2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #40100

Promoting Success through Building Community for Computer Science and Computer Engineering Undergraduates

Prof. Sarah L. Harris, University of Nevada - Las Vegas

Dr. Harris is a Professor at the University of Nevada, Las Vegas (UNLV) in the Electrical & Computer Engineering Department. She earned her M.S. and Ph.D. at Stanford University and has worked at Hewlett Packard, Nvidia, and the Technical University of Darmstadt. Before joining the UNLV faculty in 2014, she was a faculty member at Harvey Mudd College for ten years. Her research interests include embedded systems, biomedical engineering, and robotics, and she has co-authored three popular textbooks, most recently Digital Design and Computer Architecture: RISC-V Edition in 2021.

Dr. Yingtao Jiang, University of Nevada - Las Vegas
Christine Clark
Ed Jorgensen
Tiberio Garza, Florida International University
Norma A Marrun, University of Nevada - Las Vegas
Valerie L. Taylor

Promoting Success Through Building Community for Computer Science and Computer Engineering Undergraduates

Sarah L. Harris, Christine Clark, Norma A. Marrun, Edward Jorgensen, Yingtao Jiang, Valerie Taylor, Tiberio Garza
University of Nevada, Las Vegas (all except T. Garza), Florida International University (T. Garza)

Abstract
Building on prior studies that show a sense of belonging and community bolster student success, we developed a pilot program for computer engineering (CpE) and computer science (CS) undergraduates and their families that focused on building a sense of belonging and community supported by co-curricular and socioeconomic scaffolding. As a dually designated Hispanic-Serving Institution (HSI) and Asian American and Native American Pacific Islander-Serving Institution (AANAPISI) – two types of federally designated Minority-Serving Institutions (MSI) – with 55% of our undergraduates being first-generation students, we aimed to demonstrate the importance of these principles for underrepresented and first-generation students. Using a student cohort model (for each incoming group of students) and also providing supports to build community across cohorts as well as including students' families in their college experiences, our program aimed to increase student satisfaction and academic success. We recruited two cohorts of nine incoming students each across two years, 2019 and 2020; 69% of participants were from underrepresented racial or minority groups and 33% were women. Each participant was awarded an annual scholarship and given co-curricular support including peer and faculty mentoring, a dedicated cohort space for studying and gathering, monthly co-curricular activities, enhanced tutoring, and summer bridge and orientation programs. Students' families were also included in the orientation and semi-annual meetings. The program has resulted in students exceeding the retention rates of their comparison groups, which were undergraduates majoring in CpE and CS who entered college in the same semester as the cohorts; first- and second-year retention rates for participants were 83% (compared to 72%) and 67% (compared to 57%). The GPAs of participants were 0.35 points higher on average than the comparison group and, most notably, participants completed 50% more credits than their comparison groups, on average. In addition, 9 of the 18 scholars (all of the students who wanted to participate) engaged in summer research or internships. In combination, the cohort building, inclusion of families, financial literacy education and support, and formal and informal peer and faculty mentoring have correlated with increased academic success. The cohorts are finishing their programs in Spring 2023 and Spring 2024, but data up to this point already show increases in GPA, course completion, and retention and graduation rates, with three students having already graduated early, within three and a half years. The findings from this study are now being used to expand the successful parts of the program and inform university initiatives, with the PI serving on campus-wide STEM pipeline committee aiming to recruit, retain, and support more STEM students at the institution.

Keywords
Diversity, inclusion, families, underrepresented, co-curricular

1. Introduction

Recent research has shown that building communities increases satisfaction and overall success [1]. Our project focuses on three facets of building communities: cultural responsiveness, drawing on family support and connectedness, and building student cohorts [2, 3, 4]. Cultural

responsiveness, which includes building community and a sense of belonging, has shown to benefit students in many areas, such as satisfaction and academic success. Cultural responsiveness benefits students and families from all backgrounds, including all socioeconomic backgrounds, geographic communities, ability groups, genders, religions, etc., by 1) promoting instructional practices that accommodate and affirm student differences; 2) prioritizing students' academic development; 3) building educational environments that are personally, culturally, and physically inviting; and 4) encouraging individuality and collaboration [5]. Research has shown that students perform better academically when educational leadership at all levels is adapted to students' cultural experiences and frames of reference [6].

In addition, the ways families are involved in their children's education, at school, at home, and in community spaces have been linked to students' academic success and socioemotional well-being [7, 8, 9]. In acknowledging the positive influences that families (broadly understood and defined) have on their children's educational journeys, few programs have actively engaged families during their college years, but those that have done so, especially targeting first-generation college students, have demonstrated improvement in students' success [10].
Our program also builds on other educational research, including a seminal study conducted at the University of California at Berkeley that emphasized the importance of cohorts by demonstrating the benefits of a "learning interest culture" for an array of non-traditional college students in their department [11, 12, 13]. In the Berkeley study, workshops in which an individual student's evaluation was based on the collective performance of his or her workshop group members were instrumental in enhancing the overall academic performance of all students and in encouraging the development of cross-group relationships and peer-teaching acumen [14, 15, 16]. Not surprisingly, this initiative also reduced cross-group tensions [13]. Our program has drawn from the success of this workshop model in its focus on building cohorts and by integrating the collective performance principle into co-curricular workshops and summer bridge courses.

The idea of relationship building is tied to Ethnic Studies and multicultural education pedagogies and has been shown to produce powerful improvements in student learning outcomes, especially for students who come from groups that have and continue to experience various forms of oppression and discrimination in schools and society. In fact, using a quasi-experimental study that included regression discontinuity (RD) design, Dee and Penner found a causal link between the presence of Ethnic Studies curriculum in California high schools and increases in students' mathematics and English learning outcomes regardless of whether or not students were enrolled in Ethnic Studies courses [17].

Given hat 55% of our undergraduate students are first-generation and that our university is a dually designated Hispanic-Serving Institution (HSI) and Asian American and Native American Pacific Islander-Serving Institution (AANAPISI), our project took an asset-based approach to family engagement by including students' extended notions of family and by learning about and incorporating practices and values that draw from families' cultural wealth [18, 19, 20, 21, 22]. We also built on the foundation of our university's Multicultural Educational Services Alliance (MESA) to further connect the campus to the community through family engagement and by building and sustaining the connection between students' families and faculty and staff in the computer science and computer engineering departments. Through focus groups and informal interactions with families, we gained a deeper understanding of what cultivated and sustained their engagement over five years. We ran two focus groups, one in Spanish and one in English;

family members self-selected into the focus group based on language affinity. Through these focus groups, as well as through informal interactions (at both on and off campus activities, including over meals at local restaurants), we learned about parents'/caregivers' relationships with their children, aspirations for their children, and how they were involved in their children's college education. Most importantly, we learned about their experiences with the LV Scholars Program primarily through our welcome meetings, summer orientations, and end-of-year celebratory dinners. Table 1 lists an overview of family-related program aspects.

Table 1. Overview of Family-Related Program Aspects

Sense of Belonging: Faculty & Staff as Extended Family	Awareness of the Academic Demands of Majoring in CpE and CS
"Ustedes están al pendiente de nuestros hijos. Les hablan por teléfono y les preguntan como se estan sintiendo. Ellos se sienten como estar en una segunda familia." (Latino parent) Translation: "You are all watching out for our children. You call them, you ask questions about how they are feeling. They feel like you are all their second family."	"Summer bridge was wonderful! [Our child] liked the way the math professor taught and it enabled [them] to overcome those difficulties. To see [our child] that excited about math was really great! [They] wanted to keep going. So that was a good thing!" (demographics not reported).
• **Moving Beyond Offering Financial Aid Workshops:** Families appreciated: 1) the emphasis on building relationships and community with program students; 2) the small size cohorts; and 3) being engaged in program activities and the conversations that took place during these activities. • **Navigating the University:** The first-year cohort of LV Scholars led the campus tour for the second-year cohort with an emphasis on the College of Engineering. • **Interpretation & Translation:** Forms and surveys were offered in Spanish and Tagalog. Being able to communicate with some of the program leadership team members in Spanish was viewed by families as a positive. • **Ongoing and Thoughtful Communication:** The program leadership team took the time to directly email and call families to personally invite them to program events. Although families were not always able to make it, they appreciated the invitations.	• **Presenting Specific Information:** Families appreciated learning about the retention and graduation rates of CpE and CS majors at the Summer Orientation. • **Course of Study:** Families appreciated the opportunity to build understanding of course requirements, including the average time toward graduation based on these requirements. • **Homework:** The program leadership team talked with families about the numbers of hours of homework per academic credit. Many parents were shocked but appreciated learning and having an hours per credit formula. • **Focus on the Future:** Families appreciated guidance on coursework, including how courses prepared their children for the job the market (internships) or graduate school (e.g., research opportunities).

Families' stories derived from their participation in this program challenge dominant narratives that leave unquestioned deficit assumptions about low-income and of color families' perceived lack of support for their children's college. Accordingly, this program helps to build asset driven counterstories about the community cultural wealth that these students' families leverage to support their academic and career success.

Because students within and across the two program cohorts entered the program with different levels of academic preparation in the CpE and CS majors, they also moved through the majors at different paces. Accordingly, the cohort model was not formally curriculum based. However, where possible, program students were enrolled together in classes. However, as noted, the cohort model was built more around the program students' shared study space and collaborative participation in social (events), academic (research), and professional (internship) program activities (sometimes in pairs, sub-cohort groups, whole cohorts, or combined cohorts).

2. Program Challenges and Goals

We developed this program to address particular needs, challenges, and opportunities in our campus community, as well as in the larger surrounding community, focusing on the following factors that affect our student population[1]:

- The university is largely a commuter campus (93% of students commute to campus).
- Many students work during the semester (over 60% of students in a pilot study reported working at least 20 hours per week).
- Many students have high financial need (35% of undergraduates are Pell Grant recipients, and 93% of students reported financial stress in a pilot study completed just before this program began in 2016).
- The state's K-12 system ranks the lowest in the nation [23], and 86% of the university's undergraduates (including CpE and CS students) are native to the state.
- The College of Engineering has relatively low selectivity (88% acceptance rate vs. a national average of 66% - both CpE and CS are part of the College of Engineering).
- The undergraduate population has a majority (55%) of first-generation students.

These factors correlate with a need for co-curricular and socio-economic support, specifically in areas of promoting a sense of belonging, supporting academic preparation, and providing financial support. For example, students' commuter status can both take students' focus away from academics and make it more difficult for them to attend classes and to take advantage of in-person tutoring and office hours; commuting and work demands also make it more difficult to build a sense of belonging and community and correlate with less engagement with peers, faculty, staff, and campus life. With 55% of engineering students being first-generation, and even fewer having family members with careers in STEM fields, students' ability to visualize life as an engineer or computer scientist becomes more challenging. Non-cognitive factors such as low self-efficacy may also play a role in students' sense of belonging in college and in STEM majors. Especially with the low state-wide K-12 ranking and the high percentage of first-generation students, these factors correlate with a need to support stronger study skills and study habits, including bridging gaps in K-12 learning and skills. Some students also report that they and their families can often underestimate the importance of academic workload demands and logistics, such as attending lectures and participating in labs. In addition, research reveals that STEM degrees usually take longer to secure because of the course load and difficulty [24].

These factors correlate with low six-year graduation and first-year retention rates in the College of Engineering, particularly in CpE and CS, compared to the overall university rates. In the years

[1] These statistics are for College of Engineering undergraduates, but the trends are similar or the same for CpE and CS undergraduates.

just prior to the start of this program in 2019, first-year retention rates were 50-56% for CpE and CS majors, and 6-year graduation rates were 10-16%. Overall university first-year retention was 76% and 6-year graduation was 41%. Our program has aimed to meet or exceed the university rates.

We have specifically focused on the challenges described above and the related student needs, with an aim to provide opportunities for students. In particular, the program has focused on student need for: a sense of belonging, academic preparation, support due to academic demand, and financial support, all in the context of community building. The support structures, methods, and activities we designed to address these challenges and needs, and to provide these opportunities, are described in detail in the next section.

3. Program Support Structures, Methods, and Activities

Our program has focused on building cohort communities and strengthening the departments' cultural responsiveness, including supporting family engagement and promoting a sense of belonging, with a correlated effect on increased student success in academics. While we supported 18 students through this program, the program also serves as a pilot program for enhancing retention and graduation for engineering and other STEM programs on campus, as well as similar programs at other designated MSI and HSI institutions.

Table 2 lists the program support structures, methods, and activities that we designed to build community and address the underlying challenges of belonging, preparation, academic demand, and financial need, as discussed in the last section. These were incrementally implemented and designed to have a cumulative impact the longer students stayed in the program. The collective and synergistic application of structures, methods, and activities provided flexibility to enhance student-centered support and resources for academic success and sense of belonging.

Table 2. Program Support Structures, Methods, and Activities

<table>
<tr><th>Belonging</th><th>Preparation</th><th>Academic Demand</th><th>Financial Need</th></tr>
<tr><td colspan="2">Scholars as co-researchers with education faculty, Monthly cohort activities</td><td></td><td></td></tr>
<tr><td colspan="3">Family involvement (including Family Orientation), Welcome Meeting, Summer Orientation, "TEDx Talks" & workshops, Faculty and peer mentoring, Enhanced tutoring</td><td></td></tr>
<tr><td colspan="4">Summer bridge: math and general education course (Gender, Race, and Class), Research opportunities, Career fairs and development, Summer internships, Annual scholarship, Cohort membership, Dedicated cohort space, Cohort scheduling</td></tr>
</table>

The program elements listed in Table 2 all fall under the umbrella of building community and a sense of belonging, with many of them having an impact across multiple needs, as shown, and as discussed in greater detail below. These programmatic features help students make meaning of their academic and social experiences within the College of Engineering and campus by fostering and ensuring their sense of belonging in their majors and their feeling connected with the campus community.

Sense of Belonging & Preparation: We laid the foundation for a sense of belonging and preparation with a *Welcome Meeting* in the spring before each cohort entered the university. During this time, we invited students and their families to come to campus, meet us and each other, and learn more about the program and the university through community building

activities, including discussing the academic programs and sharing a meal together. We continued close correspondence with each of the students, helping them with *cohort scheduling* (enrolling cohort students into the same sections as much as possible) and answering their questions. We followed this with a 1-day *Summer Orientation* five weeks before the semester began. We also invited families to attend these two meetings with their students, and most of them did. The orientation included get-to-know-you interactions to seed *cohort-building*, as well as a *Family Orientation*, where families met with program leaders to discuss what the university schedule and demands would look like and answer questions they had. A few days after the orientation, all nine students in each cohort attended a Summer Bridge course called "Race, Class, and Gender" that not only fulfilled one of their general education requirements but also enabled students to discuss factors that affect many aspects of their intersecting identities (e.g., race, class, and gender) and experiences navigating higher education. This 3-hour per day 5-week course proved to be pivotal in building a deep community that was willing to be vulnerable, share experiences, and learn from and rely on each other. While most first-year students take this course, the fact that program students were in an intensive cohort-based group, with whom they'd already started to build relationships, seemed to strengthen their sense of community and willingness to support each other in this course and beyond. A subset of cohort students, who didn't already qualify for taking calculus during their first semester, also participated in a summer math bridge program prior to Summer Orientation, but that course was much larger (~50 students); students benefited from math learning and other skills offered in the course.

Through the Summer Orientation and Bridge, students were also able to transition to campus life while taking just one course, with a small class size and a group of students they knew. Other aspects that bolstered students' sense of belonging and preparation were monthly cohort activities, some of which were organized by the faculty leaders and others that were self-organized; activities included attending career fairs together, gathering at the end of each semester with students and their families, and holding workshops about resume building, graduate school, internships, research opportunities, and other relevant topics. The College of Engineering also provided a dedicated cohort room with computers, a white board, and couches, where students could informally interact and support each other. This aspect also proved critical in building the cohort and sense of belonging. We also recruited cohort members to be student leaders. Two members from each cohort served as the leadership team. They not only helped coordinate activities but, most critically, they also checked in with each scholar and maintained communication with the cohorts, including over social media.

It is important to note that relationship building between students and academic support staff and faculty has amplified the students' broader sense of belonging. Additionally, students have encouraged each other, both privately and in public spaces, to take advantage of academic supports to improve their learning outcomes; this encouragement has interrupted shame narratives tied to students' past experiences of academic challenge by affirming that academic success is more a function of students' willingness to take advantage of supports and to grow in relationship to new learning leveraged from engagement with those supports, rather than depending on specific academic pre-dispositions.

Academic Demand: In addition to the monthly activities and workshops where we discussed some academic topics, including study skills, time management, budgeting, and school/life balance, the program also provided program-specific tutoring (focused on the courses the cohorts

were taking) as well as faculty and peer mentoring. The faculty leadership team led a faculty mentor training session that was effective in both training the faculty and teaching by example (demonstrating sharing and support through discussions such as: “what was your undergraduate experience like?” and “How did your life experiences affect your perspectives?”). The mentors also benefitted from the trainers’ perspectives, as they are also a part of the university’s MESA (Multicultural Educational Services Alliance). These training sessions did not just talk about mentoring; they instead demonstrated mentoring and community building by developing deeper understanding and community amongst the faculty members present.

Many models of first-year programs exist. For example, some are residential where students who have expressed a major early on live and learn together in a dorm setting with classrooms embedded in the dorm. Others are recruitment-minded, aiming to attract and support students to develop a commitment to a major. Still others simply focus on supporting students in becoming oriented to the college or university community and the resources it offers (e.g., library, learning technology, academic tutoring, financial aid, various kinds of wellness programming and supports, among others). The program described here draws from all of these models but is also expressly situated in Ethnic Studies and multicultural education pedagogies, which prioritize relationship building and systems change to meet the specific cultural, social, academic, and career needs of students who are first-generation college students, from working class communities, from historically and persistently marginalized and minoritized communities in the United States, and/or from families that include members who are first- and second-generation immigrants.

Cohort scheduling (enrolling students in the same sections when possible) occurred throughout the program and was also a key factor in student academic success. This allowed students to know at least one (or more) students in their section and enabled them to support each other academically as well as in other ways, including socially and emotionally.

Financial Need: All program participants were selected because of their potential for excellence as well as their financial need, as measured by their being eligible for the Pell Grant. Table 3 summarizes the students’ average financial need (cost of attendance: COA) and financial aid (scholarships and loans). On average, students were supported with 82% of their COA, leaving them with 18% of unmet financial need. Without the program’s scholarship, students would have had an average of 45% of their financial need left unmet. In addition to the program scholarship, the team also aided students in obtaining other scholarships (included in Table 3) as well as paid internships and research experiences, which numbers are not included in Table 3.

Table 3. Average COA and Financial Aid for Program Participants

Category	Average Annual Amount	Percentage of COA
COA (cost of attendance)	$23,539	100%
EFC (expected family contribution)	$1,904	8%
Program Scholarship	$6,247	**27%**
Other Scholarships & Grants	$11,299	48%
Met Financial Need	$19,209	**82%**
Unmet Financial Need	$4,089	18%

4. Results & Discussion

This program has run since 2019 and, as noted above, has admitted 18 CpE and CS

undergraduates across two cohorts, nine in fall 2019 and nine in fall 2020. Overall, the program admitted 7 CpE students and 11 CS students. We compare the CpE and CS students in the program with all other CpE and CS students who were admitted in the same two semesters as the cohorts (fall 2019 and fall 2020). Table 4-5, below, show demographic information, retention, average GPAs, and credits passed for the cohorts and comparison group. When considered with the comparison group, the cohorts include higher percentages of women (32% vs. 13%) and ethnically or racially underrepresented students (69% vs. 49%), as shown in Table 4.

Table 4. Demographics of Cohorts and Comparison Group

Group	Male	Female	Hispanic	Asian	Two or more races	Black\Afric. Amer.	White	American Indian or Alaska Native	Native Hawaiian or Pacific Islander	Unknown	Non-resident	Underrepresented
Cohorts	68%	32%	47%	26%	16%	5%	5%	0%	0%	0%	0%	69%
Comparison	87%	13%	30%	22%	11%	6%	24%	0.1%	0.4%	0.4%	5%	49%

Figure 1 shows cohort and comparison group rates of retention in their major, college (Engineering), and university. Blue represents CS and CpE majors retained within their department; orange shows CS and CpE majors who left their department but who changed to another College of Engineering major; grey shows CS and CpE students who left the college of engineering but who stayed at the university in another major; students in yellow were not retained at the university. The comparison group includes 427 (342 CS and 85 CpE) students who entered the university as first-year, full-time students in the same semester as the cohorts.

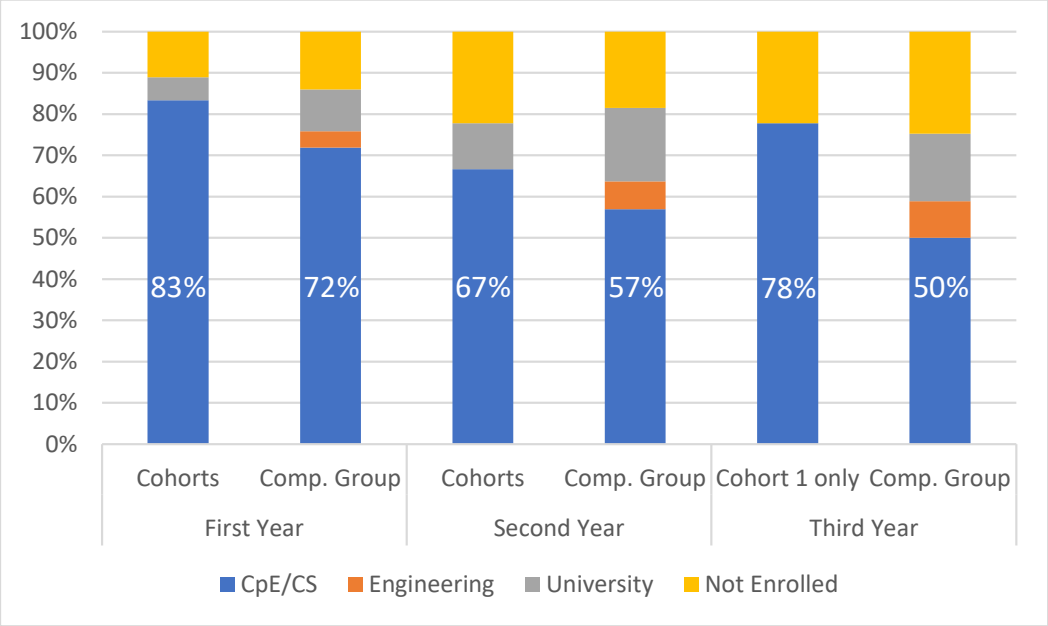

Figure 1. Persistence (Major, College, University) for Cohorts and Comparison Groups

Each year, in-major retention rates (shown in white text on the figure) are ~10% higher for cohort students compared to other CS and CpE majors. The third year shows a jump in cohort retention because it only includes Cohort 1 (who entered the university in 2019); Cohort 1 had higher retention rates overall than Cohort 2 (who entered the university in 2020). The lower retention of Cohort 2 may be correlated with their entering the university just as the COVID pandemic began. Cohort 2 is now completing their third year, so third year retention rates (retention from their third year into their fourth year) are not yet available for that cohort.

So far, 13 of the 18 participants (72%) have been retained. Figure 1 shows only 67% retention (in second year cohort retention), but this does not include the student who recently returned to the program, after the census taken at the beginning of the academic year (fall 2022).

We also note that these annual retention rates are higher for even the comparison group when compared to retention rates just before the program began. For example, first year retention rates in the major were ~50% for CS and CpE students who graduated just before the program began. This overall increase (from 50% to 72%) in the comparison group is likely due to programmatic changes that are synergistic with this program's goals, including redesigning the first- and second-year seminars and adding mid-semester intervention for first- and second-year students.

The retention rates in Figure 1 also project preliminary graduation results. Although both cohorts are not yet expected to have graduated, the majority of students (12 out of 18) are on track to do so within the next year or shortly thereafter, which conforms to a 4- to 5-year time to graduation. In fact, three students have graduated early (within 3.5 years), which already gives a resulting graduation rate of 33% for the first cohort. A fourth student also plans to graduate this spring 2023. Even though it is only a preliminary result, this graduation rate of 33% is already 2-3 times the 10-16% graduation rates of students who completed the CpE and CS programs just before the program began. The projected graduation rates are even higher, at 61-67%, if all cohort students who are currently still enrolled complete their CpE and CS degrees. These projected numbers are consistent with likely graduation rates, because retention rates typically decline at a much slower rate after year 3 for CS and CpE majors, even for students outside of this program. The projected graduation rate of 61-67% is 4-7 times the 6-year graduation rates of prior CS and CpE cohorts (10-16%). Moreover, the cohort students are graduating in a shorter time, 3-5 years, as compared to average time to graduation of 6 years for other CS and CpE students.

As shown in Table 5, the GPAs of cohort students are on average 0.35 points higher than the comparison groups (3.64 vs. 3.29) and cohort students have on average completed 50% more credits than comparison students (108 credits vs. 73). So, not only are students in the program performing better in their classes on average, as evidenced by their higher GPA, but they are also proceeding through the program faster than their peers, as shown by credits completed.

Table 5. Average GPA and Cumulative Credits

Group	Ave GPA	Cumulative Credits
Cohort 1	3.59	**115**
Cohort 1 Comparison Group	3.37	90
Cohort 2	3.70	**82**
Cohort 2 Comparison Group	3.23	61
Overall – Both Cohorts	3.64	**108**
Overall – Both Comp. Groups	3.29	73

As mentioned earlier, our program also aided students in obtaining internships and research experiences by advertising specific programs to them, obtaining departmental funding for some students, helping them with applications, and writing recommendation letters. We have found that it takes more than just announcing programs to student; following-up and actively helping students complete applications is also critical. Table 6, below, shows the number and percentage of participants who participated in an internship, research, or both. Half of the students in the program participated in either opportunity, and one-third of the students participated in both. Of the participants who have been retained in the program, 69% of them participated in an internship or research. The remaining retained participants plan on engaging in an internship or research during summer 2023. Five of the eighteen students have not been retained in the program.

The question of scale is more important in research situated in quantitative methodologies. This research is informed by qualitative research approaches (e.g., individual and focus group interview data) which focus on the reasons that a given student is or is not successful in the CpE or CS major, rather than on how many students share the same reason. The goal is to identify and respond, curricularly and co-curricularly, to these reasons discretely (in the moment for a given student) and more broadly by making structural changes in how departmental, college, and university staff and faculty engage with and serve all students, but especially students who are underrepresented in specific majors. Accordingly, the university is interested in the findings of this research in order to consider adapting (not merely duplicating) the program model in other majors. The goal of adaptation is to think about what the impact of the unique curricular and co-curricular context of another major might require in terms of model adjustments. Growth in the integration of this model is anticipated through amplification of small cohorts (increasing the number of small cohorts), not amplification of cohort size.

Table 6. Research and Internship Experiences

Type of Experience	Overall Percentage	Percentage (of Students Retained in Program)	#
Research or internship	**50%**	**69%**	9
- Research only	11%	15%	2
- Internship only	6%	8%	1
- Both internship and research	33%	46%	6
Did not participate in either yet but plan on participating	**22%**	**31%**	4
Not retained in program	28%	N/A	5

5. Future Improvements

While we have shown much success, as described in the previous sections, we have also reflected on program improvements, especially those that could help the students who have not been retained. These improvements include increasing engagement of faculty mentors, meeting more frequently with students during their first year, and offering more support in beginning classes, especially beginning math, computer science, and computer engineering courses. We propose that increasing engagement of faculty mentors, especially mentors who match students' racial/ethnic/gender identities, would be most effective if this form of community-building mentoring is more systematically included in the structure of the department and college.

Part of the program model involved intentionally pairing program students with faculty members

in their major. Training for these faculty as mentors was provided and, generally, appreciated. Accordingly, many of the faculty easily built and have sustained relationships with their program mentees through having the students in their courses, being assigned to the students as academic advisors, and working with the students on internships and/or research projects. Some faculty selected as mentors struggled with what it meant to build relationships with students outside of contexts for engagement that were related to the academic major (e.g., meeting the students for coffee and informal conversation, interacting with students and their family members socially at program orientation and celebration events). Additionally, a small number of faculty mentors expressed the view that if the students needed mentorship, they should probably not have been accepted into the program. The program leadership team has continued to engage with all faculty mentors to support their growth and development around informal relationship building with the students, learning why it is important as well as how to do it more effectively. There is still work to do to improve the departmental (and larger disciplinary) climate and culture of CpE and CS at our university and nationally.

In addition to these challenges, we also had to address the COVID pandemic, that occurred near the beginning of our program. We had just admitted our second cohort in March 2020 when the pandemic and pandemic measures began. This proved challenging for our program and, especially, for the first-year CS and CpE students who were starting their college careers. However, we were able to continue monthly cohort meetings remotely and met with students often during this time to offer them individual and group support. Many of the students commented about how our meetings brought them back in connection with each other, being largely alone due to remote classes. Building on the strong structure that was already in place was critical; this foundation especially built on the strong foundation and community of the first cohort, who was in-person during most of their first year. That cohort offered their support and guidance to the incoming students as well as helping to build a strong sense of community.

We did notice a less cohesive second cohort right at the beginning of the program, likely due to holding our orientation and summer bridge remotely because of the COVID pandemic. However, because of the leadership and continued reaching out of the first cohort students, as well as faculty leadership, this second cohort has now also built a strong community, both within that cohort as well as between the two cohorts. COVID also negatively impacted the efficacy of the program's research efforts as electronic (and post-COVID in-person) survey, interview, and focus group administration was not as effective as pre-COVID efforts were.

Nonetheless, while COVID made relationship building difficult, over time, as we worked to improve our synchronous and asynchronous online pedagogical approaches, we were able to maintain and even grow relationships within and across cohort students, including with members of their families, project personnel, and other departmental and college staff and faculty. Post-COVID in-person engagement has been different, but still restorative.

6. Conclusions

Overall, the program's efforts to build a sense of belonging and community and to address the underlying needs associated with building community have shown to be effective in summative data. Particularly, when compared with other students starting in the same terms, the cohorts have higher retention across all years (higher by 10% or more each year), 50% more cumulative credits (108 vs. 73 credits), and a higher average GPA (by 0.35 points). Beyond the summative

data, we have seen how cohort students have reached out to each other, and even each other's families, to both draw on and provide support. While we are currently performing ongoing assessment and analysis of qualitative survey and focus group data to further understand the mechanisms that have resulted in these summative metrics, we have seen how building strong communities that include both students and their families is correlated with increases in academic success, as measured by retention, progression (GPA and courses completed), and 4- to 6-year graduation rates, for both computer engineering and computer science students. We have demonstrated these effects in a dually designated Hispanic-Serving Institution (HSI) and Asian American and Native American Pacific Islander-Serving Institution (AANAPISI) and have done so as a pilot study for other, including similar, institutions as well as other STEM fields.

Acknowledgments
This work was funded in part by NSF Grant #1742607.

References

[1] Fernández, E., Rincón, B. E., & Hinojosa, J. K. (2021). (Re)creating family and reinforcing pedagogies of the home: How familial capital manifests for Students of Color pursuing STEM majors. *Race Ethnicity and Education*. https://doi.org/10.1080/13613324.2021.1997971

[2] Kendricks, K., & Arment, A. (2011). Adopting a K-12 family model with undergraduate research to enhance STEM persistence and achievement in underrepresented minority students. *Journal of College Science Teaching, 41*(2), 22-27.

[3] Rodriguez, S., Pilcher, A., & Garcia-Tellez, N. (2021). The influence of familismo on Latina student STEM identity development. *Journal of Latinos and Education, 20*(2), 177-189.

[4] Sweeder, R. D., Kursav, M. N., Valles, S. A. (2021). A cohort scholarship program, that reduces inequities in STEM retention. *Journal of STEM Education, 22*(1), 5-13.

[5] Rincón, B. E., Fernández, É, & Dueñas, M. C. (2020). Anchoring comunidad: how first- and continuing-generation Latinx students in STEM engage community cultural wealth.

[6] Gay, G. (2000). Culturally responsive teaching: Theory, research, and practice. New York, NY: Teachers College Press.

[7] Knight, M. G., Norton, N. E. L., Bentley, C. C., & Dixon, I. R. (2004). The power of Black and Latina/o counterstories: Urban families and college-going processes. *Anthropology & Education Quarterly, 35*, 99-120.

[8] Perna, L. W., & Titus, M. A. (2005). The relationship between parental involvement as social capital and college enrollment: An examination of racial/ethnic group differences. *The Journal of Higher Education, 76*, 485-518.

[9] Tierney, W. G., Corwin, Z. B., & Colyar, J. E. (2005). (Eds.). *Preparing for college: Nine elements of effective outreach*. Albany, NY: State University of New York Press.

[10] Ceja, M. (2006). Understanding the role of parents and siblings as information sources in the college choice process of Chicana students. *The Journal of College Student Development, 47*(1), 87-104.

[11] Asera, R. (1990). The mathematics workshop: A description. *Professional Development Program, 1*(3), 1–16.

[12] Conciatore, J. (1990, February 1). From flunking to mastering calculus. *Black Issues in Higher Education*, pp. 5–6.

[13] Fullilove, R. E., & Treisman, P. U. (1990). Mathematics achievement among African American undergraduates at the University of California, Berkeley: An evaluation of the mathematics workshop program. *Journal of Negro Education, 59*, 463–478.

[14] Gutstein, E., & Peterson, B. (2005). *Rethinking mathematics: Teaching social justice by the numbers.* Milwaukee, WI: Rethinking Schools.

[15] Moses, R. (2002). *Radical equations: Civil Rights from Mississippi to the Algebra Project*. Boston, MA: Beacon Press.

[16] Settlage, J. & Southerland, S. (2012). *Teaching science to every child: Using culture as a starting point (second edition)*. New York, NY: Routledge.

[17] Dee, T., & Penner, E. (2016). The causal effects of cultural relevance: Evidence from an Ethnic Studies curriculum. *Stanford Center for Policy Analysis (CEPA).* Working Paper No. 16-01). http://cepa.stanford.edu/wp16-01

[18] Delgado Gaitan, C. (2013). *Creating a college culture for Latino students: Successful programs, practices, and strategies*. Thousand Oaks, CA: Sage Publications.

[19] Fine, M. (1993). Apparent involvement: Reflections on parents, power, and urban public schools. *Teachers College Record, 94*, (4), 682-729.

[20] Moll, L., Amanti, C., Neff, D., & González, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory Into Practice, 31*(2), 132-41.

[21] Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race Ethnicity and Education, 8*, 69-91.

[22] Crisp, G., & Nora, A. (2010). Hispanic student success: Factors influencing the persistence and transfer decisions of Latino community college students enrolled in developmental education. *Research in Higher Education, 51*(2), 175-194.

[23] Kenny Guinn Center for Policy Priorities (2022). National Education Rankings: What Nevada Can Learn: Phases One & Two – April to June 2022.

https://doe.nv.gov/uploadedFiles/ndedoenvgov/content/Boards_Commissions_Councils/State_Board_of_Education/2022/July/Guinn_Center_Nevada_Education_Rankings_Phase_I_and_II_Report_June_2022.pdf. Accessed February 21, 2022.

[24] Chen, X. (2013). STEM Attrition: College Students' Paths Into and Out of STEM Fields (NCES 2014-001).Washington DC: National Center for Education Statistics, Institute of Education Sciences U.S. Department of Education. Retrieved from: https://nces.ed.gov/pubs2014/2014001rev.pdf. Accessed on: February 19, 2017.