# Increasing Hispanic Engagement in Computing Through Service Learning

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## Abstract

Shortages of college graduates in computing studies imperil the nation's ability to remain economically competitive. Hispanics—the fastest growing U.S. workforce segment—have historically shown low employment levels in computing fields. By 2020, Hispanics will account for 50% of the workers in California, and, by 2050, the Hispanic population is projected to triple in the United States with 25% of the U.S. population being of Hispanic-Latino origin.

The Hispanic Computer Brigade (HCB) project at San José State University (SJSU) is aimed at recruiting and retaining Hispanic high school students into computing. Hispanic Computer Brigade, an informal education program, incorporates socio-cultural methodologies and best practices that have been found effective with Hispanic learners. The pilot project consisted of a one-week residential summer computer camp, Silicon Valley Computer Camp, and after-school Hispanic Computer Brigade Clubs for computing service-learning projects. To inspire and support learning computing among Hispanic Computer Brigade students, Hispanic Computer Brigade built a support network of peers, teachers, family members, mentors, and computer professionals. The goals were to: (1) generate awareness among students and parents about higher education and career opportunities in computing, and (2) increase the recruitment and retention numbers of Hispanic students' participation in the Hispanic Computer Brigade.

The preliminary results from the Hispanic Computer Brigade project are promising. The Silicon Valley Computer Camp provided students with an opportunity to learn basic computing skills and the Hispanic Computer Brigade Clubs encouraged them to work on computing projects throughout the year. The assessment indicated that establishing club environments where students' interest in computing could grow and thrive required smaller incremental steps than originally planned. Although we faced initial challenges in establishing Hispanic Computer Brigade Clubs at two local high schools, the students were enthused about participating in the Silicon Valley Computer Camp and Hispanic Computer Brigade activities, which was reflected by the increase in the number of students from 22 to 39 during a one-year period.


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## Introduction

The United States is facing a computing workforce crisis. According to the U.S. Department of Labor, jobs in computer-related fields are expected to be among the fastest growing occupations in the next decade with an estimated need for 700,000 additional technology workers in the United States [1]. Shortages of well-qualified computer graduates imperil the nation's ability to remain competitive in a global economy increasingly driven by technology innovations. Promoting computer studies is a national imperative, particularly among Hispanics—the fastest growing U.S. workforce segment and projected to account for 50% of the California workforce by 2020 [2]. By 2050, the Hispanic population is projected to triple in the United States [3, 4] with 25% of the U.S. being of Hispanic/Latino origin [5].

San José State University (SJSU), in the heart of Silicon Valley, is in a unique position to attract Hispanic students to engineering. Among all regions in the nation, Silicon Valley has the highest percentage (13%) of its workforce in technological occupations. It has been the technology center of the world, known for advancing technology frontiers from semiconductors to networking to software to web technologies. Also, SJSU is situated in one of the most diverse parts of the western United States. Although our campus community draws students from an increasingly wide area, the diversity of the population of Santa Clara County and the City of San José is reflected in the composition of our students, faculty, and staff. The 1.8 million residents of Santa Clara County are 44% white, 26% Asian, 24% Latino/a, and 3% African American. Leveraging the intellectual resources in Silicon Valley and the high percentage of K-12 Hispanic students gives SJSU a unique advantage to attract and engage the next generation of Hispanic engineers.

The Charles W. Davidson College of Engineering (CoE) at SJSU proposed a new approach for recruiting Hispanic students into computing studies and careers through the *Broadening Participation in Computing—Hispanic Computer Brigade* initiative. By forming Hispanic Computing Brigades in two local high schools, we hoped to inspire and engage Hispanic students through information technology (IT) service learning projects. The first segment of the HCB program was the Silicon Valley Computer Camp. The Silicon Valley Computer Camp was held on June 22-26, 2009, with a total of 22 students from two local high schools. At the summer camp, students built their own computers and were taught a range of fundamental computing skills to equip them to create socially relevant projects for their local communities during the academic year. The second segment of this pilot project was the Hispanic Computer Brigade clubs. The students who participated in the Silicon Valley Computer Camp held after-school Hispanic Computer Brigade club meetings at their respective high schools to work on community-oriented computing projects.

## Engaging Students through Informal Learning Environments

Informal learning has been identified by the Academic Competitiveness Council as one of the three key components (along with K-12 and higher education) to ensure that U.S. educational institutions produce citizens who are literate in STEM concepts, and future scientists and engineers who will secure continued U.S. economic competitiveness [6]. Informal education—such as after-school programs, clubs, science centers, camps, and

museums—is believed to increase student inquiry, enjoyment, and a sense that science learning can be personally relevant and rewarding. A 2009 National Research Council (NRC) report [7] strongly indicates that informal environments can make substantial contributions to STEM education and broaden participation. Hispanic Computer Brigade incorporated the methodology and best practices cited in the NRC report, in particular, the "strands of science learning" framework to organize and assess science learning supported by informal environments. Strands 1 and 6 of that framework had singular application to Hispanic Computer Brigade:

> Strand 1—Identifies personal interest and enthusiasm as being important to student involvement in science learning. Examples that support this strand include interest groups and after-school programs. Its assessment is based on the participant's interest and motivation to undertake activities that promote learning and emotional associations, with interest as the major factor helping students learn and retain.
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> Strand 6—Emphasizes the science learners' concept of themselves as individuals who know about, use, and sometimes contribute to science. "Enculturation" involves developing one's identity as part of a community and informal environments can influence one's developing identities as science learners. Educational programs that help students develop identities, solidify social networks, and provide access to scientific communities and careers address this strand. An example is that a long-term study found that science center interns who received mentoring and support experienced enhanced personal learning that led them to choose science-related careers.

The Hispanic Computer Brigade project adopted the precepts of Strands 1 and 6 through activities generating excitement and interest, and integration of achievable hands-on projects appropriate to the student level and ability. Student involvement in Silicon Valley Computer Camp and weekly Hispanic Computer Brigade Clubs, in which they had extensive and repeated exposure to mentors and role models, encouraged the enculturation factor of Strand 6. Through this integration of activities, we hoped to examine the different cultural and familial factors that influence environments impacting individuals' identities as science learners.

**Motivating Hispanic Students through Social Applications**

The Hispanic Computer Brigade was anchored in the theoretical foundation that the future of computing education must include practical student experiences. Students require "not only the knowledge needed but how to use the knowledge in authentic contexts [8]." Several studies over the past decade [9, 10, 11] have led to the same recommendation for engineering education: engineering students need to acquire traditional engineering fundamentals, but also must develop skills to use their disciplinary knowledge in real-world situations.

As for the types of projects that are most appealing to Hispanic students, it is found that traditional engineering projects such as building robots and bridges are not the most effective with students of color and women [12, 13]. In other words, an approach using

"technology for technology's sake" does not appear to work for women and Hispanic students. To date, most educators have been using this approach, but several studies [14, 15, 16] show that Hispanic students generally have greater intrinsic motivation or underlying interests in social and relational issues; that is, they could be attracted to computing if it were presented in a social context as a means to solve "community problems" that were meaningful to them. Therefore, one key component for the Hispanic Computer Brigade program was to engage students in the use of computers to advance their personal interests in serving humanity or giving back to the community. As they learned of the utility of computing, they were inspired to further the development of technology to meet their desire to serve, thereby aligning their personal interests with the pursuit of computing.

Another key component for the Hispanic Computer Brigade was the design and implementation of a social support network for the students to develop a sense of "belonging," which is necessary for their expansion into and maintenance of computing interests. Networking with teachers, mentors, and their peers not only provided them with a sense of belonging but also changed their culture of computing at their high schools. Hispanic Computer Brigade activities incorporated a supportive approach through hands-on projects and activities emphasizing collaborative teamwork and support from the Hispanic Computer Brigade mentors. Based upon research that shows that school-based, structured, extracurricular activities are associated with positive adolescent outcomes [17] and additional research that reveals that adolescents both teach and learn from each other [18, 19], the Silicon Valley Computer Camp structure encouraged peer interactions and the development of student support systems. That concept was broadened in the Hispanic Computer Brigade Clubs through weekly meetings with peer mentors to conceive and develop community service projects.

## HCB Project Goals

The purpose of the Hispanic Computer Brigade project is to develop an innovative approach of stimulating and sustaining Hispanic students' interest in learning and applying computing and embed this project in SJSU College of Engineering's demonstrably successful efforts in recruiting and retaining Hispanic students. The goals of this project are to provide a program that:

- **L**inks service learning to participants' interests in computing disciplines;
- **E**xposes participants to accessible and relatable role models in computing;
- **A**dvances participants' likelihood to pursue careers in computing;
- **D**evelops (or enhances) participants' positive attitudes towards computing.

## Description of the Silicon Valley Computer Camp

The Silicon Valley Computer Camp was a collaborative project between schoolteachers and administrators, industry leaders, and university professors. It took six months to design and implement a residential camp experience at SJSU, which comprised both programmatic components and support networks. The summer camp was the first step in building a sense of community within the student's high schools and at the college level that might positively affect their college aspirations.

We adapted our camp curriculum from the Colorado School of Mines [20, 21]. The Colorado School of Mines utilized basic computer programs to teach middle school students about computer engineering and programming, including ALICE basic programming software [22], Lego Mindstorms robot kits, FrontPage website design, and GPS tracking systems. Silicon Valley Computer Camp students built their own computers, which they were invited to keep (a particularly powerful appeal given that less than one in two Hispanics own home computers [23]).

An important aspect of our summer camp was the inclusion of student mentors. We divided the student mentors into three categories to provide different interactions with the high school students: (1) computing mentors, (2) residential leaders, and (3) social mentors. Each category had a different responsibility and purpose within the camp structure. For example, the residential leaders supervised the high school students during nighttime hours, the social mentors were recruited from the SJSU student chapter of SOLES (Society of Latino Engineers & Scientists) to participate in evening activities (e.g., bowling, board games, and movies), and the computer mentors assisted with all computer-related lesson plans. The purpose of the student mentors was to bridge the gap between high school and college. In many ways, the high school students could relate to the university students and could learn about college through casual conversations. Through our intensive mentoring, we hoped to expand the students' perceptions of their communities and provide them with links to the university.

Many of the student mentors were recruited from engineering disciplines and could draw upon their own educational experiences to encourage and mentor the high school students. Each mentor was trained by Dr. Andrew Wood, Director of the SJSU Peer Mentor Program. The mentors attended a one-day session, which prepared them to be effective mentors and positive influences on the high school students. Topics in the peer mentor training included: principles of mentoring, effective listening, personal assessment of learning styles, dealing with stress while mentoring, motivational strategies, boundary setting, and code of conduct.

On Day 1 of the summer camp, Silicon Valley Computer Camp activities focused on building a computer. To control for gender stereotyping, the students were separated by gender into two adjacent work rooms. Research shows that women are socially conditioned to avoid technology [24]. When they participate in STEM fields, they do not expect to succeed because of gender stereotyping [25]. By separating the participants, the girls were encouraged to work together to solve computer-related issues.

On Day 2, students installed software onto their computers. An afternoon visit to The Tech Museum of Innovation in downtown San Jose afforded students a hands-on and interactive learning experience. Computer programming was the focus on Day 3. We selected ALICE software because it benefits students with weak math skills and/or little programming backgrounds, enabling their success in computing [26]. Students continued to practice programming skills by constructing PicoCricket robots on Day 4. This program includes a "drag and drop" interface which reduces human error, creating a positive learning environment that has greater student appeal than traditional robot kits [27].

Figure 1. Computer mentor (left) guided students through computing activities

After dinner each night, corporate representatives from high-tech companies such as Google, IBM, Microsoft, and AnyBot were invited to speak to the students about careers in computers (see Table 1). Many of the speakers were of Hispanic origin, and they were encouraged to discuss their pathway into computing and offer advice for minority students. The guest lecturers had the opportunity to connect with young students and share some advice that might prepare students for computing careers. The students were excited to meet the guest lecturers and learn, firsthand, exactly what a computing career might entail. We also hosted a student panel with several of the SJSU student mentors as well as faculty. Collectively, the student mentors represented five engineering disciplines within the College of Engineering, and they discussed their career goals and explained why they chose engineering careers. Halfway through the panel, the high school students asked the camp instructors about their areas of expertise. The high school students wanted to know what led the faculty to become teachers and what degrees they had earned. The student panel fostered a discussion with the students about their own plans for college and what fields of study they might like to pursue.

Table 1. List of Industry Speakers

| **Company** | **Representative** |
|---|---|
| IBM | Dulce Ponceleón |
| Google | Gaby Aguilleras, Luiz Mendes, Raquel Romano |
| AnyBot | Benjie Nelson |
| Microsoft | Claudia Galvan |

On the final day, students "brainstormed" activities for the Hispanic Computer Brigade Clubs and presented their projects to their parents. The week concluded with a banquet attended by student participants, staff, faculty, and the students' families. Many siblings and extended family members attended to celebrate the students' accomplishments. Each student received a certificate and SJSU memorabilia.

As a follow-up to the summer computer camp, Microsoft hosted a daylong event on its Silicon Valley campus for Hispanic Computer Brigade participants (as well as 13 other

Hispanic students) on October 25, 2009. For most students, visiting one of the world's leading high-tech companies located just miles from their homes was an exciting, memorable experience.

**Description of the Year 1 Hispanic Computer Brigade Club Activities**

During the 2009-2010 academic year, participants formed HCB Clubs at their high schools to continue learning about computing. School 1 met weekly and School 2 met every two weeks to develop community service projects that positively affected their local communities (see Table 2). We defined community to include the students' peers, their schools, families, neighborhoods, and, ultimately, the larger community. The Hispanic Computer Brigade activities were situated in a learning ecology framework, which posited that student learning takes place across multiple settings including school, home, and the community [28, 29, 30]. These community environments constituted the socio-cultural learning environments for the Hispanic Computer Brigade Clubs.

Table 2. HCB clubs projects during 2009-2010

| **Project Name, School** | **Description** |
|---|---|
| HCB Club Websites, School 1& 2 | The students at both schools spent several weeks learning HTML code and website management. Their websites are designed to keep their peers, family, and community members informed of the club's activities. |
| Dove Hill Robotics Club, School 2 | Twice a month, students from School 2 walked to an elementary school to provide support to their local robotics club. In the process of mentoring elementary students, the high school students improved their programming skills, learned more about robotics, and encouraged children to pursue math and science. |
| Technology Forum, School 2 | The students designed a forum to share computer information with their peers, families, and teachers. The forum topics included fixing and building a computer, making a website, software assistance, and technology "slick" deals. |
| Sports Database, School 1 | The students created a Microsoft Access database to track student athletes. The purpose of the database is to monitor the athletes' positions, identify which sports they play, record their academic eligibility, and note whether they have received recognition. This database will accumulate information over time and generate more detailed reports each year. |
| Adult Education Workshop, School 1 | The students had a chance to place themselves in their teachers' shoes by giving two adult education workshops to Latino/a adults in the local community. The workshops focused on creating and using email accounts. The students planned the presentation, scheduled the computer lab in the high school library, and gave bilingual lessons. |
| PicoCricket Kids Workshop, School 1 | The students gave two one-hour workshops with interactive "PicoCricket" robots for elementary children (ages 5 to 10). Using play dough, food, and computer sensors, the children made their own music. |
| Online Math Workshop, School 1 | The students gave a computer tutorial to children (ages 5 to 10) on where to find and play online math games. These games are an educational and fun way for children to improve their math skills. |

In June 2010, Hispanic Computer Brigade students presented their projects to an audience of high school teachers, SJSU faculty, parents/guardians, and community members, as the culmination of a year of learning and growth. Students received awards recognizing their accomplishments in planning and implementing community projects, and learning new skills within the Clubs.

**Assessment of the Hispanic Computer Brigade Program after Year 1**

Steve Schneider and Susan Arbuckle of West Ed served as the evaluation team for the Hispanic Computer Brigade program. The evaluators employed multiple methods following the implementation of the Silicon Valley Computer Camp and Hispanic Computer Brigade Clubs. Two online surveys were created and given to the students at the beginning and end of their one-week summer session to measure attitude, interest, use, and self-efficacy (pre); and student perception of the utility and value of the week's content and organization (post). Two observations were made during the Silicon Valley Computer Camp, including the introduction and closing, lectures, hands-on activities, and parent presentations. Interviews were conducted with the project director, two SJSU student mentors, and 3 high school club advisors. One club meeting at School 1 was observed.

Figure 2. HCB students teaching PicoCricket to elementary students

From the outset, implementation of the Silicon Valley Computer Camp presented real-life challenges to the project directors, which they handled with fluidity. Bringing a co-ed group of 24 high school students (ages 14 – 17; 9 girls and 15 boys; 21 Latino/a and 3 African American), who do not already know one another, to spend 4 nights and 5 days living at the university; hosting their parents; arranging for a number of professors, mentors, counselors, guest speakers, meals, social recreation, tours, and field trips; and supplying all the hands-on materials for each computing activity required extensive planning and execution. Four students who did not show up had to be replaced at the last minute from the wait list; one student dropped out after the first day; and estimated time schedules had to be tweaked to allow for unanticipated needs and delays. Overall, the mechanics and logistics proceeded relatively smoothly, with quick thinking and behind-the-scene actions on the part of the project director and her assistants.

The Hispanic Computer Brigade clubs in Year 1 evolved differently at each school, with School 1 experiencing more success than School 2. At both sites, the respective mentors and advisors made an effort to guide club members and simultaneously enable them to implement

their community service project. Attendance and sustained interest at School 2 was low, but the reasons are varied, and not all the intertwining factors are readily apparent. At School 2, the club met in a large computer lab that felt less like a home base. Lack of involvement was addressed in earnest by players at each level; the mentors, advisors, as well as visits by the project director and phone calls to student homes.

At School 1, where club attendance was higher and more regular, club members were able to meet in the classroom of a very accommodating science teacher who made herself available for extended hours, and who heads the Advancement Via Individual Determination (AVID) program. The second advisor at this school was a counselor who already worked in outreach and with parents. However, even in this supportive setting, there was a delay in HCB club activities because the students had no easy access to computers until the slow machinations of the district bureaucracy allowed SJSU to install five new computers devoted to the Hispanic Computer Brigade.

Starting with a blank slate was perhaps more overwhelming for novice students than it was conducive to their creativity and engagement. If the plan of the club was for its members to devise and execute a community service project based on computer use, the students may have felt daunted before they even began. It is difficult to think in terms of helping others in a field in which you yourself are a novice. One student cited the desire for the club to be already "up and running" in order to attract her, while another attributed his lack of interest to the fact that little is accomplished since few attended.

The assessment indicated that establishing club environments where student interest in computing could grow and thrive was a slower building process that necessitated much smaller incremental steps than originally imagined. As one advisor stated, "More focus on getting the club started needs to be implemented. Roles should be defined and leadership skills honed. Our community needs basic technology help first." Advisors at School 1 were confident that this first year of the program constituted a steep learning curve and that now they know which obstacles to tackle so that next year significant progress can be made with student engagement.

The predicament of lower-than-expected student engagement can be partially understood by consideration of this target population's lack of immersion throughout life in a wide variety of computer use. Authors of a recent study [31] point beyond the simplicity of the digital divide notion to the existence of a multidimensional construct which may help explain Hispanic Computer Brigade student reticence. It is not only lack of computers and Internet in the home but also an encompassing array of factors that distance students from jumping into the Hispanic Computer Brigade offerings. Even though they are growing up in Silicon Valley, their demographic and socioeconomic variables isolate them from the full impact of the technological revolution and predict shallow breadth and depth of technological encounters. They are less likely than students from more affluent communities to have parents who use computers for work, who buy technology and bring it into the household, who offer direct explanations for technological tools or phenomenon, or who create opportunities for their children to find out more about computers through co-activities, camps, clubs, neighbors, relatives, and peers. This lack of experience and access tends to deflate students' confidence, interest, and knowledge of the advantages of computing. The

students' learning ecology, defined as the existing interdependencies of variables between the student and his/her environment, is somewhat barren. Learning opportunities provided by HCB in the informal setting of the after school club and summer induction may have the power to mediate student reluctance once a critical mass of students are engaged and projects are undertaken. The energy of peer networking (committed friends attract other friends to actively join in) may carry the momentum as long as logistical barriers (such as scheduling conflicts or lack of equipment) are not prohibitive.

**Description of the Year 2 Hispanic Computer Brigade Club Activities**

Certain elements of the pilot's deployment in Year 1, academic year 2009-10,—in particular, the operation of Hispanic Computer Brigade Clubs—revealed areas for improvement. For example, allowing students to select an open range of community service projects was not a successful strategy as students were sometimes uncertain about what to do, and some of their selected projects were outside their technical competencies. As a result, the students were not as engaged in those Club activities and tended to lose motivation.

The Year 2 proposed Hispanic Computer Brigade club design for academic year 2010-11 incorporates programmatic changes based on preliminary evaluation results from our external evaluator. The plan for our HCB clubs during Year 2 includes more structure for the Hispanic Computer Brigade Clubs, new computing modules with higher rates for achieving successful outcomes, and a redefinition of community service in relation to student projects.

During the first year, we identified challenges that hindered Club progress. In Fall 2009, one partner high school found it difficult to establish Club activities due to poor leadership. The other high school successfully engaged students in Club activities by drawing upon a network of resources. We learned that successful Club leadership did not necessarily correlate with computer experience; rather, Club advisors needed the agility to navigate academic bureaucracy to implement and plan Club activities.

Another major challenge was a lack of confidence by students in directing Club activities. In Spring 2010, the Hispanic Computer Brigade student mentors began to create mini-lessons that they presented to the students at each Club meeting. A revised Hispanic Computer Brigade Club approach for Year 2 lets students choose their curriculum within a series of pre-selected community projects, or modules, starting with simple to progressively harder activities over the year. Sample modules include building a website, creating an animated database of Hispanic computer professionals, refurbishing old computers, creating video tutorials, and teaching adults about computers. These activities are examples of projects that research has shown will increase fluency in computing and will be compelling for youth [32, 33].

We are focusing the Hispanic Computer Brigade Club projects in the Fall 2010 semester to benefit the local school community. Spring-semester projects target family members and students' neighborhoods. The modules reflect a systematic program change that will allow students to progress from beginning computer concepts to more difficult concepts over the

span of one year, as research has indicated that adolescents will be more motivated to be involved in activities in which they feel competent [34].

## Conclusion

The reasons underlying Hispanic underperformance in computing studies and lower entry numbers into computing professions are varied and complex [35]. Negative attitudes developed toward science by the time of secondary education can contribute to low entry numbers in STEM fields [36]. Studies reveal that certain methodologies are effective in developing Hispanic student interest in STEM subjects and in motivating them to continue in those studies.

Hispanic Computer Brigade advances knowledge and understanding of effective methods to recruit and retain Hispanics to computing fields. It enhances Hispanic students' interest in computing by enabling them to apply their growing mastery of hardware and software in solving problems in their community, thus making their computer education immediately relevant and culturally rewarding. By creating an informal learning program that engages Hispanic students, HCB offers an innovative model on how immersive and personal outcomes-based learning environments can engage students' interest in and motivation for learning skills and knowledge related to computing.

Based upon our assessment of Hispanic Computer Brigade students' high school transcripts, many Hispanic Computer Brigade students have persisted in their math and science courses. 70% of HCB students (13 out of 20) have passed their math courses in the previous two semesters. 55% of HCB students (11 out of 20) have taken advanced math and science courses that exceed their high school graduation requirements. Over half of the Hispanic Computer Brigade students are preparing themselves for careers in computing disciplines. Among our two high school graduates, one has already decided to pursue computer engineering at the University of California, Davis.

The Hispanic Computer Brigade is premised on an informal learning experience model. We have found through our pilot program that our Hispanic Computer Brigade model for informal education can increase student interest and enjoyment of computing. The Hispanic Computer Brigade provides a new approach for increasing the participation of Hispanic students in computing by developing programs that utilize students' internal and social process for learning as well as leveraging local partnerships with technology companies and organizations. The new approach presents computing in a social context with applications that are meaningful to target students. As it focuses on applications instead of technology, it could attract students who otherwise would not consider studying computing in college, especially those in underrepresented groups. The result will be a larger talent pool that is critical for the U.S. if it aspires to innovate and lead in information technology.

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JANET SUNDRUD is a graduate student in the Department of Communication Studies. She studies issues related to gendered identities, intercultural diversity, and critical assessment. Since 2008, she has worked with the SJSU College of Engineering on several college-wide initiatives and assisted in the implementation of the HCB program.