right away (from a peer leader)." "When the PLTL sessions did help, it was because they went over what we needed to know to complete the lab."

Table 16: Students' Open-ended Responses Regarding Effective PLTL Strategies

Of greatest importance to CAHSI is the extent to which PLTL increases student aspirations in computing academia and computing careers (16 student responses). The following quotes exhibit the ways in which PLTL students feel connected to their computing community, and realize they can be successful computer scientists.

"I have become more comfortable with my capacity to deal with the demands of solving problems through the use of programming. I'm more likely to take more programming courses at this point than I was before the class."

"I will be continuing my major in Computer Science as opposed to switching to CIS."

"It has convinced me to continue on with the courses in the CS Degree."

"If I have some one to help me in understanding the programs I can take more computing courses."

"The best part about PLTL (is that it convinced me to) continue pursuing my degree in CS."

"It helped confirm this is what I want my major to be."

"Yes it has given me the self confidence to continue

"It gives us more confidence to continue on with the courses the remain in the CS degree

"It has made me want to continue studying computer science."

"(It) makes me feel like I can continue my education in this field."

"I feel more comfortable in continuing my Computer Science major."

"Even though I am not doing well, I still want to try hard and succeed in computer science. Having peer leaders shows me that not everyone does well the first time, but when you finally get it, everything is that much better."

4.2.9 The value of PLTL for students

PLTL sessions appear to be effective in increasing student confidence in and understanding of computer science. The practice provides a venue for tiered mentoring of undergraduate students by their near-peers, students a few years ahead of them in their studies. Successful student course completion in PLTL courses has increased since the inception of the CAHSI Alliance, indicating the impact of this intervention is great.

4.3 Peer leader outcomes: Gains in confidence and knowledge

4.3.1 Peer leader demographics

A survey assessing peer leaders' gains in skills, confidence, and career aspirations was distributed to all peer leaders in spring and fall 2008. Thirty-nine students completed the survey, a sample too small to yield statistically significant differences among groups. The majority of peer leaders were from UTEP and TAMU-CC, while only four students attended CSU-DH. Most students had minimal experience as peer leaders: 45% had served for one semester and 37% had served for two semesters. Students were diverse racially and ethnically: 51% were Hispanic, 41% were Caucasian, and 8% were Asian. Peer leaders were not diverse as far as gender, 84% of peer leaders were male. Peer leaders also tended to be upperclassmen: 58% were seniors, 26% were juniors, 11% were sophomores, and 5% were freshmen.

4.3.2 Peer leaders gain teaching and communication skills

Peer leaders made considerable gains in communication, teaching, and interpersonal skills, and lesser gains in study and decision-making skills. Almost all peer leaders (97% of peer leaders) agreed or strongly agreed that being a peer leader had improved their oral communication and teaching skills, while 90% felt that peer leading had enhanced their interpersonal skills. Almost all peer leaders (91% of peer leaders) thought that their leadership skills had improved. However, peer leaders noted slightly weaker gains in study skills and decision-making skills. Almost two-thirds of peer leaders reported that their study skills had improved, while 80% of peer leaders noted improvement in their decision-making skills. There were no significant differences in students' gains in skills according to gender or ethnicity.

4.3.3 Peer leaders are confident in their abilities

Peer leaders demonstrated confidence in their abilities to help students and effectively lead PLTL sessions. In fact, almost all peer leaders (97%) expressed confidence in their abilities to help students understand computing concepts. All peer leaders also reported that they knew the steps necessary to effectively communicate computing concepts. In addition, almost all peer leaders (92%) felt that they generally facilitated PLTL sessions effectively. Peer leaders were also confident in their ability to work with and help students. Most peer leaders (86%) were confident in their ability to motivate students. However, a few peer leaders (10%) questioned whether they had the necessary skills to facilitate PLTL. In contrast to peer leaders' confidence in other areas, 32% of peer leaders reported that they saw little change in students' achievement when they put more effort into their PLTL sessions. Therefore, peer leaders expressed confidence in their ability to communicate effectively, help students understand concepts, and motivate students, although they expressed less confidence that their effort and hard work may lead to changes in students' learning. There were no statistically significant differences in students' gains in confidence according to gender or ethnicity.

4.3.4 Peer leaders became more interested in a career in computer science

Peer leaders became more interested in a computing career as a result of their experience as a peer leader. Some peer leaders also became more interested in attending graduate school or becoming a computer science professor.

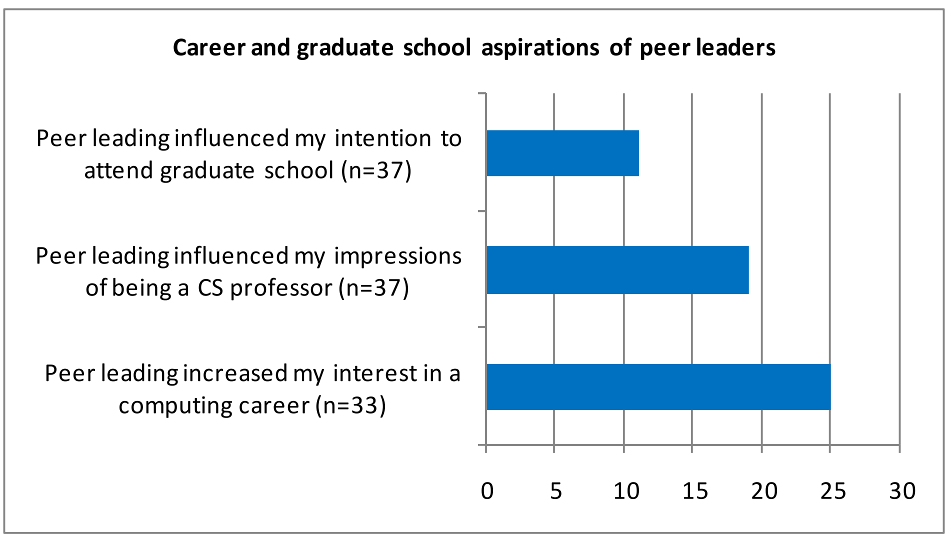

Figure 7: Career and Graduate School Aspirations of Peer Leaders

In fact, 82% of peer leaders reported that their role as a peer leader had increased their interest in a computing career. However, only 30% of students reported that peer leading had influenced their intentions to pursue graduate school. Most peer leaders commented that they were already planning to attend graduate school before their peer leading experience or that research had more influence on their decision to apply to graduate school. The few students whose peer leading experience affected their decision to attend graduate school reported that they gained confidence and interest in computer science from their experience.

> *Sure! I realized I'm capable of much more, and learned to love CS!* (Male Hispanic computer science major)

On the other hand, 51% of peer leaders reported that peer leading had influenced their thoughts about becoming a professor. Peer leaders who became more interested in being a professor often cited teaching and helping students as their motivation. Through peer leading, these students discovered that they liked teaching and enjoyed working with students.

> *Being a Peer Leader has helped me see how I can effectively teach and help students and this has influenced me a bit*. (Male Asian computer science major)

> *Now I would like to be. I've learned a lot, and I realized I like teaching!* (Male Hispanic computer science major)

4.3.5 Peer leaders view PLTL as an effective way to help students learn computer science

Peer leaders strongly believed in the effectiveness of PLTL in helping students to learn computing concepts. Indeed, 94% of peer leaders believed that PLTL is an effective way to teach students with little background in computing. In an open-ended question, peer leaders described their role as a facilitator, helper, or guide, rather than a traditional teacher. Peer leaders also emphasized that they encouraged students to work together and learn from one another.

> *Facilitate discussion in my sessions to promote a group approach to learning activities* (Male Hispanic computer science major)

> *Helper, guide to help students to understand the concepts better* (Male Asian computer science major)

4.3.6 Peer leaders increased their knowledge of computing concepts

Peer leaders were also confident in their understanding of key computing concepts. All peer leaders reported that they understand computing concepts well enough to be an effective peer leader. In addition, all peer leaders believed that they are typically able to answer students' computing questions. Peer leaders also reported that leading PLTL increased their computing knowledge (81% agreed or strongly agreed with this statement).

4.3.7 Practice activities and peer interactions helped to train peer leaders

Peer leaders were asked several open-ended questions about their training. They were asked about the most effective part of their PLTL training and what it may have lacked. Students found practice activities and peer interaction to be the most helpful aspects of their peer leader training.

Practice exercises gave students confidence and helped them to feel prepared for their work as a peer leader.

> *Probably the run through of our first PLTL session. We had a mock run through of the exercise we were going to use the first class and it put me more at ease about the first day.* (Male Caucasian computer science major)

Peer leaders found social interactions with colleagues and faculty to be beneficial aspects of their training.

> *Networking with teachers, students, and other peer leaders. The satisfaction of helping students, and learning to make better teaching strategies.* (Male Hispanic computer science major)

> *Bonding. As students bonded within each other, made friends, and saw each other as an approachable person, things got MUCH easier for everyone.* (Female Caucasian computer science major)

A few peer leaders also appreciated the opportunity to learn how to create activities for students.

Creating a real lab activity was really effective training. (Male Hispanic computer science major)

> *Learning how to come up with activities to facilitate during the actual session* (Female Caucasian computer science major)

4.3.8 Peer leaders wanted more training in creating PLTL activities and motivating students

Peer leaders were also asked what their training may have lacked. A few students commented that their training did not lack anything. Some peer leaders felt that the peer leader training could be more organized. Some of these students mentioned that the training had improved since last year, but still lacked organization at times.

> *Well, it got better than last semester I think, however, probably a little of organization once in a while... but not often* (Male Hispanic computer science major)

> *It was better than last year, but we could use more interdepartmental coordination* (Male Hispanic computer science major)

Some peer leaders also mentioned that they would have liked more training in ways to create PLTL activities from course content.

How to derive an activity from the course material. (Male Hispanic computer science major)

Finally, some peer leaders also requested to learn more techniques for motivating students or working with difficult students.

> *Learning ways to better motivate the students to learn and participate*. (Male Hispanic computer science major)

> Maybe some more info on how to deal with problem students. (Male Hispanic computer science major)

4.3.9 Peer leaders found student resistance to be challenging

In an open-ended question, students were asked about the challenges of being a peer leader. Peer leaders most frequently mentioned creating and designing PLTL activities as the most challenging aspect of their role.

> *The greatest challenge was finding different ways to portray the course material to the students.* (Male Hispanic computer science major)

> *Coming up with activities to engage the students* (Male Hispanic computer science major)

> *The greatest challenge for me as a Peer Leader was coming up with activities that will be fun and engaging for the students* (Male Caucasian computer science major)

Another common response was that it is challenging to work with students who are unmotivated, unengaged, or resistant to PLTL activities.

> *My greatest challenge as a Peer Leader was dealing with the students that didn't care about anything or anyone, including themselves. They would show up to the lab, but just sit there. They would bring others down, and make others not want to participate.* (Female Caucasian computer science major)

> *I feel that my greatest challenge would be getting the students motivated to participate and to stay interested.* (Male Hispanic computer science major)

4.3.10 The value of being a peer leader

Peer leading had multiple benefits for students and the implementation of PLTL achieved many of the Common Core Goals for the Broadening Participation in Computing program. The majority of peer leaders were Hispanic, indicating that CAHSI is effectively reaching underrepresented groups of students, particularly their target group of Hispanics. Peer Led Team Learning has been instituted across several CAHSI campuses, suggesting that effective PLTL practices are replicable in a variety of institutions. Through dissemination of activities on the CAHSI website and PLTL trainings, these institutions also serve as visible models for effective practice in broadening participation in computing.

Moreover, the peer leaders themselves benefited from their role in facilitating PLTL sessions. Peer leaders made considerable gains in communication, teaching, and interpersonal skills, though they achieved lesser gains in study and decision-making skills. Peer leaders also expressed confidence in their ability to communicate effectively, help students understand concepts, and motivate students, although they expressed less confidence that their effort and hard work may lead to changes in students' learning. Peer leaders found practice activities and social interaction to be the most helpful aspects of their training; however they expressed a need for more guidance in creating PLTL activities and working with unmotivated students. Finally, being a peer leader influenced students' career aspirations. Most peer leaders became more interested in a computing career as a result of their peer leading experience, and some peer leaders became more interested in attending graduate school or becoming a computer science professor.

4.4 Affinity Research Groups- Apprenticing Computer Science Professionals

4.4.1 Overview

Overall, 98 Affinity Research Group (ARG) students completed a survey about their personal, professional and intellectual gains from participation in research: 32 students in spring 2008, 34 students in summer 2008, and 32 students from the research course at University of Puerto Rico, Mayaguez. Survey responses were received from UTEP (34% of student participants), TAMU-CC (9%), UHD (2%), CSU-DH (12%), NMSU (7%), and UPRM (36%--all but three of these students participated in the research course).

ARG students were primarily undergraduates, with a few graduate student participants. Undergraduate students tended to be upperclassmen. Only 2% of ARG students were 1st year students, 9% were 2nd year students, 16% were 3rd year students, 26% were fourth year students, and 34% were 5th year undergraduates. In addition, 10% were master's students, and 3% were Ph.D. students.

Many ARG students were relatively inexperienced researchers. Two-thirds of students had only completed 1-2 semesters or summers of research. A little less than one-quarter of students had completed 3-4 semesters or summers of research, and the remainder had completed 5 or more semesters or summers of research.

ARG students were predominantly Hispanic (76% of students). The remainder was Caucasian (11%), Asian (6%), mixed race/ethnicity (4%) or African-American (3%). ARG students were also predominantly male (77% of students). The gender representation of ARG students is consistent with the national average: in 2005, 22% of bachelor's degrees in computer science were awarded to women (NSF, 2006). Finally, 61% of students were computer science majors, while the rest were computer engineering majors.

4.4.2 ARG students understood their research tasks and goals

Students answered a series of questions about the clarity of their project goals, its fit with the work of the research group, and their sense of ownership of their research tasks. The overall mean for these items was quite high (3.46 out of 4.0),[7] indicating that most students had a solid understanding of the tasks at hand and how they related to the work of the larger group. In fact, almost all students (93%) understood their research goals and tasks for the semester and 92% of students understood how their tasks related to the goals of the group. Almost all students (96%for each item) found their research work to be challenging and gained a sense of responsibility for their project. A sense of ownership over the project and clarity about the project's goals are essential for achieving the greatest gains from an apprenticeship experience in research (Thiry, Hunter & Laursen, 2009).

4.4.3 Students' top gains were technical knowledge and research skills

Students were asked to pick their top three gains from their research experience. The most frequently selected gain was technical knowledge (70% of students cited this as a top three gain). Two-thirds of students also picked research skills as a top gain. Many students also cited intellectual skills (e.g. critical thinking and problem solving) (52%), personal growth, (e.g. confidence, maturity, interest in subject) (54%), teamwork skills (49%), and communication skills (43%). Fewer students cited clarification of career goals (32%) as one of their top three gains from research. Students' top three gains are outlined in the figure below.

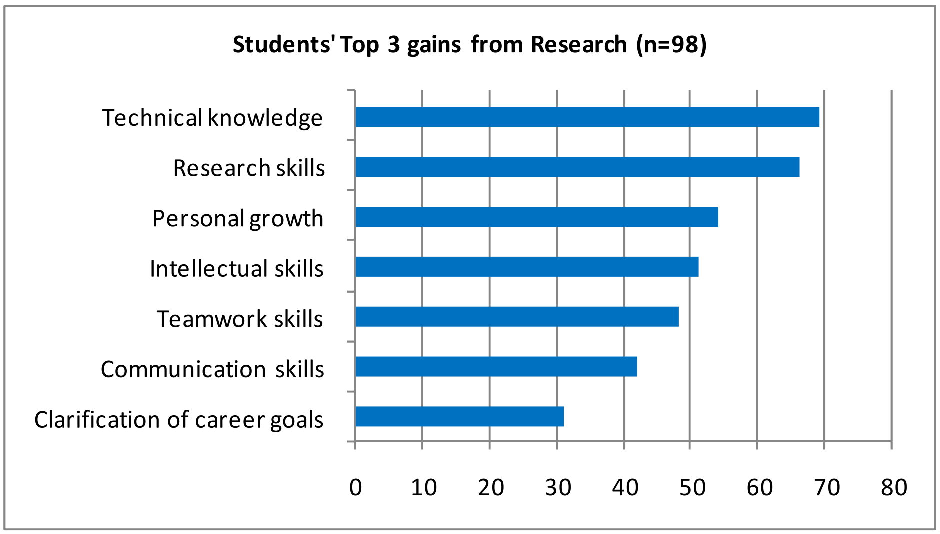

Figure 8: Students' Top 3 Gains from Research

4.4.4 Research gain scales

Students evaluated their growth and development in several areas:

- *Career clarification:* Clarification and/or confirmation of students' career and educational goals.

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

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

Students made roughly equal gains in all of the above categories. Tests of statistical significance (to compare means from different groups) revealed no statistically significant differences among different groups such as gender, ethnicity, institution, or amount of research experience. The overall means for these scales are outlined in the figure below.

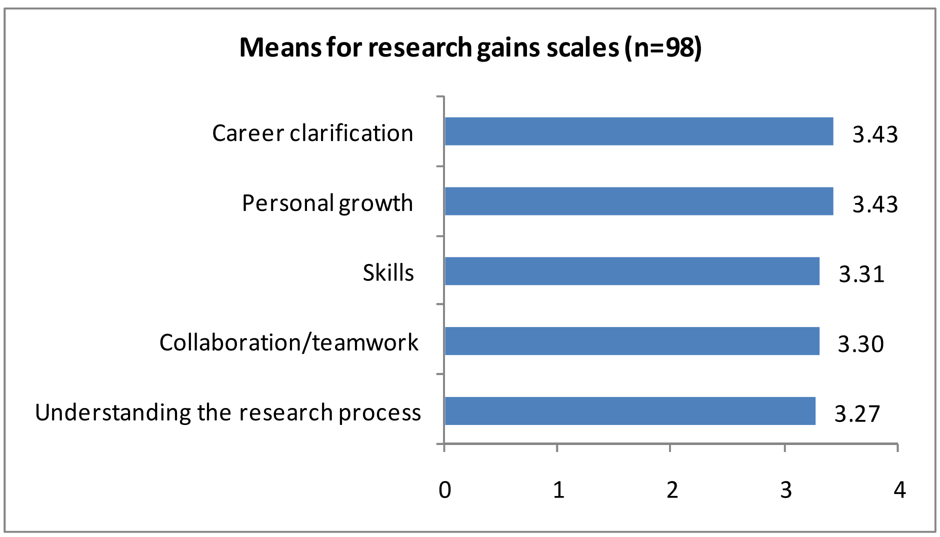

Figure 9: Student Responses Regarding Research Gain Scales

4.4.5 Students became more interested in graduate school and a computing career

Although students were less likely to cite clarification of career goals as one of their "top 3" gains from their research experience, they rated career and educational gains as their top gains on the gains scales. The overall mean for items related to the clarification or confirmation of career goals was 3.43 out of 4.0—the highest mean of any gains scale. Therefore, students strongly believed that research helped to prepare them for graduate school and/or a career and helped their decision-making process about their future goals. Almost all students (99%) agreed or strongly agreed that research had enhanced their résumé. Almost all students (94%) thought they had greater knowledge of career and education options as a result of their research experience and 94% of students felt more prepared for a career in computer science. Faculty advisors and professors were also helpful in providing students with information about graduate school and careers. Almost all students (94%) reported that their faculty advisor (or course professor in the case of UPRM) had provided useful career information. Therefore, students clearly gained clarity about their career goals and preparation for future educational and career pursuits from their research experience. The clarification of career and educational goals as well as gaining knowledge about future options are particularly important outcomes for students from underrepresented groups who may not have the same awareness of career and educational options as their majority peers (Dryburgh, 1999; Mulkey & Ellis, 1990). In this sense, minority students receive important professional socialization benefits from participating in undergraduate research, particularly in learning about professional practice from working closely with faculty and graduate students in a shared research endeavor (Thiry & Hunter, 2008).

In addition, 74% of students felt that their research experience had influenced their thoughts and impressions about graduate study. Students had the opportunity to expand on their answer in an open-ended comment. Students' responses about the influence of research on their thoughts about graduate school were varied. The most common response (25% of students) was that students had learned what graduate school and research are like from working with graduate students during their research experience. Greater knowledge about graduate school also instilled confidence in students that they could successfully complete the degree.

Yes, because of my involvement in research, I now know that graduate study is about learning to contribute to the body of knowledge of a discipline; technical specialization is just a side effect. (Male Hispanic computer science major)

It did influence my impressions about graduate studies because I was not sure if I could obtain my Masters at first. After starting my research experience, I learned that it was not as hard as I thought it would be. This experience opened the door for me to attempt a Masters and maybe even a Doctorate degree. (Male Hispanic computer science major)

It makes graduate school seem more interesting, and not seem to be too far out of reach since we had graduate students working on the project. (Male Hispanic computer science major)

It allowed me to see more clearly the work expected and being done by graduate students and gave me a more clear understanding of my role as future engineer. (Male Hispanic computer engineering major)

The second most frequent response (16% of students) was that the students had decided to attend graduate school before participating in an ARG; therefore, research did not influence the decision.

No, I have been thinking about graduate studies before I joined. (Male Hispanic computer science major)

Five students reported that they learned the importance of graduate school for their career goals and within the field of computer science in general.

I was able to attend a professional conference which indeed enlightened me to the importance of graduate studies. I have since been seriously contemplating a Masters in Computer Science. (Female Hispanic computer science major)

A few students commented that they discovered they liked research.

Doing research as an undergrad allowed me to see that it was actually fun and very interesting. (Male Hispanic computer science major)

In addition, a few students learned about educational and career options from their research experience.

After doing research for a semester I was more interested in furthering my education. I learned what I can do after I go to graduate school. I use to think going to graduate school was for people that wanted to teach. (Male Caucasian computer science major)

Fewer students (50%) felt that research had influenced their thoughts and impressions about being a professor. Students (39%) most frequently responded that they had never considered being a professor; therefore, the research experience had not influenced their thoughts about the professoriate. Many students cited graduate school attendance or the job requirement of teaching as the primary reasons that they were not interested in being a professor.

I have gained a great respect for my professor and the work he does, and is able to do. I am fairly certain I do not wish to become a professor however, simply because I do not want to be in a school my whole life. (Male mixed race computer science major)

I never intended to become a professor and my intentions have not changed. (Hispanic male computer science major)

However, 27% of students commented that they had learned more about being a professor from observing their faculty research mentor and had become more committed to a career in the professoriate.

Yes, I was exposed to what it really means to be a professor, and the kind of work they do. Besides teaching, they also do research. (Female Hispanic computer science major)

Gave me a sense of what I would be doing since that is one of my goals in life. (Male Hispanic computer science major)

By becoming involved in research I realized that the best way to conduct research was to become a faculty member. (Male Hispanic computer science major)

I have a closer view on the kind of research some professors do and the way they do it. That had a positive influence. (Female Hispanic computer engineering major)

On the other hand, 11% of students reported that they knowledge they gained about the everyday life of a professor had made them less interested in the career.

Although I enjoy research, I realized that I do not want to be a professor at this time. (Male Hispanic computer science major)

In addition, 11% of students commented that they might be interested in the professoriate but had not firmly committed to pursuing this career.

Through my research experience I have gained interest in becoming a professor (Male Hispanic computer science major)

Finally, four students stated that they had always planned to become a professor and research had not influenced their decision. On the other hand, three students mentioned that their research experience had helped them to confirm their original career goal of becoming a professor.

Reinforced my desire to become a faculty member in a well known university. (Male Hispanic computer science major)

Students already enrolled or interested in attending graduate school noted a range of influences on their decision to pursue a graduate degree. A majority of students (51%) cited research as a critical influence on their graduate school aspirations. Likewise, 40% of students cited their faculty research mentor and 32% of students reported that another faculty member had influenced their decision. Parents and family were also important influences in students' educational decisions; 35% of students reported that parents and family impacted their decision. Less often, students cited graduate students (24%) or undergraduate peers (16%) as important influences in their decision to pursue a graduate degree.

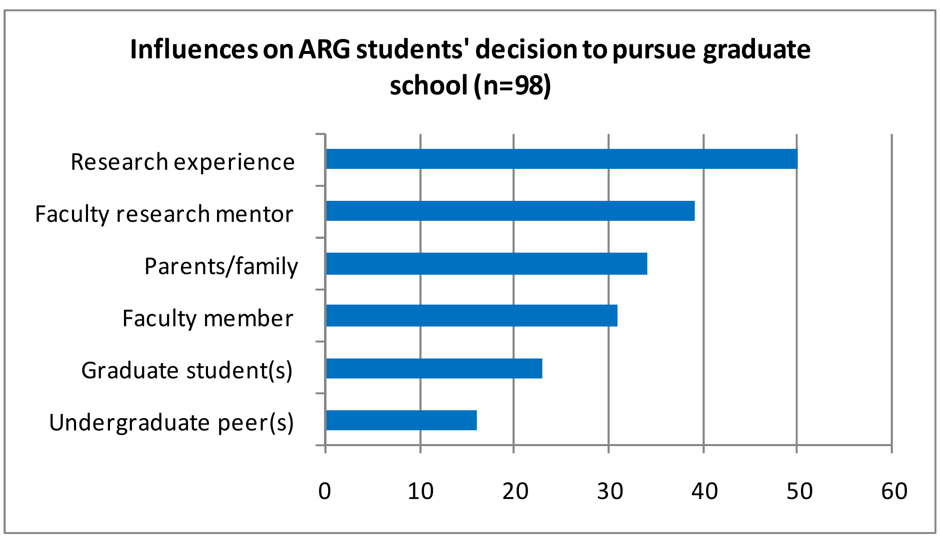

Figure 10: Student Responses Regarding Decisions to Pursue Graduate School

In sum, participation in research helped students to confirm, clarify, or refine their career and educational interests and goals. Students' research experience was the most influential factor in helping them to decide whether to enroll in graduate school. Students benefited from observing graduate students at work and learning about the roles and responsibilities of graduate students. Likewise, several previous studies have documented the educational and career gains from participation in research for minority students, including increased interest in science careers (Nagda, Gregerman, Jonides, von Hippel & Lerner, 1998) and an increased likelihood that students will pursue graduate school (Alexander, Foertsch, & Daffinrud, 1998; Barlow & Villarejo, 2004; Hathaway, Nagda, & Gregerman, 2002). CAHSI students also clearly benefited from the knowledge they gained about education and career options and an increased interest in a computing career and enrollment in graduate school.

4.4.6 Students gained confidence and interest in their field

Participation in research helped students to gain confidence in their abilities, become more independent as learners, and increased their interest in computer science. The overall mean for all of the items related to personal growth was 3.43 out of 4.0, indicating that students made strong gains in this area. Almost all students (93%) reported that they became more comfortable trying things on their own from their research experience. Most students (96%) also gained confidence in their research abilities. Finally, almost all students (93%) became more interested in computer science. Therefore, students gained both confidence and interest in their field as a result of their research experience. Gains in confidence and interest are particularly important for minority students because their persistence in their majors is more closely linked to their enthusiasm for their discipline than it is to their GPA (Grandy ,1998).

4.4.7 Students gained intellectual and communication skills

Students gained a variety of skills from their research experience. The overall mean for all of the items regarding skills was 3.31 out of 4.0. Students reported that they gained problem-solving skills from research (93% of students agreed or strongly agreed that they gained this skill). However, students also increased their communication skills, particularly their oral presentation skills (93% agreed or strongly agreed) and scientific writing skills (85%). In sum, students gained both communication and intellectual skills from their participation in research.

4.4.8 Affinity Research Groups modeled effective strategies for teamwork and collaboration

Students made solid gains in developing collaborative relationships and teamwork skills. Students were asked a series of questions about the collaboration among their research group. The overall mean for the questions on this scale was 3.30 out of 4.0. Students felt that they were an essential part of the research group; 92% of students felt that they contributed to decisions that impacted the direction of the research group. Students also valued their research mentors; 92% of students felt comfortable talking to their mentor or professor about problems. Almost all students (94%) also reported that their research group gave them feedback on their work. In addition, almost all students (94%) felt that their mentor or professor gave them the appropriate amount of guidance that they need to be successful on their research project. In conclusion, ARG students worked collaboratively and collegially with their research mentors and peers during their research experience.

In an open-ended question, students documented their processes for resolving disagreements within their research groups.

By far, the most frequent response (69% of students) was the use of discussion and debate to resolve differences.

In the meetings we had, it seemed we just had a democratic process where ideas were tossed out, and the most popular ones were used, while the less popular were not. (Male Caucasian computer science major)

Discuss and reach consensus. That simple process forces you (as a student) to communicate your ideas adequately to your peers and professors. It forces you to be on top of things and to articulate your arguments to defend your positions. (Male Hispanic computer science major)

We all sit to discuss the problem and the solution and reach a medium term where all the parts felt comfortable. (Male Hispanic computer engineer major)

To a lesser extent, students (27%) described a process of analyzing and examining options, choosing the best solution and developing a plan to implement it.

We take each problem as they come, work to see what we can and can't do in the allotted time, and systematically work out how to put our plan into action. (Male Hispanic computer science major)

If we had different ideas and didn't know which would be best, we each would try out one of them and if any of us got better results than then other, his/her idea would be the one used then. (Male Hispanic computer science major)

We all must present our views and backing arguments which are verified and evaluated. The alternative that seems more suitable is chosen. (Male Hispanic computer engineering major)

Fifteen percent of students mentioned that they had brought problems to the faculty research advisor of the group; however, this was always mentioned as a last resort when a solution could not be achieved through discussion and consensus alone.

If we can't decide amongst ourselves we ask our Mentor. If he is unsure we individually research our own ideas for more data to make a more informed decision. (Male Hispanic computer science major)

Thirteen percent of students noted that they had not had disagreements among their research group.

No disagreements have really occurred. (Male Hispanic computer science major)

In conclusion, student felt that they were valued members of their research group who contributed to the work and direction of the group. Students also felt comfortable with their research mentors and peers. In addition, most students described democratic and fair processes for resolving conflicts or disagreements among their research group.

4.4.9 Students gained a deeper understanding of the research process

Participation in authentic research tasks and projects helped students to develop a more accurate understanding of the process of scientific research. Students began to understand that research is a slow process that is rife with setbacks, failure, and ambiguity. The overall mean for all of the items on this scale was 3.27 out of 4.0. Indeed, almost all students (91%) reported that they gained a better understanding of what everyday research work is like. Students' research work also translated to the classroom. Most students (87%) thought that their knowledge from computer science courses seemed more relevant as a result of their research work. Our previous work on undergraduate research has indicated that developing an accurate understanding of the research process is a critical step in helping students to decide whether graduate school or a career in research are the right paths for them (Hunter et al., 2007; Seymour et al., 2004; Thiry et al., 2009).

4.4.10 Students participated in professional communities

Most ARG students had the opportunity to participate in professional forums in their field of interest. Over two-thirds of students attended a professional conference within the past year. Less often, students had the opportunity to present or publish their results; however, our prior research on UR has shown that these accomplishments are rare for undergraduates (Hunter et al., 2007; Seymour et al., 2004). Nevertheless, over one-third of ARG students presented a poster at a conference in the past year, 18% of students authored or co-authored a journal manuscript, and 10% presented a conference paper. Therefore, ARG students seemed to have had ample opportunities to engage in authentic research that led to publishable results. Access to "real-world" research is essential for socializing students into the profession and producing the strongest intellectual and professional gains (Thiry et al., 2009).

Professional activity undertaken in the past year (n=98)	Number of students	Percentage of students
Attended a professional conference	64	65%
Authored or co-authored a journal paper	18	18%
Presented a conference paper	10	10%
Presented a poster at a professional conference	37	38%

Table 17: Student Responses Regarding Professional Scientific Research Activity

4.4.11 Students took pride in helping to solve real-world problems

In an open-ended question, students were asked to describe their most important accomplishment from their research experience.

The most common response (40% of students) was making a contribution to the progress of the research project or achieving results on the project. Some students also appreciated the real-world applications of their research contributions.

> *This year, I felt that I was able to contribute to the solution of a real world problem.* (Male Hispanic computer science major)

> *Designing a solution that is better than the existing one.* (Male Hispanic computer science major)

> *Being able to produce a result which may help current technology and applications.* (Male Hispanic computer engineering major)

Twelve percent of students commented that they gained a better understanding of the research process in computer science.

> *A greater understanding of the amount of research that is put into a discovery and the way they are presented to the field.* (Male Hispanic computer science major)

Ten percent of students mentioned that acquiring teamwork skills was their most important accomplishment from participation in research.

> *To work in groups and to receive feedback from my teammates and my mentor for every step that we took in our research group.* (Male Hispanic computer science major)

> *Getting comfortable with working with teammates and being able to meet project deadlines as a whole.* (Male Caucasian computer science major)

Ten percent of students thought that research had enhanced their personal growth, particularly in terms of confidence, maturity, leadership, and independence.

> *Confidence and hard work* (Male Caucasian computer science major)

> *Get to know myself better and my capabilities* (Male Hispanic computer engineering major)

Seven percent of students believed that their most important accomplishment from research was the opportunity to present a paper or publish an article.

> *Getting an abstract and poster accepted to a conference. I was able to have a poster presentation and an oral presentation.* (Male Caucasian computer science major)

A few students each also mentioned the following gains as their most important accomplishment from their research experience: communication skills, clarifying future career goals, intellectual gains, such as problem solving, clarifying their field of interest, and enhanced organizational skills.

4.4.12 ARG Conclusion

Participation in research has numerous benefits for students and the Affinity Research Group model has helped to achieve many of the Common Core Goals for the Broadening Participation in Computing program. The vast majority of ARG participants were Hispanic, indicating that CAHSI is effectively reaching underrepresented groups of students, particularly their target group of Hispanics. Moreover, participation in research has been shown to have many positive outcomes for minority students, including increased interest in a scientific career (Nagda, et al., 1998), enhanced preparation for graduate school (Alexander, Foertsch & Daffinrud, 1998), increased rates of graduate school attendance (Alexander, Foertsch & Daffinrud, 1998; Barlow & Villarejo, 2004; Hathaway, Nagda & Gregerman, 2002), and increased retention in the major and baccalaureate graduation rates (Barlow &Villarejo, 2004; Nagda et al., 1998). Likewise, findings from this evaluation demonstrate the participation in research boosted students' interest in computing careers and graduate school.

The Affinity Research Group model has been instituted at multiple CAHSI institutions both in and out of the classroom, suggesting that the model is replicable in a variety of contexts. ARG students made a variety of gains from their research experience, including growth in confidence, increased interest in computer science, increased interest in graduate school attendance, and increases in communication, technical, and intellectual skills. In keeping with the ARG model's emphasis on teamwork and communication, students learned to work collaboratively within their research group and gained skill in democratically resolving disagreements among group members. Many students also had the opportunity to attend professional conferences and a sizeable minority disseminated their research results through conference papers or peer-reviewed journal articles. The opportunity to engage in authentic research and work side-by-side with graduate students and faculty offers students invaluable educational benefits that cannot be gained in a traditional classroom (Thiry, Hunter, & Laursen, 2009).

5 Discussion

According to institution-level data, CAHSI interventions are increasing the number of students retained in computer science courses specific to the major. The modest but statistically significant rise in one-time enrollment student success rates in CAHSI targeted courses indicate that the CAHSI practices have impact in the CAHSI institutions. The stable enrollment of students in CAHSI institutions, in a time when PhD granting universities saw an 18% drop in enrollment is encouraging. While CS-0 impact appears low at this time, an expansion of data collection to include all computing fields may show a greater number of students recruited into computing fields. ARG students appear to be advancing their scientific careers through participation in conferences and through dissemination of their work. This is significant, as most undergraduate researchers do not have these high-level participation opportunities.

CAHSI's multiple pronged strategy of a) mainstreaming mentoring opportunities through ARG and PLTL b) easing students into programming via visual, project-based programming curricula in CS-0 and c) developing students' career and academic readiness through workshops is impacting the number of students, particularly Hispanic students, who are succeeding in computing courses. As we continue to follow students throughout their academic careers, we will ascertain whether the number of students pursuing and completing the computer science degree does in fact increase over time. The goals of the next funding cycle include expanding the number of CAHSI institutions as well as outside institutions utilizing the CAHSI model.

The evaluation of such a widespread, diverse program as CAHSI faces many challenges. Obtaining data from 7 institutions regarding student course enrollment requires many person-hours, and requires much turn around time, as offices vary in staff, funding, and numbers of requests. In some cases, evaluators receive data 5-6 months after it was requested. Involving P.I.s from institutions has helped in getting this data expediently, though each institutional research office has a unique method for collecting and presenting data (even in cases such as these where the format is prescribed by the evaluators), and much data cleaning is necessary before data can be analyzed.

A tension faced by the evaluation team is that between formative and summative assessment of the CAHSI program. The goals of the evaluation team include collecting, analyzing, and presenting CAHSI with data to inform their current practice, as well as evaluating the ways in which the interventions impact student behavior and outcomes. This tension may be alleviated somewhat with the addition of an internal evaluator to the CAHSI team, and with the addition of BPC common core indicators, currently being developed by a team of BPC evaluators in collaboration with Daryl Chubin of the American Association for the Advancement of Science (AAAS).

6 References

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

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

Bransford, J.D., Brown, A., & Cocking, R. (2000) (Eds.), *How People Learn: Mind, Experience and School, Expanded Edition.* Washington, D.C: National Academies Press.

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

Grandy, J. (1998). Persistence in science of high-ability minority students: Results of a longitudinal study. *Journal of Higher Education*, 69(6), 589-504.

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

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

Lent, Robert W.; Hackett, Gail; Brown, Steven D.(1999). A Social Cognitive View of School-to-Work Transition. *Career Development Quarterly, v47 n4* p297-311.

Lent, Robert W.; Brown, Steven D.; Sheu, Hung-Bin; Schmidt, Janet; Brenner, Bradley R.; Gloster, Clay S.; Wilkins, Gregory; Schmidt, Linda C.; Lyons, Heather; Treistman, Dana (2005) Social Cognitive Predictors of Academic Interests and Goals in Engineering: Utility for Women and Students at Historically Black Universities. *Journal of Counseling Psychology*. *Vol 52(1)*, p 84-92.

Margolis, Jane (2008). *Stuck in the Shallow End: Education, Race, and Computing.* MIT Press: Cambridge, MA.

Margolis, Jane, & Fisher, Allan (2003). *Unlocking the Clubhouse: Women in Computing.* MIT Press: Cambridge, MA.

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

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

National Science Foundation (2006). Women, minorities, and persons with disabilities in science and engineering. NSF 4-311, Arlington, VA: NSF.

Olson, D. & Torrance, N. (1998) (Eds.) *The Handbook of Education and Human Development.* Blackwell Publishers: Malden, MA.

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

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57(1)*, p.1-22.

Steele, C. & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69(5),* p 797-811.

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

Thiry, H. Hunter, A-B. & Laursen, S.L. (2009). Where do students become scientists? A comparative study of research and other sources of personal and professional gains for STEM undergraduates, manuscript submitted to the *Journal of Higher Education*.

Appendix B:
CAHSI Survey Instruments

CAHSI Affinity Research Group (ARG) student survey Spring 2008

1. CAHSI ARG SURVEY

The purpose of this survey is to understand the experience of students participating in undergraduate and graduate research. All data will be collected and analyzed by the ATLAS Assessment and Research Center at the University of Colorado at Boulder. Thank you for your time.

1. Which school do you attend?

- ◯ University of Texas, El Paso
- ◯ Texas A&M, Corpus Christi
- ◯ University of Houston, Downtown
- ◯ California State University, Dominguez Hills
- ◯ New Mexico State University
- ◯ Florida International University
- ◯ University of Puerto Rico, Mayaguez

2. What year in college are you?

- ◯ Freshman
- ◯ Sophomore
- ◯ Junior
- ◯ Senior
- ◯ Graduate/Master's
- ◯ Graduate/PhD

3. Please list all undergraduate and graduate research programs in which you have participated (e.g. AGEP, AMP, and GEM)

4. If you are a graduate student, did you participate in an Affinity Research Group (ARG) as an undergraduate?

- ◯ yes
- ◯ no
- ◯ not applicable

5. How long have you been in the research group?

- ☐ 1-2 semesters
- ☐ 3-4 semesters
- ☐ 5 semesters or longer

6. In the past year, I have (mark all that applies):

- [ ] Attended a professional conference, meeting or workshop
- [ ] Authored or co-authored a journal paper
- [ ] Presented a conference paper
- [ ] Prepared a poster for a conference

Please specify:

7. (For participants who are in graduate school or plan to go to graduate school) My decision to go to graduate school was most influenced by (mark all that applies):

- [ ] Parent/family member
- [ ] Faculty research mentor
- [ ] Faculty member
- [ ] Undergraduate peer(s)
- [ ] Graduate student(s)
- [ ] Research experience
- [ ] Other (please specify)

8. In the past year, the areas in which I have grown the most are (pick the top 3):

- [ ] Technical knowledge
- [ ] Research skills
- [ ] Communication skills (written and/or oral)
- [ ] Team skills
- [ ] Intellectual skills (critical thinking, problem solving)
- [ ] Personal growth (confidence, patience with setbacks)
- [ ] Clarification of my intended career path

9. ARG: Collaboration / distribution of tasks

In my research experience, or because of my research experience:

	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
I feel that I contribute to decisions that impact the direction of the group.	◯	◯	◯	◯	◯
My research group gives me feedback on my work.	◯	◯	◯	◯	◯
My research group gives me feedback on my oral presentations.	◯	◯	◯	◯	◯
I understand what my goals and tasks are for the semester.	◯	◯	◯	◯	◯
I understand how my own tasks relate to the greater goals of the group.	◯	◯	◯	◯	◯
I am challenged by my work in the research group.	◯	◯	◯	◯	◯
I feel confident that I can complete the tasks for my research.	◯	◯	◯	◯	◯
My mentor provides the amount of guidance I need to be successful.	◯	◯	◯	◯	◯
I have changed direction or approach to a research task based on feedback from my research group.	◯	◯	◯	◯	◯
I enjoy my time in the research group.	◯	◯	◯	◯	◯
When I have a problem, I am comfortable talking to my mentor(s) about it.	◯	◯	◯	◯	◯
I am comfortable disagreeing with my faculty mentor(s) and/or senior group members.	◯	◯	◯	◯	◯
(If your group has more than one faculty mentor): I am equally comfortable with all mentors.	◯	◯	◯	◯	◯
I feel equal to my peers, whether they are graduate or undergraduate students.	◯	◯	◯	◯	◯
I gained a sense of responsibility for the project.	◯	◯	◯	◯	◯

CAHSI Affinity Research Group (ARG) student survey Spring 2008

10. ARG: Skill/knowledge development

In my research experience, or because of my research experience:

	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
My problem solving skills have improved.	○	○	○	○	○
My oral presentation skills have improved.	○	○	○	○	○
My scientific writing skills have improved.	○	○	○	○	○
I have gained a lot of new knowledge about computer science.	○	○	○	○	○
I have gained a greater depth of knowledge about computer science.	○	○	○	○	○
I have become more creative in my thinking.	○	○	○	○	○

11. ARG: Computer science research interest/confidence

In my research experience, or because of my research experience:

	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
I have become more comfortable with trying new things on my own.	○	○	○	○	○
I became more interested in computer science in general.	○	○	○	○	○
I became more confident in my ability to do research.	○	○	○	○	○
I put extra work into this research project.	○	○	○	○	○

12. ARG: Process of Research

In my research experience, or because of my research experience:

	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
My knowledge from computer science courses seems more relevant (after participating in ARG).	○	○	○	○	○
I understand the process of computer science research.	○	○	○	○	○
I understand what everyday research work is like.	○	○	○	○	○

CAHSI Affinity Research Group (ARG) student survey Spring 2008

13. ARG: Academic Program / Career Readiness

In my research experience, or because of my research experience:

	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
I believe my resume has been enhanced.	◯	◯	◯	◯	◯
My faculty advisor has provided useful career advice/information.	◯	◯	◯	◯	◯
I have greater knowledge of career options.	◯	◯	◯	◯	◯
I have greater knowledge of education options.	◯	◯	◯	◯	◯
I feel more prepared for a career in computer science.	◯	◯	◯	◯	◯

14. The most important thing I accomplished in my research group this year was...

15. (Referring to above item) Why? Please explain your response.

16. Describe the process for resolving disagreements in your research group.

17. Did your research experience influence your thoughts and/or impressions about graduate studies?

- yes
- no

Please explain.

18. Did your research experience influence your thoughts and/or impressions about becoming a professor?

- yes
- no

Please explain.

19. Please indicate your gender:

- Male
- Female

20. What is your ethnicity?

- Hispanic/Latino/a
- African American/Black
- Caucasian/White
- Asian, from Indian subcontinent
- Asian, not from Indian subcontinent
- Native American

Other (please specify)

21. In which department is your major?

- Computer Science
- Computer Engineering

Other (please specify)

22. What is your overall GPA?

23. Additional Comments:

CAHSI PLTL Peer Leader Fall 2008

1. PLTL LEADER SURVEY

The purpose of this survey is to understand the experience of students participating in Peer-Led Team Learning (PLTL). All data will be collected and analyzed by the ATLAS Assessment and Research Center at the University of Colorado at Boulder. Thank you for your time.

1. Which school do you attend?

- ◯ University of Texas at El Paso
- ◯ Texas A&M, Corpus Christi
- ◯ California State University, Dominguez Hills
- ◯ University of Houston, Downtown
- ◯ New Mexico State University
- ◯ Florida International University
- ◯ University of Puerto Rico, Mayaguez

2. Please answer to the best of your ability with regard to your PLTL leader experience.

	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
I often think of better ways to facilitate PLTL sessions.	◯	◯	◯	◯	◯
Leading PLTL has improved my oral communication skills.	◯	◯	◯	◯	◯
I know the steps necessary to effectively communicate computing concepts.	◯	◯	◯	◯	◯
I generally facilitate PLTL sessions effectively.	◯	◯	◯	◯	◯
PLTL is an effective way to teach students will little background in computing.	◯	◯	◯	◯	◯
My role as a PLTL leader has increased my interest in a computing career.	◯	◯	◯	◯	◯
Leading PLTL has improved my teaching skills.	◯	◯	◯	◯	◯
Leading PLTL has increased my computing knowledge.	◯	◯	◯	◯	◯
I understand computing concepts well enough to be an effective peer leader.	◯	◯	◯	◯	◯
Leading PLTL has improved my interpersonal skills (in other words, my ability to cooperate with others).	◯	◯	◯	◯	◯
When I put more effort into my PLTL sessions, I see little change in students' achievement.	◯	◯	◯	◯	◯

CAHSI PLTL Peer Leader Fall 2008

Leading PLTL has improved my study skills.	◯	◯	◯	◯	◯
I am typically able to answer students' computing questions.	◯	◯	◯	◯	◯
Leading PLTL has improved my leadership skills.	◯	◯	◯	◯	◯
I question whether I have the necessary skills to facilitate peer-led team learning.	◯	◯	◯	◯	◯
I am confident in my ability to help students understand computing concepts.	◯	◯	◯	◯	◯
Leading PLTL has improved my decision-making skills.	◯	◯	◯	◯	◯
I am uncomfortable addressing students' questions.	◯	◯	◯	◯	◯
I am confident in my ability to motivate students.	◯	◯	◯	◯	◯

2. PLTL LEADER SURVEY

1. The most effective aspect of PLTL training was:

2. The one thing my PLTL training lacked was:

3. How would you describe your role as a Peer Leader?

4. What strategies or methods have been most useful to you as a Peer Leader?

5. What has been your greatest challenge as a Peer Leader?

6. Has your experience as a Peer Leader influenced your intention to go to graduate school in computing?

- yes
- no

Please explain

7. Has your experience as a Peer Leader influenced your thoughts and/or impressions about being a computer science professor?

- yes
- no

Please explain

8. How could you improve collaboration with the PLTL course professor?

CAHSI PLTL Peer Leader Fall 2008

3. PLTL LEADER SURVEY

1. What is your gender?

- Male
- Female

2. What is your year in college?

- Freshman
- Sophomore
- Junior
- Senior
- Graduate Student

3. What is your ethnicity?

- Hispanic/Latino/a
- African American/Black
- Caucasian/White
- Asian, from Indian subcontinent
- Asian, not from Indian subcontinent
- Native American

Other (please specify)

4. What is your overall GPA?

5. How many semesters have you served as a PLTL leader?

- 1
- 2
- 3
- 4
- 5

Thank you for your time!

PLTL Student Survey fall 2008

1. PLTL STUDENT SURVEY

The purpose of this survey is to understand the experience of students in Peer Led Team Learning (PLTL) courses. The data will be collected and analyzed by the Assessment and Research Center of the University of Colorado at Boulder. Please contact Sarah Hug hug@colorado.edu with any questions or concerns regarding this survey. Thank you for your time.

1. What is your PLTL course name and number?

2. What school do you attend?

- ○ University of Texas at El Paso
- ○ Texas A&M University Corpus Christi
- ○ Florida International University
- ○ New Mexico State University
- ○ California State University Dominguez Hills
- ○ University of Houston Downtown
- ○ University of Puerto Rico Mayaguez

3. Please rate your level of agreement to the following statements:

	Strongly Disagree	Disagree	Agree	Strongly Agree	I don't know
The PLTL sessions helped me to understand difficult computing concepts.	○	○	○	○	○
The activities in PLTL sessions prepared me for tests.	○	○	○	○	○
The activities in PLTL sessions helped me understand course material.	○	○	○	○	○
The activities in PLTL sessions helped me to learn how to solve problems.	○	○	○	○	○
I study with people from my PLTL session on my own time.	○	○	○	○	○
I feel comfortable asking my PLTL leader for individual help.	○	○	○	○	○
I would like PLTL in my other computing courses.	○	○	○	○	○
My professor took extra time in class to review material that students had difficulty understanding.	○	○	○	○	○
My participation in the PLTL sessions showed me that I could succeed in computing.	○	○	○	○	○
My participation in the PLTL sessions increased my confidence in computing.	○	○	○	○	○

I had confidence that my peer leader could help me.	◯	◯	◯	◯	◯

4. Has this course influenced your decision to take more computing courses?

◯ yes

◯ no

5. If it has influenced your decision to take more courses, how?

6. If Peer-Led Team Learning (PLTL) did help you, please explain how.

7. If Peer-Led Team Learning (PLTL) did not help you, please explain why.

8. What was the best part of the PLTL sessions?

9. What (if anything) would you change about the sessions?

10. What percentage of PLTL sessions did you attend?

- ◯ 0-50%
- ◯ 51-75%
- ◯ 76-90%
- ◯ 91-100%

11. What is your gender?

- ◯ Female
- ◯ Male

12. What is your ethnicity?

- ☐ Hispanic/Latino/a
- ☐ African American/Black
- ☐ Caucasian/White
- ☐ Asian, not from Indian subcontinent
- ☐ Asian, from Indian subcontinent
- ☐ Native American

Other (please specify)

PLTL Student Survey fall 2008

13. What is your major or intended major?

- ☐ Art
- ☐ Astronomy
- ☐ Biology
- ☐ Chemistry
- ☐ Communication
- ☐ Computer Science/Computer Engineering
- ☐ Creative Writing
- ☐ Criminal Justice
- ☐ Engineering (non Computer Science)
- ☐ English
- ☐ Environmental Science
- ☐ Ethnic Studies (Chicano Studies, African-American Studies, etc.)
- ☐ History
- ☐ Languages & Linguistics
- ☐ Mathematics
- ☐ Multimedia Design
- ☐ Music
- ☐ Philosophy
- ☐ Physics
- ☐ Political Science
- ☐ Psychology
- ☐ Sociology & Anthropology
- ☐ Theatre, Dance & Film
- ☐ Unsure

14. What is your overall GPA?

15. How many computing courses have you taken in college?

- 0
- 1
- 2
- 3
- 4
- 5 or more

16. How many math courses have you taken in college?

- 0
- 1
- 2
- 3
- 4
- 5 or more

CS-0 Pre-Survey Fall 2008

1. CS-0 PRE SURVEY

The purpose of this survey is to get background information from all students enrolled in [CS-0]. As this course is an introductory course, we expect many students will have few experiences in computing. The information we receive from students will help shape the course. You may discontinue participation at any time. If you have any questions regarding this survey, please contact Dr. Sarah Hug from the University of Colorado at Boulder, at hug@colorado.edu.

* 1. Please provide your birthdate (e.g. 05/27/1987) so that we can match your pre survey with your post survey information.

2. Did you take any courses in high school about technology (e.g. keyboarding, Microsoft Office, web design)?

- [ ] yes
- [ ] no

3. Please list technology courses here, if applicable.

4. Did you take any computer programming courses in high school?

- [ ] yes
- [ ] no

5. Please list high school computer science courses here, if applicable.

CS-0 Pre-Survey Fall 2008

6. What math courses did you take in high school? Please check all that apply.

- ☐ Pre-algebra
- ☐ Basic math
- ☐ Consumer Math
- ☐ Algebra I
- ☐ Algebra II
- ☐ Business Math
- ☐ Statistics
- ☐ Geometry
- ☐ Discrete Math
- ☐ Trigonometry
- ☐ Pre-Calculus
- ☐ Calculus

Other (please specify)

7. Have you programmed a computer before?

- ☐ Yes
- ☐ No

* 8. What school do you attend?

- ○ University of Texas at El Paso
- ○ Texas A&M University Corpus Christi
- ○ Florida International University
- ○ New Mexico State University
- ○ California State University Dominguez Hills
- ○ University of Houston Downtown
- ○ University of Puerto Rico Mayaguez

CS-0 Pre-Survey Fall 2008

2. UTEP

1. What is your course section number?

2. Please rate your interest in the following computing activities.

	Not at all interested	Somewhat interested	Moderately interested	Very interested
Writing computer programs	○	○	○	○
Using computer applications to do work	○	○	○	○
Assembling, configuring, or diagnosing computers and their installations	○	○	○	○
Using computer applications to edit multimedia	○	○	○	○
Playing games with computers	○	○	○	○
Specifying what a computer program will do (e.g. designing the characters or storyline of a game)	○	○	○	○
Learning about a field of engineering other than computing	○	○	○	○

3. Are you on an athletic scholarship?

○ Yes

○ No

3. PROGRAMMING

1. If you have programmed before, which programming languages have you used (fill in all that apply)?

- [ ] Java
- [ ] C/C++
- [ ] Scheme
- [ ] Python
- [ ] VisualBasic
- [ ] Alice
- [ ] None

Other (please specify)

CS-0 Pre-Survey Fall 2008

4. CS-0 PRE SURVEY

1. Have you taken any computer programming courses in college?

- [ ] yes
- [ ] no

5. COMPUTER SCIENCE IN COLLEGE

1. Please list college computer science course titles here, if applicable.

6. MATH IN COLLEGE

1. Which math courses have you taken in college? Please check all that apply.

- [ ] Basic math
- [ ] Consumer Math
- [ ] Algebra
- [ ] Business Math
- [ ] Business Statistics
- [ ] Business Calculus
- [ ] Statistics
- [ ] Geometry
- [ ] Discrete Math
- [ ] Linear Algebra
- [ ] Mathematical Modeling
- [ ] Differential Equations
- [ ] Trigonometry
- [ ] Calculus I
- [ ] Calculus II
- [ ] Calculus III

Other (please specify)

7. IMAGE EDIT

1. Have you ever edited an image using computer software such as Adobe Photoshop or Paintshop Pro?

- ◯ Yes
- ◯ No

CS-0 Pre-Survey Fall 2008

8. IMAGE EDITING

1. How would you rate your experience editing images?

- [ ] I have never done this
- [ ] I can do this with some guidance
- [ ] I can do this independently
- [ ] I can teach this to others

9. CS-0 PRE SURVEY

1. Have you ever edited video using software such as Adobe Premiere, Imovie, or Final Cut Pro?

- [ ] yes
- [ ] no

CS-0 Pre-Survey Fall 2008

10. VIDEO EDITING

1. How would you rate your experience editing video?

- [ ] I have never done this
- [ ] I can do this independently
- [ ] I can do this with some guidance
- [ ] I can teach this to others

CS-0 Pre-Survey Fall 2008

11. CS-0 PRE SURVEY

1. Have you ever created or edited music using software such as Sound Forge, ACID, or GarageBand?

- [ ] yes
- [ ] no

CS-0 Pre-Survey Fall 2008

12. MUSIC EDITING

1. How would you rate your experience creating or editing music?

- [ ] I have never done this
- [ ] I can do this independently
- [ ] I can do this with some guidance
- [ ] I can teach this to others

CS-0 Pre-Survey Fall 2008

13. CS-0 PRE SURVEY

1. Please use the scale below to rate the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree	I don't know	Not applicable (NA)
I am confident in my computer programming ability.	○	○	○	○	○	○
I enjoy problem solving.	○	○	○	○	○	○
I am confident in my math ability.	○	○	○	○	○	○
Computing is boring.	○	○	○	○	○	○
Programming is a creative activity.	○	○	○	○	○	○
Programming languages can be learned through practice.	○	○	○	○	○	○

2. Indicate how you would feel if you spent most of your work day:

	very satisfied	somewhat satisfied	somewhat dissatisfied	very dissatisfied	don't know
Constructing and completing a project	○	○	○	○	○
Analyzing the principles underlying a project	○	○	○	○	○
Having the flexibility to create new solutions for a project	○	○	○	○	○
Working on a project that directly improves others' lives	○	○	○	○	○
Focusing on a task that requires attention to detail and accuracy	○	○	○	○	○
Being the leader of an important project	○	○	○	○	○

3. Please use the scale below to answer the following questions.

	Very Likely	Somewhat likely	Somewhat unlikely	Very unlikely	I don't know	Not applicable (NA)
How likely are you to major in computing?	○	○	○	○	○	○
How likely are you to minor in computing?	○	○	○	○	○	○
How likely are you to take more computing courses?	○	○	○	○	○	○
How likely are you to pursue a graduate degree in computing?	○	○	○	○	○	○

CS-0 Pre-Survey Fall 2008

4. I enrolled in this course because (check all that apply):

- [ ] I was interested in the topic.
- [ ] This course was required of all students.
- [ ] This course was one of several courses that fulfill a general requirement.
- [ ] This course was recommended to me.
- [ ] This professor was recommended to me.

* 5. What do you hope to learn from this class?

* 6. How do you define computer science?

7. Would a career in computing interest you? Why or why not?

* 8.
What are your career goals when you graduate from college?

9. What is your gender?

- ( ) Female
- ( ) Male

CS-0 Pre-Survey Fall 2008

10. In what department(s) is/are your major(s)?

- [ ] Art
- [ ] Astronomy
- [ ] Biology
- [ ] Business
- [ ] Chemistry
- [ ] Communication
- [ ] Computer Science/Computer Engineering
- [ ] Creative Writing
- [ ] Criminal Justice
- [ ] Engineering (non Computer Science)
- [ ] English
- [ ] Environmental Science
- [ ] Ethnic Studies (Chicano Studies, African-American Studies, etc.)
- [ ] General Studies
- [ ] Health Sciences (Kinesiology, Nursing, Physical Therapy, etc.)
- [ ] History
- [ ] Languages & Linguistics
- [ ] Mathematics
- [ ] Multimedia Design
- [ ] Music
- [ ] Philosophy
- [ ] Physics
- [ ] Political Science
- [ ] Psychology
- [ ] Sociology & Anthropology
- [ ] Theatre, Dance & Film
- [ ] Unsure

Other (please specify)

______

11. What is your ethnicity?

- [ ] Asian, not from Indian subcontinent
- [ ] Asian, from Indian subcontinent
- [ ] Caucasian/White
- [ ] African American/Black
- [ ] Hispanic/Latino/a
- [ ] Native American

Other (please specify)

12. Did you earn college credit as a high school student?

- ○ yes
- ○ no

13. Did you receive college credit from a community college before attending this university?

- ○ yes
- ○ no

14. What year in college are you?

- ○ freshman
- ○ sophomore
- ○ junior
- ○ senior
- ○ graduate

15. Do you work?

- ○ yes, on campus
- ○ yes, off campus
- ○ no

16. If you are employed, approximately how many hours per week do you work?

- ○ 1-10
- ○ 11-20
- ○ 21-30
- ○ 31-40
- ○ more than 40
- ○ not applicable

17. What are your other obligations outside of school and work (e.g. family, sports, clubs, etc.)?

CAHSI CS-0 Post Survey fall 2008

1. CS-0 POST SURVEY

The purpose of this survey is to understand the student experience of CS-0 courses. Results will inform this course in the future. All data will be collected by the Assessment & Research Center at the University of Colorado at Boulder, and personal information will not be disclosed. Contact Sarah Hug hug@colorado.edu with any questions or concerns.

* 1. What school do you attend?

- ◯ University of Texas at El Paso
- ◯ Texas A&M University Corpus Christi
- ◯ Florida International University
- ◯ New Mexico State University
- ◯ California State University Dominguez Hills
- ◯ University of Houston Downtown
- ◯ University of Puerto Rico Mayaguez

* 2. Please provide your birthdate so that we can match your pre survey with your post survey information.

____

3. Please use the scale below to rate the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree	I don't know	Not applicable (NA)
I am confident in my computer programming ability.	◯	◯	◯	◯	◯	◯
I enjoy problem solving.	◯	◯	◯	◯	◯	◯
I am confident in my math ability.	◯	◯	◯	◯	◯	◯
I enjoy solving problems with computers.	◯	◯	◯	◯	◯	◯
The professor increased my interest in this course.	◯	◯	◯	◯	◯	◯
Programming languages can be learned through practice.	◯	◯	◯	◯	◯	◯
The class environment was conducive to asking questions.	◯	◯	◯	◯	◯	◯
Attending lectures helped me learn in this course.	◯	◯	◯	◯	◯	◯
Doing homework helped me learn in this course.	◯	◯	◯	◯	◯	◯
I learned skills from this class that will be useful in other areas of my life.	◯	◯	◯	◯	◯	◯
I learned technical skills from this class.	◯	◯	◯	◯	◯	◯
Working with others on assignments helped me learn in this course.	◯	◯	◯	◯	◯	◯
I developed my problem solving abilities in this	◯	◯	◯	◯	◯	◯

course.						
Programming is a creative activity.	○	○	○	○	○	○
Computing is boring.	○	○	○	○	○	○

4. Please use the scale below to answer the following questions.

	Very Likely	Somewhat likely	Somewhat unlikely	Very unlikely	I don't know	Not applicable (NA)
How likely are you to major in computing?	○	○	○	○	○	○
How likely are you to take more computing courses?	○	○	○	○	○	○
How likely are you to pursue a graduate degree in a computing discipline?	○	○	○	○	○	○

5. Course tasks: Please use the scale below to rate the following course tasks.

	very difficult	difficult	easy	very easy	not applicable
Homework	○	○	○	○	○
Labs	○	○	○	○	○
Quizzes	○	○	○	○	○
Midterm exams	○	○	○	○	○
Final exams	○	○	○	○	○

6. The following changes would increase my engagement in this course:

	I would prefer MORE of this	I would prefer the same amount of this (no change)	I would prefer LESS of this
Manipulation/creation of graphics and sounds	○	○	○
Designing and modifying of programs	○	○	○
Relevance of these projects to my intended career	○	○	○

7. Indicate your enjoyment of each of the following as related to course exercises:

	very satisfied	somewhat satisfied	somewhat dissatisfied	very dissatisfied	don't know
Having constructed and completed the project	○	○	○	○	○
Analyzing the principles required to solve the problems	○	○	○	○	○
Having the flexibility to "design your own" solutions	○	○	○	○	○
Recognizing how the solutions you developed could be helpful to others (as appropriate to the project)	○	○	○	○	○
Focusing on the details necessary to perfect your solutions	○	○	○	○	○
Directng others in completing the project	○	○	○	○	○

8. Please rate your interest or lack of interest in a career that involves the activities listed below:

	Not at all interested	Somewhat interested	Moderately interested	Very interested	I don't know
Writing computer programs	◯	◯	◯	◯	◯
Using computer applications to do work	◯	◯	◯	◯	◯
Assembling, configuring, or diagnosing computers and their installations	◯	◯	◯	◯	◯
Using computer applications to edit multimedia (sounds, pictures, videos, animations)	◯	◯	◯	◯	◯
Playing games with computers	◯	◯	◯	◯	◯
Specifying what a computer program will do (e.g. designing the characters or storyline of a game)	◯	◯	◯	◯	◯
Engaging in a field of engineering other than computing	◯	◯	◯	◯	◯

Comments or clarifications

CAHSI CS-0 Post Survey fall 2008

9. Has your interest in the following activities changed as a result of this course? If so, how? Please indicate below.

	I am MUCH LESS interested now	I am LESS interested now	No change	I am MORE interested now	I am MUCH MORE interested now	I don't know/Not applicable
Writing computer programs	○	○	○	○	○	○
Using computer applications to do work	○	○	○	○	○	○
Assembling, configuring, or diagnosing computers and their installations	○	○	○	○	○	○
Using computer applications to edit multimedia (sounds, pictures, videos, animations)	○	○	○	○	○	○
Playing games with computers	○	○	○	○	○	○
Specifying what a computer program will do (e.g. designing the characters or storyline of a game)	○	○	○	○	○	○
Engaging in a field of engineering other than computing	○	○	○	○	○	○

Comments or clarifications

10. Did you feel comfortable asking questions of the instructor?

- ○ Yes
- ○ No

Please explain

* 11. Think of one project or assignment that you were particiularly proud of. What was it?

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* 12. What made the project meaningful to you?

13. Has this class affected your confidence in using computers?

- yes
- no

Please explain.

* 14. How do you define computer science?

15. Would a career in computing interest you? Why or why not?

16. Do you have a close family member who works in engineering or programming?

- Yes
- No

* 17. What are your career goals when you graduate from college?

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18. What was your favorite element of the course?

19. How could the course be improved?

20. Please indicate your mother's (or closest female parental figure, such as grandmother, stepmother, aunt) highest level of education:

- Did not finish high school
- Graduated high school/received GED certificate
- Attended some college
- Earned a 2-year degree
- Earned a 4-year degree
- Attended some graduate school
- Earned a Master's degree (MA, MS, MBA)
- Earned a doctoral level degree (PhD. EdD, MD, DDS)

Comments/Clarifications

21. Please indicate your father's (or closest male parental figure, such as grandfather, stepfather, uncle) highest level of education:

- Did not finish high school
- Graduated high school/received GED certificate
- Attended some college
- Earned a 2-year degree
- Earned a 4-year degree
- Attended some graduate school
- Earned a Master's degree (MA, MS, MBA)
- Earned a doctoral level degree (PhD. EdD, MD, DDS)

Comments/Clarifications

22. What is your gender?

- Male
- Female

23. What is your ethnicity?

- Asia, from Indian subcontinent
- Asia, not from Indian subcontinent
- African American/Black
- Caucasian/White
- Hispanic/Latino/a
- Native American

Other (please specify)

24. What is your estimated GPA?

Appendix C:

CAHSI Reliability and Validity Information

CAHSI Survey Reliability and Validity information

Traditionally the survey developer must demonstrate that the survey is both valid—that is, it measures what it purports to measure—and reliable—that it can measure whatever it is measuring in a reproducible and consistent manner. The CAHSI evaluation employed several different surveys, some of these surveys were previously developed instruments that had already undergone extensive testing for reliability and validity, and other surveys were developed specifically for this evaluation. When appropriate, we conducted reliability and validity measures on the CAHSI surveys. To test reliability, we conducted an analysis on survey scales, called Cronbach's alpha. Cronbach's alpha is a coefficient of consistency that reflects whether answers to the separate items within a scale are the same—and thus measure some common construct consistently. Values near 1 mean the scale is internally consistent; values near zero mean the scale is not. Generally, in social science research, a measurement of 0.7 for Cronbach's alpha is acceptable (Nunnaly, 1978). In addition, we enhanced the validity of surveys by grounding survey constructs on previous social science research and, when possible, conducting "think aloud" interviews with samples of students. "Think aloud" interviews help survey developers to determine how survey respondents interpret questions and, therefore, whether the survey constructs are coherent and valid. The samples in this study were not large enough to conduct other types of statistical validity studies (such as factor analysis).

To develop the Affinity Research Group survey, evaluators combined two survey instruments. The first was a survey employed by UTEP to evaluate their research programs and the other instrument, the Undergraduate Research Student Self-Assessment (URSSA), was developed by our group with funding from the National Science Foundation to evaluate outcomes from a broad array of undergraduate research programs. The URSSA has undergone extensive piloting, and reliability and validity testing. Because the Affinity Research Group survey developed by evaluators was grounded in qualitative data (Hunter et al., 2007; Seymour, et al., 2004; Thiry et al., 2009), we knew the survey addressed the "right" items. That is, we probed for gains that we already knew students could achieve from UR, and thus the underlying constructs of the survey are valid. However, we did not know whether the survey items were constructed in a way that enabled respondents to recognize these gains from reading them—that is, whether the survey items themselves were valid. Therefore, we conducted extensive piloting of the instrument with a diverse national sample of students through "think aloud" interviews. These interviews helped us to refine survey items to ensure that research students interpreted items in the manner intended by survey developers.

While validity measures address whether the survey items are measuring something meaningful and well-defined for the respondent and survey developer, reliability measures address whether the survey measures a particular construct consistently—would the respondent answer the same way twice, or would two respondents with very similar experiences respond the same way? We did conduct some studies to examine the instrument's reliability. It is important to note that these studies were conducted not on individual survey items but on "scales" or cumulative measures of clusters of related gains—such as career clarification, understanding of the research process, collaboration, and skills, among others. Each of these clusters, or scales, came from the original qualitative findings on which the survey was grounded (Hunter et al., 2007; Seymour, et al., 2004). Reliability of these scales was conducted using the measure known as Cronbach's alpha, a coefficient of consistency that reflects whether answers to the separate items within a scale are the same. A value of .7 or above is generally acceptable in social science (Nunnaly, 1978). The Cronbach's alpha value of the scales on the ARG survey is as follows:

Project scale=.81
Collaboration scale=.69
Skills scale=.87
Personal growth=.85
Research process=.71
Career clarification=.87

As the high values of Cronbach's alpha show for all groups, the internal consistency of the scales is very high, independent of the sampled group. In other words, we can expect consistent and reliable responses to the items on these scales.

The evaluators also employed several methods to increase the "construct validity" of the survey. "Construct validity" is the type of validity that ensures that what you think you are asking about is really what you are asking about—that the respondent understands the construct being probed in the same way that the surveyor does. Some degree of construct validity was achieved by grounding the data in previous qualitative findings. In addition, all of the scales, with the exception of several items on the "collaboration" scale which were adapted from a previous instrument utilized by UTEP, were piloted with diverse groups of undergraduate research students in "think aloud" interviews. Evaluators increase the validity of a survey through "think aloud" interviews by asking a sample of students to complete the survey and discuss what they thought each question was about, and why they answered the questions the way they did. Survey developers can then determine whether students' understanding of the survey items and survey scales were what they intended.

The survey instrument utilized to evaluate the peer leader outcomes was the "Science Teaching Efficacy Belief Instrument (STEBI)" (Enoch & Riggs, 1990). This instrument was originally developed to measure the self-efficacy and outcome expectations of pre-service science teachers. CAHSI evaluators adapted the instrument by replacing any reference to "teachers" or "teaching" on the survey with "peer leaders" or "peer leading." Enoch and Riggs (1990) conducted extensive reliability and validity tests on the STEBI instrument and the survey has been widely used in studies of novice STEM teachers or teaching assistants. A more recent study utilized factor analysis to re-examine the integrity of the survey scales and reported results similar to those reported by the original survey developers (Bleicher, 2004).

CS-0 surveys were given to the evaluators for use with all CAHSI schools. No reliability or validity information was available for this instrument.