WIP: CAHSI Allyship Program: An Asset-Based Approach to Build Computing Communities for Students Success at HSIs

Sanga Kim
Computing Alliance of Hispanic-Serving Institutions
The University of Texas at El Paso
El Paso, U.S.A.
skim12@utep.edu

Shiva Darian
Computer Science
New Mexico State University
Las Cruces, U.S.A.
shiva@nmsu.edu

Natalia Villanueva-Rosales
Computer Science
The University of Texas at El Paso
El Paso, U.S.A.
nvillanuevarosales@utep.edu

Nayda G. Santiago
Electrical and Computer Engineering
University of Puerto Rico, Mayagüez
Mayagüez, Puerto Rico
naydag.santiago@upr.edu

***Abstract*—This work-in-progress (research-to-practice) paper describes the Allyship program that has been implemented at Hispanic-serving institutions (HSIs) to build student support structures, particularly for women and non-binary students. As technology permeates through all aspects of our world, broadening participation in computer science education is critical to securing sustainable national technology and economic development. Unfortunately, women, especially ethnic and racial minority women, have been underrepresented in computing fields for decades. The trends in the number of bachelor's degrees in computing awarded to Latina students have not improved over the past twenty years, consistently accounting for less than 2% of the total number of undergraduate degrees awarded in computing. Most programmatic practices generally feature broader STEM disciplines, are not discipline-specific, and do not specifically support women and non-binary students in computing, which is the least diverse STEM field. Furthermore, most studies of mentoring programs rely primarily on graduate students, faculty, and professional mentorship. To fill the gap in practices and knowledge about the role of near-peer mentoring, explicitly focusing on women and non-binary students in computing fields at Hispanic-Serving Institutions, the Computing Alliance of Hispanic—Serving Institutions (CAHSI) an NSF Eddie Bernice Johnson INCLUDES, and BPC Alliance piloted the Allyship program at two HSIs. This paper describes how CAHSI implemented this program in a way that aligns with the theory of community cultural wealth. The Allyship program builds relationships among first- and second-year Latinx students with upper-division Latinx students in computing to build an inclusive community and supportive departmental environment. The goal of the Allyship program is to increase departmental engagement, retention, and persistence in the major. Preliminary assessment results from a participant survey show that following participation, students reported higher scores of sense of belonging, self-efficacy, and interest in computing compared to the beginning of the semester. The findings provide insight into using a strengths-based approach in peer support programs that allows women and non-binary students at HSIs to leverage their cultural knowledge and assets. This peer support program would be particularly impactful at low-resourced HSIs, which have high Hispanic enrollment but lack sufficient institutional resources, as the institutions can make significant changes with relatively low costs to implement sustained peer-to-peer support programs.**

Keywords—Peer-mentoring, Broadening Participation, Computing Education, Women of Color, Latina

I. Introduction

Gender disparity in degree attainment and the workplace within computing is extensively documented. According to the American Association of University Women, female students make up about 19% of total computing degrees, trailing behind male students [1]. These numbers are even lower when considering the number of women from non-dominant racial and cultural backgrounds. Black women and Latinas make up only about 2% and 3% of the computing workforce [2]. Among women of color, the persistent underrepresentation of Latinas in computing has posed a significant challenge to diversifying the field to meet national needs. Between 2013 and 2021, the percentage of Latinas completing bachelor's degrees in computing at 4-year institutions remained at 2% of total degree completions [3]. However, the underrepresentation worsened in graduate programs. During the same period, Latinas accounted for only 1% of master's degree completions, while their completion rates for doctoral degrees ranged from 0.4% to 0.7% [4]. The Bureau of Labor Statistics projects the total number of STEM occupations to grow by 11% from 2021 to 2031. Among the STEM occupations, computing-related occupations, including information security analysts (35%) and computer and information research scientists (21%), are projected to grow much faster than the average [5]. To meet societal demands and embrace the transforming engineering and computing workforce, it is paramount to increase the participation of underrepresented gender and racial minorities in computing. For broadening participation in computing, interventions to reduce gender disparity have been implemented in various areas: teaching and learning, curricular, motivational, social, and structural domains (for more information about this approach, see [6]). However, it is hard to find programmatic efforts and interventions that simultaneously consider intersectionality between gender and race/ethnicity and an asset-based approach of the population focus at Hispanic-Serving Institutions (HSIs). The Computing Alliance of Hispanic-Serving Institutions (CAHSI), an NSF Eddie Bernice Johnson INCLUDES and BPC Alliance, is a networked community dedicated to recruiting, retaining, and advancing the progress of Latinx in computing. In

2020, they piloted a peer-mentoring "Allyship" program to address the gap in practice and knowledge, with a particular focus on creating collaborative learning environments among students, particularly women and non-binary, in computing departments at HSIs. The Allyship program was designed to be a retention program for the students by equipping them with professional skills and providing them with mentorship to discuss difficulties with classes and technical skills. The year-long program pairs incoming first-year and sophomore students (protégés) in computing fields with upper-class students with the same majors (allies) and is tailored to emergent student needs. This work-in-progress (WIP) paper describes how literature informed the need for the Allyship program, details the program, and provides initial results of the program assessment.

II. Background

A. Mentorship Programs

Targeted mentoring programs are important because they are tailored to the specific needs of the communities they focus on. Researchers found that degree completion of Latinx students is highly dependent on the ability of the institution to provide adequate support [7]. Numerous studies underscore the importance of mentoring initiatives for increasing Latinx student retention in higher education [8], [9]. Mentoring programs often target a wide array of students, such as all first-year students [10] or humanities majors [11]. Most mentoring programs pair students with mentors in industry or faculty positions [12], [13]. For instance, FemProf is a research-based mentoring program aimed at increasing interest in doctoral programs among Latinas in Computing [13].

1) Peer-Mentoring Initiatives for Latinx Students

Peer-networking and peer-mentoring initiatives are distinct from initiatives that feature professional or faculty mentors because the goal of such initiatives is to foster more informal, relatable, and empathetic environments, as peers often share similar experiences, challenges, and perspectives. Such initiatives targeting Latinx students often serve as scaffolds to help manage and prioritize their time and provide academic monitoring [14]. Studies evaluating peer-mentoring programs focused on Latinx students found connections between participating in the program and academic success [15]. Furthermore, first-year Latinx students participating in peer mentorship programs improved their sense of community and belonging [11]. Foundational work on Latinx college student retention in STEM fields considers "student involvement" to be a central principle [16], [17]. Researchers found that Latinx students prefer to receive mentorship from other Latinx students that they can more easily relate to [18]. In a study of the many mentorship experiences offered by two HSIs, researchers found that Latina student-mentees in STEM were best able to establish positive learning environments and received appropriate guidance when they shared intersectional identities with their peers and faculty mentors [19]. Although these studies inform us of the benefits of peer mentoring programs among Latinx students in STEM, there are few studies primarily focusing on Latinx students in computing, especially for mentoring programs where the mentors and mentees share cultural and academic backgrounds.

2) Peer-Mentoring of Latina Students in Computing

Less research focuses on sustained peer-to-peer mentorship programs targeting Latina students in male-dominated *computing* fields. One study of a mentorship program pairing incoming STEM undergraduate Latino mentees with upper-class student mentors at four HSIs found that mentees reported feeling better prepared to overcome social and academic barriers [20], and mentors reported feeling genuine concern over mentees' academic and social success. These studies, however, often feature samples where the majority of student participants identify as male [20] or investigate informal peer relationships [21]. In this WIP paper, we describe the implementation of the Allyship peer-to-peer mentorship pilot program for broadening student participation in computing departments with an emphasis on supporting women and non-binary students.

B. Theoretical Framework

Research indicates that within Latinx communities, students often exhibit more collectivist perspectives, emphasizing collaboration and valuing communities as central units in individuals' lives [22]. In this WIP paper, we take on an asset-based perspective on learning and identity development, where engagement in one's community can help develop one's sense of identity as a member of the community. The community cultural wealth theory [23] gives value to forms of capital that are not necessarily valued or acknowledged by other socialization theories of students in higher education. This asset-based theoretical approach emphasizes that such communities can succeed despite existing inequities in the forms of capital or other experiences. The community cultural wealth theory serves as a way of conceptualizing the Allyship program, informing how to approach women and non-binary students at HSIs from a strengths-based perspective that allows them to leverage their cultural knowledge, skills, and contacts in their learning environments.

III. The Approach: CAHSI Allyship Program

The mission of CAHSI is to grow and sustain a networked community of computing departments at HSIs committed to recruiting, retaining, and accelerating the progress of Latinx in computing. CAHSI's vision is to increase Latinx representation to 20% of all credentials in computing. Significant research shows that increasing activity and participation in one's community increases their sense of belonging with that community [24], [25]. CAHSI was awarded funding from the Reboot Representation Tech Coalition to implement a pilot program at two HSIs in 2020. Two faculty members in computing departments at the institutions led the Allyship program with the support of the CAHSI backbone. The program continues to this date, with plans to expand to two other CAHSI institutions.

A. Recruiting, Selecting, and Matching Process

Each summer, applications for the upcoming academic year are advertised through the prominent communication avenues of their universities. This includes campus mailing lists and newsletters, instant messaging platforms, social media groups, in–classes, bulletin boards, and a dedicated website. Application forms request applicants' current major, year of study, interest in the program as an ally or protégé, transcript, and other demographics. Applications are reviewed by the faculty lead and supporting personnel, including CASHI members and program

coordinators. Allies are junior and senior students in certain computing programs who have passed their data structures course (considered a major milestone in learning how to code), and protégés are first- and second-year computing students. At both HSIs, there were more applications for protégés than for allies. Allies and protégés were matched primarily based on academic majors and career interests. Following acceptance, allies and protégés sign commitment forms agreeing to participate in monthly events. Allies additionally agree to hold regular office hours and be in regular communication with their assigned protégé(s). Protégés agree to meet for one-on-one office hours at a minimum of once or twice monthly, depending on the institution. With an understanding of students, the structure of the program has evolved. For instance, in one-to-one meetings, protégés can meet with a designated ally or any ally in more recent years.

B. Structure of the Allyship Program

The program participants meet throughout the academic year, leaving room for participants to prepare for finals each semester. Program participants receive a small stipend. Allies and protégés are expected to attend monthly workshops and are encouraged to meet for bi-weekly office hours. Allies fill out participation forms following office hours to mark attendance and briefly convey the topics discussed. The monthly workshop series topics address professional development, academic development, and socialization. Each event typically includes time for students to socialize at the beginning of the event. Events usually feature a guest speaker, panel discussion, or activity with professionals that serve as role models and foster the building of student's professional networks. Monthly workshop activities include topics such as creating individual plans for the year with a reflection component, preparing for technical job interviews, practicing coding skills, learning to apply for scholarship and fellowship opportunities, and learning about different career paths. Additionally, there are introductory and concluding meetings each semester. Participants are encouraged to attend other events relevant to their professional development, including those organized by CAHSI and student organizations at their institutions.

IV. THE STUDY TO ASSESS THE PROGRAM: METHODS

Considering the imperative to boost the representation of women and non-binary students in computing and empowering them in computing fields, it is important to examine their experiences and perceptions during college to support their college success and build support structures. In particular, this WIP paper examined women and non-binary students' sense of belonging, growth mindset, self-efficacy, and interest in computing while they were participating in peer-mentoring programs. This WIP paper used a student survey that a funder's external evaluators developed to measure participants' sense of belonging, knowledge of the social impact, self-efficacy/confidence, interest in computing, perceptions of supportive environments, instructor inclusiveness, and cultural responsiveness to evaluate the program. To evaluate the impact of the program, the evaluators designed a retrospective pre-and post-survey comprising baseline data about students' perceptions and experiences at the beginning of the fall semester and the same questions but referring to the end of the spring semester. For instance, in the spring of 2021 survey, students were asked to respond, "At the beginning of the fall 2020 semester, how much did you agree or disagree with the following statement- I feel like I belong in computing. Now, how much do you agree or disagree with the following statement - I feel like I belong in computing."

Data for this survey were collected from two HSIs that implemented the Allyship program. For students who participated in the program during the 2020-21 academic year, we collected their data in the spring of 2021, and for those who participated in the 2021-22 academic year, we administered the survey in the Spring of 2022. In the spring of 2021 and 2022, the first author, a researcher at CAHSI Backbone and not part of the Allyship Program, administered an online survey to students who participated in the program. The first author had exclusive access to the data and was responsible for collecting, cleaning, analyzing, and reporting it in this paper. This evaluation study was approved by the IRBs in the two institutions.

A. Participants

With funding from the Reboot Representation Tech Coalition, 44 students participated in the 2020-21 academic year, and 28 students participated in the 2021-22 academic year. The analytical sample for this WIP paper consisted of participants who identified as women and non-binary students and completed the entire survey during these two academic years. In the spring 2021 survey, this sample included 26 participants, of whom 31% were first- or second-year students and 65% were juniors or seniors (self-reported). In the spring 2022 survey, the sample included 10 participants, with 30% being first- or second-year students.

B. Measures and Analysis

In this WIP paper, we examined students' sense of belonging, growth mindset, self-efficacy, and interest in computing as indicators of the effectiveness of the Allyship program. We used eleven survey items to create a scaled measure of sense of belonging, such as 'I see myself as a computing person,' 'I feel like I belong in computing,' 'I feel welcomed in the computing community,' etc. Using six survey items, we created a measure of growth mindset (e.g., people have a certain amount of computing ability that really can't be changed, people can learn new things, but they can't change their basic ability to do computing, etc.) and the items are reversed coded based on the context of questions. To measure self-efficacy, we used seven survey items: 'If I pursue computing, I am confident that I can get admitted to a graduate computing program, find employment in an area of computing interest, and complete an undergraduate degree in computing, etc.' To create a scaled measure of interest in computing, we used three survey items (e.g., 'I am glad that I chose to take computing courses', overall, 'I am satisfied with the computing program at my institution,' 'I would recommend taking computing courses at my institution to a friend'). For all four factors, the scales ranged from 1 (strongly disagree) to 5 (strongly agree). We conducted paired t-tests to investigate whether there were differences in participants' perceptions between the beginning of the fall semester and the end of the spring semester, analyzing each year's survey data separately.

V. INITIAL FINDINGS

Among the analytical samples from the 2020-21 academic year, there were significant differences in the sense of belonging, growth mindset, self-efficacy, and interest in computing. First, the difference in the sense of belonging between the beginning of the fall semester (M = 3.92; SD = 0.13) and the end of the spring semester (M = 4.39; SD = 0.11) was significant ($t(25) = -4.44$; $p = .0002$). We also found this pattern of improvement in students' self-efficacy and interest in computing. The difference in self-efficacy was statistically significant between the program's beginning and end (paired t-test; $t = -6.60$, $df = 25$, $p = .0000$). The mean difference in the scales between semesters was -1.19 (95% CI: -1.56 to -0.82). In terms of interest in computing, the difference between the beginning of the fall semester (M = 4.09; SD = 0.15) and the end of the spring semester (M = 4.32; SD: 0.12) was significant ($t(25) = -2.41$; $p = .0235$). These three results reveal that students in the analytical sample perceived more of a sense of belonging and increased self-efficacy and interest in computing when they finished the program compared to when they started participating in the program. Interestingly, students' perceptions of growth mindsets showed an opposite pattern, in which the mean at the beginning of the fall semester was higher (M = 3.71; SD = 0.13) than at the end of the spring semester (M = 2.10; SD = 0.07), and the difference was significant ($t(25) = 10.19$; $p = .0000$). However, this reverse pattern was only shown in the spring of 2021 survey.

With the 2021-22 analytical sample, we found the differences in the sense of belonging and self-efficacy between the beginning and end of the semester were statistically significant. First, the difference in the sense of belonging was statistically significant between the program's beginning and end (paired t-test; $t = -6.14$, $df = 9$, $p = .0002$). The mean difference in the scales between semesters was -1.17 (95% CI: -1.60 to -0.74). In terms of self-efficacy between the beginning of the fall semester (M = 3.02; SD = 0.34) and the end of the spring semester (M = 4.02; SD = 0.20) was significant ($t(8) = -2.61$; $p = .0311$). We did not find a statistically significant difference in growth mindset and interest in computing between the beginning and end of the program.

VI. LIMITATIONS AND FUTURE WORK

While the results of the Allyship participant's survey provide valuable insights for the literature and development of programs and practices to support this group, there are important limitations to consider. First, this study utilized survey datasets from two HSIs, limiting its generalizability. Second, although we aimed for high participant engagement in survey data collection, we had no control over voluntary participation, resulting in a smaller sample size in the spring 2022 survey compared to spring 2021. With fewer than 50 participants each year, we were unable to account for additional factors, hindering a more comprehensive analysis. Consequently, we could not deeply investigate why students' growth mindset scores were lower at the end of the spring of 2021 or why growth mindset and interest in computing showed no statistical significance between the beginning and end of the 2021-22 academic year.

Additionally, the survey instruments were the same for all Allyship participants, without differentiation between allies and protégés. However, based on students' roles, their experiences and learning outcomes might differ. For instance, allies could have developed leadership and communication skills while interacting with protégés. However, as the survey used was not specifically designed for research purposes, future endeavors should develop measures to assess potential differences in learning outcomes based on students' primary roles in the Allyship program. To gain a richer understanding of participants' experiences, we plan to conduct mixed-method research by refining survey instruments and incorporating qualitative studies of the students participating in peer mentoring programs in upcoming academic years at HSIs, including the same universities, in this WIP paper.

VII. CONCLUSION AND IMPLICATIONS

In this WIP paper, we presented the CAHSI Allyship pilot program. The Allyship program provided opportunities for participants to explore career paths, extend their professional network through interaction with their peers and role models (i.e., computing professionals), and develop their professional skills (e.g., creating individual plans and participating in workshops).

In addition, we shared results from a student survey that a funder's external evaluators developed to measure participants' perceptions and learning outcomes to evaluate the program. We have highlighted the potential of peer-mentoring and supporting programs to positively influence women and non-binary students' experiences in computing fields at HSIs. The assessment results suggest improvements in participants' sense of belonging and self-efficacy in the analytical sample. These findings resonate with the community cultural wealth theory [23], which emphasizes the unique forms of capital that women and non-binary students bring into academic settings. The framework advocates for an asset-based approach in programmatic and educational interventions, both recognizing and leveraging the inherent strengths and cultural knowledge of students. Allies and protégés share both cultural and academic identities, which aligns with previous research suggesting that mentoring relationships that reflect shared identities can significantly enhance the educational experience and success of racial minority students. The Allyship program fostered an environment where students could see themselves as integral and valued members of the computing community.

As institutions, particularly HSIs, consider adopting peer-mentoring programs, it is crucial to recognize and adapt to the unique characteristics of institutions and departments and the student populations they serve. Each campus has distinct dynamics, resources, and a body of students, and even interaction among each factor can significantly influence the implementation and success of such initiatives. Therefore, before adopting the Allyship model, universities should thoroughly assess their institutional characteristics, such as student demographics, student learning outcomes, faculty composition, available resources, and existing support structures, to ensure the program can complement rather than duplicate existing programs. Additionally, a deep understanding of the student population, such as their identities, educational motivation, and career aspirations, is vital for the program's success. For example, one of the institutions specifically had a

workshop dedicated to finding computing career paths while remaining local to the area, with a deep understanding of their students and their needs. Lastly, one of the unique features of the Allyship program is its sustainability, using relatively low operational costs, in which under-resourced HSIs might be able to further promote their students' college success. The advantage of the program's design is also to foster durable interpersonal relationships, which are likely to sustain beyond formal mentoring sessions.

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