(Work-in-Progress) Developing Key Interventions from a Tightly Integrated Partnership to Increase Transfer Rates and Post-Transfer Success

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The transfer pathway is a crucial route that many students pursue to earn a bachelor's degree, but numerous studies highlight the challenges and barriers students face both before and after the transfer process. This study aims to identify prominent challenges commonly encountered by students at both 4-year and 2-year institutions, describe the closely integrated partnership and key interventions designed to address these issues, and present the progress and impact on students to date.

Sponsored by the Center for Inclusive Computing (CIC) at Northeastern University, the California State University Los Angeles (CSULA) Computer Science (CS) Department partnered with the three departments at East Los Angeles College (ELAC), where most prospective CS students are enrolled to develop several joint initiatives. This closely integrated partnership involves a joint team of chairs, directors, and faculty members from both institutions working together, dedicating significant time to collaboratively analyze institutional data, co-develop pathways, co-host events, and co-revise curricula.

The first step involved identifying key challenges and barriers through student surveys, curriculum analysis by faculty, and focus group meetings. Some of the significant recurring challenges included (Pre-transfer) insufficient or lack of information and advisement on transfer requirements and processes at ELAC, (Post-transfer) adjusting to different teaching styles after transferring, (Post-transfer) changes in academic expectations and the increased difficulty of course content (Both pre- and post-transfer) limited access to additional support such as tutoring, counseling, and advisement, and (Both pre- and post-transfer) a lack of community support and a sense of belonging.

To address these challenges, we developed a holistic transfer pathway through the following key interventions: 1) establishing clear transfer pathways and roadmaps and updating articulation agreements, 2) providing adaptive and consistent advisement, incorporating new pathways information, 3) aligning the CS1 courses between the 4-year and 2-year institutions, embedding socially responsible components (SRC) to encourage retention, especially among Hispanic and female students, 4) offering academic support, including boot camps for post-transfer students and tutoring for both pre-and post-transfer students, and 5) building transfer student communities and facilitating resource sharing, managed by student ambassadors, via Discord and in-person social events.

The joint team began implementing these interventions in the Fall of 2023, and we are now in the second year of the project. Most interventions have been rolled out, including pathways, articulation updates, course alignment for CS1, and community building. Since the implementation, we've seen a slight increase in the number of transfer students from ELAC. Upon full implementation, we aim to see not only a meaningful increase in computing transfer students from ELAC and other community colleges but also improved post-transfer student success rates in the sequence courses at CSULA. The paper will present tracked transfer rates, academic performance data in early programming courses, and a comparison of outcomes before and after implementing interventions.

In parallel, our research aims to assess 1) the effectiveness of each intervention in addressing specific challenges and 2) the overall most effective intervention. The project is still in its early stages and is not yet prepared to present meaningful quantitative or qualitative results regarding each intervention. However, to carry out this assessment, we will analyze student survey data and participation rates in

events in conjunction with institutional data to discover correlations. Ultimately, we plan to identify the most effective interventions and share them with other feeder 2-year colleges.

1. Introduction

The transfer pathway is a critical route for many students seeking to earn a bachelor's degree. However, numerous studies [4],[5],[7],[8] have highlighted the challenges and barriers they encounter both before and after transfer. This project seeks to identify major and unique challenges students face, specifically at both CSULA and ELAC. It also aims to outline the closely integrated partnerships and key interventions developed to tackle these issues.

CSULA is a federally designated Hispanic-Serving Institution (HSI) and Asian American and Native American Pacific Islander-Serving Institution. As of Fall 2023, the Computer Science program's enrollment demographics are 63% Hispanic/Latino and 37% non-Hispanic. The gender distribution is 82.9% male, 16.7% female, and 0.4% non-binary. ELAC is a public community college and also a designated Hispanic-Serving Institution (HSI). As of Fall 2023, students enrolled in Computer Science (CS) or Computer Information Systems (CIS) courses are 65.6% male and 66.7% Hispanic/Latino. Historically, ELAC has been a top feeder school to CSULA, largely due to their geographic proximity. The engineering programs at both institutions have a long-standing history of collaboration in establishing transfer pathways. However, collaboration between the computer science programs is a more recent development, and this project represents the first effort to establish concrete transfer pathways through close partnerships.

In the summer of 2023, a joint team of the Computer Science (CS) Department at CSULA and three departments at ELAC launched the Transfer Pathways Project, funded by the Center for Inclusive Computing, Northeastern University. As an initial step, the project concentrated on identifying key challenges and barriers by conducting student surveys, analyzing the curriculum with faculty input, and holding focus group meetings. Our key findings are summarized below.

Pre-transfer

Currently, ELAC offers computer science (CS) courses through three departments: the Business Administration Department, Mathematics Department, Engineering (ENGR), and Technologies Department. Each department provides its own sequence of courses, which come with different prerequisites and course structures (e.g., lecture only, lecture + lab.) [1],[3],[6]. In this environment, ELAC does not provide direct transfer pathways for Computer Science students. Thus, CS students interested in transferring to a CSULA learn the transfer requirements of each 4-year institution by identifying courses through articulation agreements on Assist https://assist.org/ (the official course transfer and articulation system for California's public colleges and universities [2]. In addition, counselors often advise students to check Assist https://assist.org to identify the required courses for transfer.

Although all transfer students are required to complete Major Specific Criteria (MSC) courses as a part of the CSULA CS Department transfer requirements [7], many students experience difficulties meeting the requirements due to confusion and a lack of consistency in the curriculum. Often, students take out-of-sequence or irrelevant courses, which hinder them from completing the MSC requirements in the given time. Also, enrollment and retention rates in CS courses at ELAC are low; consequently, these courses are often canceled due to low enrollment in ELAC, which makes it harder for students to complete the MSC requirements.

Post-transfer

Meanwhile, CSULA faces many of its own challenges, including high failure rates of transfer students in CS3, particularly those students unfamiliar with the JAVA programming language. In addition, many transfer students often find it challenging to keep up with the course content and increased academic performance requirements. Due to the increased difficulties with coursework and higher academic demand, transfer students often seek additional support such as extra office hours, tutoring, and advisement. However, the limited availability of such support only exacerbates these challenges, putting transfer students behind, which results in repeating the courses and causing further delays in graduation.

Pre- and Post Transfer

Students reported limited access to additional support, such as tutoring, counseling, and advisement, both before and after transferring. Additionally, they experienced a lack of community support and a diminished sense of belonging.

This project aims to implement key interventions to address these issues. The project is still in its early stages. This paper details the interventions addressed in Section 2 and presents preliminary data analysis in Section 3. Early indications from the data suggest a modest increase in the number of transfer students for the Fall 2024 term, following the interventions implemented in Spring 2024.

2. Challenges and Interventions

2.1 Challenge 1: (Pre-transfer) Insufficient or lack of information and advisement related to transfer requirements and processes

At ELAC, many students expressed confusion and lack of information regarding the transfer process, often feeling overwhelmed by the amount of information and lack of precise guidance. This challenge often leads prospective transfer students to miss critical deadlines or fail to meet transfer prerequisites, resulting in delaying transfer to CSULA [4]. To address this challenge, we have proposed and implemented the following interventions.

- Establishing Clear Transfer Pathways and Creating Comprehensive Course Roadmaps: We developed explicit transfer pathways and roadmaps to facilitate students' understanding of their transfer options. These are designed to give students straightforward access to vital information and support regarding transfer requirements, ensuring they can make informed decisions about their educational futures. In addition, we recognized the need for a more structured approach to curriculum planning. By creating comprehensive course roadmaps, we outlined various pathways for students at different transfer levels. Visual aids, such as flowcharts, were also developed to give students a clear picture of the curriculum and the steps necessary for successful transfer.
- Updating Articulation Agreements: We thoroughly reviewed related courses to further enhance the transfer process and updated our articulation agreements. This ensured that the transfer credits would be recognized and that students would understand how their coursework at ELAC translates to their future studies.
- Conducting Holistic Advisement with New Pathways Information: Effective communication is essential for successful advisement. We prepared various advertising materials, including tri-fold cards, and engaged with students directly by visiting classes alongside instructors. Additionally, we utilized our Discord server to disseminate information widely. We also collaborated with

various student organizations, ensuring that our messaging reached diverse student groups and fostered an inclusive environment for all.

2.2 Challenge 2: (Post-transfer) Adjusting to different teaching styles after transferring

Upon transferring to CSULA, many students reported feeling disoriented by the differences in teaching approaches and course structures compared to their previous institutions [5]. This adjustment period can impact students' overall academic performance and confidence, making it imperative for institutions to provide effective support. At CSULA, we recognized the need to support students in their transition, leading to a series of targeted interventions to foster a more cohesive educational experience. To address this challenge, we have proposed and implemented the following interventions.

- Aligning CS1 Course Content: To address the disparity in course expectations, we comprehensively reviewed existing CS1 course content from CSULA and ELAC. This collaborative effort led to the creation of a standardized course syllabus and content for CS1 courses, which was implemented in Spring 2024. This standardization not only streamlines the learning experience for students but also ensures consistency across different instructors and campuses. As we build on this foundation, we are currently developing standardized content for CS2 and CS3 courses to enhance the continuity of learning further.
- Building a Community of Practice Among CS Instructors: Recognizing the importance of collaboration in addressing instructional challenges, we established a community of practice among Computer Science instructors. Monthly meetings allow educators to share their experiences, teaching techniques, and strategies for engaging students more effectively. This collaborative environment fosters professional development and creates a knowledge base that compiles lessons learned, benefiting instructors and students.
- Training CS Instructors: To ensure the successful rollout of the standardized syllabus and course content, we implemented training sessions for CS1 instructors. This training focuses on effective teaching strategies that align with the new curriculum, equipping instructors with the tools necessary to facilitate a smooth transition for students. As instructors implement these teaching strategies in the future, the effectiveness of this training will be monitored through feedback and assessment metrics, helping us refine our approach continuously.

2.3 Challenge 3: (Post-transfer) Changes in academic expectations and the increased difficulty of course content

As students enter CSULA, they face a considerable shift in the rigor of their coursework and academic expectations. This change can lead to feeling overwhelmed and, without adequate support, can lead to reduced retention rates. It is crucial for the CSULA to recognize these challenges and respond proactively to help students navigate this critical period. In response, we implemented strategic interventions designed to support students during this transitional phase. To address this challenge, we have proposed and implemented the following interventions.

- Embedding Socially Responsible Components (SRC): To create a more inclusive and supportive academic environment, we embedded socially responsible computing components into our curriculum. This initiative was designed specifically to engage students with real-world issues and foster a sense of community and belonging. By incorporating culturally relevant and socially impactful content, we aimed to not only enhance academic engagement but also encourage retention, particularly among Hispanic students. This approach acknowledges the unique

experiences and perspectives of our diverse student body, promoting an inclusive atmosphere where all students can thrive.

- Offering Academic Support: In addition to curricular changes, we implemented in-semester boot camps tailored for post-transfer students. These boot camps are designed to provide additional academic support in key subject areas, equipping students with the necessary skills and knowledge to succeed in their courses. The boot camps emphasize collaborative learning and tailored instruction, allowing students to address specific challenges they may encounter in their coursework.

2.4   Challenge 4: (Both pre-and post-transfer) Limited access to additional support such as tutoring, counseling, and advisement

Transitioning from a two-year institution to a four-year university can be a daunting experience for many students. Often, the challenges faced during this pivotal moment are rooted in limited access to additional support services, such as tutoring, counseling, and academic advisement. Recognizing the importance of bridging this gap, several interventions have been implemented to ensure that both pre- and post-transfer students receive the guidance and assistance they need to thrive academically. To address this challenge, we have proposed and implemented the following interventions.

- Virtual Tutoring Service: One of the most effective interventions has been the introduction of virtual tutoring services tailored specifically for both pre-and post-transfer students from two-year and four-year institutions. This intervention was particularly important for transfer students who may have had difficulty accessing in-person tutoring due to time constraints, distance, or unfamiliarity with the new institution's resources. The virtual platform allowed students from both CSULA and ELAC to connect with tutors at times that fit their schedules, ensuring that academic support was available when needed. These virtual tutoring sessions have proven invaluable, allowing students to seek help in a flexible and accessible manner. Whether struggling with specific subjects or needing assistance developing study skills, students can connect with experienced tutors who understand the unique challenges faced during the transfer process. This initiative not only enhances students' academic performance but also fosters a sense of community and support among those navigating similar paths.
- Information Sessions: In addition to tutoring, hosting information sessions has emerged as a critical component of the support structure for transfer students. These virtual and in-person sessions allow prospective transfer students to gain insights into CSULA's academic expectations and resources. These sessions aimed to offer personalized guidance about the transfer process, academic planning, and career pathways. Through these info sessions, students receive essential counseling and advisement, equipping them with the knowledge and tools to make informed decisions regarding their educational futures. Moreover, these gatherings provide a platform for students to interact with academic advisors and current students, further demystifying the transfer process and alleviating any associated anxieties. The sessions were offered to students from both CSULA and ELAC, ensuring that prospective transfer students had access to accurate and relevant information regardless of where they were in their academic journey.

2.5   Challenge 5: (Both pre- and post-transfer) Lack of community support and a sense of belonging.

For many transfer students, transitioning from a two-year to a four-year institution can come with feelings of isolation and a lack of community support [5]. This sense of not belonging can impact their overall academic success, social integration, and emotional well-being [5]. While many students enter college

eager to learn and grow, transfer students often struggle to connect with their peers, faculty, and the campus environment, leaving them with a diminished sense of engagement and belonging.

The absence of a strong support network can exacerbate feelings of loneliness, anxiety, and even disengagement from their studies. For students making the leap from a smaller, close-knit two-year community college to a larger, more diverse four-year institution, the lack of familiarity with the new campus environment and student body can create a sense of alienation.

Addressing these challenges is vital to ensuring that transfer students not only succeed academically but also thrive socially and emotionally in their new setting. Thus, to combat this issue, several interventions have been implemented to foster a sense of belonging and community among students, thereby enhancing their educational journey.

- Hosting In-Person and Virtual Social Events: One of the primary interventions to address the lack of community support was the organization of in-person social events for students at both CSULA and ELAC. These events were designed to foster opportunities for transfer students to meet, network, and form connections in an informal, supportive environment. In-person events provided a space for students to build relationships, share experiences, and develop friendships that would contribute to a stronger sense of community. Social events such as mixers, student meet-ups, and recreational activities were specifically tailored to create a welcoming atmosphere for transfer students, where they could feel a part of something larger than their academic pursuits. These events not only offered students the chance to relax and unwind but also helped ease the anxiety of entering a new academic environment. By fostering these social connections, we aimed to combat transfer students' isolation and help them feel more integrated into the campus community.
- Student Ambassadors: Recognizing the importance of peer support, we hired three student ambassadors—one from the ELAC and two from the CSULA—to assist with social events, recruitment, and promoting the Transfer Pathways Program. The ambassadors played a crucial role in making transfer students feel welcome and supported as they navigated the transition to their new academic home. These ambassadors were uniquely positioned to offer advice, guidance, and camaraderie because they had firsthand experience as transfer students. Their role was to assist with organizing social events, connect students to available resources, and serve as mentors for those struggling to adjust. By hiring student ambassadors, we created a peer-driven support system that allowed students to engage with individuals who understood their challenges and could offer relevant advice or simply a listening ear. Furthermore, the ambassadors played an active role in promoting the Transfer Pathways Program, which provides a structured pathway for students transitioning from ELAC to CSULA. Their efforts helped ensure that students were aware of the resources and opportunities available, further reinforcing the sense of community within the transfer student body.
- Utilizing the Discord Server: Recognizing the increasing reliance on digital platforms for communication and community-building, we introduced a Discord server as a virtual space for transfer students to connect. This online channel provided a centralized platform where students could share information, ask questions, and support one another in a relaxed, informal setting. The Discord server was used to promote upcoming social events, share resources for academic success, and provide general guidance for students navigating the transfer process. As a virtual platform, we could continue to create a space for students to build relationships, engage in group discussions, and foster a sense of belonging, even when they are not physically present on campus. This virtual community allowed students to feel connected to their peers, regardless of their location or schedule, by providing a consistent and accessible space for interaction. For

many students, the Discord server became a central hub for staying informed, seeking advice, and forming lasting bonds with others in the transfer community.

2.6   Challenge 6: (Pre-Transfer) Recruitment

Both ELAC and CSULA have faced challenges in increasing the enrollment of female students in computing programs. Although increasing female students' retention is not a primary focus of the project, we acknowledge the significant difficulties in creating a welcoming community for them while the percentage of female students is very low. Consequently, we have made efforts to enhance the visibility of the computing program on both campuses within the local community to attract more female students.

In the Summer of 2024, we hosted a recruitment workshop named "CodeCraft" LA (Recruitment Summer Camp) for rising high school students and ELAC students. The workshop featured a hands-on session focused on building a drone and developing a mobile remote-control app to operate it. The full-day event began with a drone-building activity, where students learned about essential hardware components, such as microcontrollers, motor controllers, and I/O ports. Once the drones were assembled, the second session guided students through the process of creating a mobile app to control their drones.

The programming learning objectives included:

1. Understanding how a drone communicates with a remote-control app.
2. Learning how data is transferred from the app to the drone.
3. Exploring the concept of event-driven programming.

The active learning objectives focused on:

1. Programming fundamentals.
2. Developing a mobile app.
3. Building an interface to connect the app with a remote device.
4. Designing and controlling the flight parameters of a mini drone using the app.

3. Preliminary Data Analysis

In order to see the effectiveness of our interventions done in both institutions quantitatively, we have tracked the trends of transfer rates and students' success rates in the early programming courses CS1-CS3.

3.1   Transfer Rates

The project released the established roadmaps, together with flow charts, at the end of Fall 2023 and began advertising them in the Spring of 2024. The table below indicates that there has been a marginal increase in the total number of students and a significant increase in female students from the Fall 23 to the Fall 24 admission term, suggesting a possible influence on our efforts to encourage female students to participate in computing. We are optimistic about the positive impact future data may reveal.
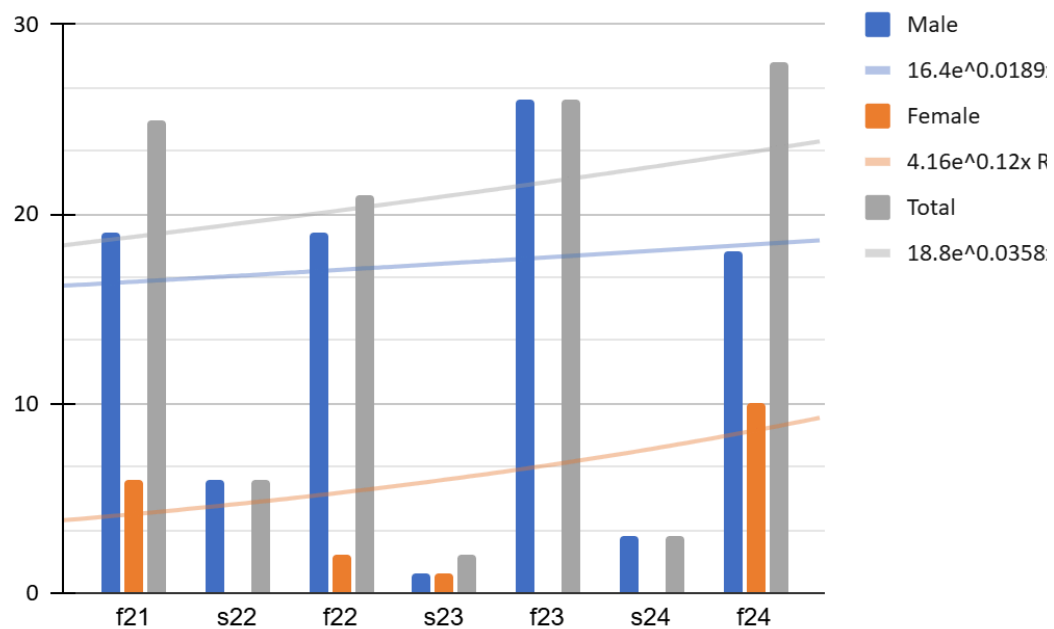
Table 1. Transfer students from ELAC to CSULA and the ratio of female students

Admission **Term**	**Male**	**Female**	**Total**	**Female %**
f21	19	6	25	24.00%

s22	6	0	6	0.00%
f22	19	2	21	9.52%
s23	1	1	2	50.00%
f23	26	0	26	0.00%
s24	3	0	3	0.00%
f24	18	10	28	35.71%

Figure 1. Transfer students from ELAC to CSULA

3.2 Academic Performance in Early Programming Courses: CS1 - CS3

We have evaluated whether our interventions, which aim to support transfer students to enhance their retention and success rates, have impacted student performance in early programming courses.

3.2.1 Data Trends in CSULA

CSULA offers a three-semester introductory programming sequence: CS1, CS2, and CS3. CS1 serves as the introduction to programming, while CS3 focuses on Data Structures. Students are eligible to enroll in the subsequence course only after completing the pre-requisite course with a C or higher grade.

Upon transferring to CSULA, transfer students usually begin with CS2 or CS3 in their first semester because CS1 completion with a C or higher grade is the admission requirement.

Figure 2 shows that the number of transfer students enrolled in CS2 and CS3 has been increasing, except for an unusual surge in Fall 2023, when the Computer Science program experienced a notable spike.

Figure 2. The number of transfer students enrolled in CS2 and CS3 at CSULA
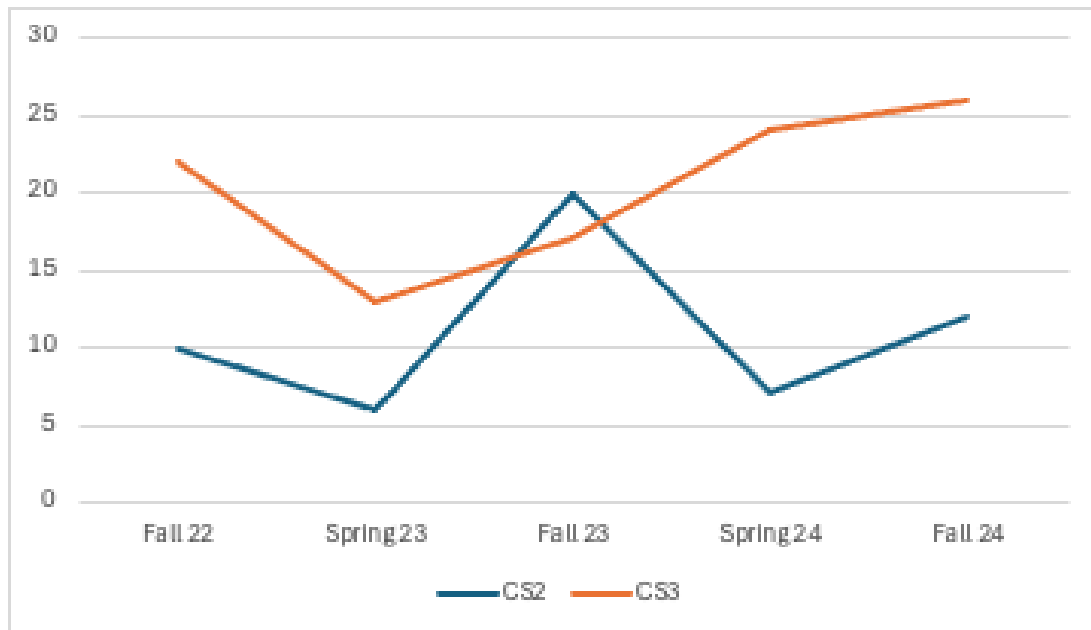

Further data analysis revealed that

- Enrollment of transfer students, particularly Latinx students, in CS3, has been improving, while the enrollment numbers for CS2 have fluctuated.

- The number of transfer students from our partner ELAC is trending upward, particularly in the enrollment numbers for CS3, which have been increasing.

- The overall DFW rate for students enrolled in CS2 increased slightly from 15.4% in Fall 2023 to 15.8% in Fall 2024. Similarly, the DFW rate for CS3 rose from 10.5% in Fall 2023 to 17% in Fall 2024.

- D, F, Withdraw (DFW) rates for transfer students in both CS2 and CS3 also rose from Fall 2023 to Fall 2024. However, transfer students from our partner ELAC who were enrolled in CS2 achieved a 100% pass rate in both Fall 2023 and Fall 2024. Similarly, all but one transfer student passed CS3 during the same timeframe. Therefore, there have been no significant changes in the pass rates for these students. We plan to conduct further analysis of their academic performance, focusing on overall grades.

- Although DFW rates for CS2 and CS3 remain below 20% compared to the academic years 2020-2022, this preliminary data underscores the necessity of supporting students to enhance their retention in their first post-transfer course.

3.2.2 Data Trends in ELAC

ELAC offers various introductory programming course sequences equivalent to CS1, CS2, and CS3 from three departments: Business Administration Department, Mathematics Department, and Engineering and Technologies Department.

After implementing a series of initiatives in Fall 2023, the total enrollment in CS2 increased significantly, averaging 40.5 in semesters before Fall 2023 to 73 in Fall 2023 and Spring 2024. There was also a significant increase in the total enrollment in CS1 in Fall 2023. The total enrollment in CS3 remained relatively stable after the implementation of the initiatives.

Figure 3. Total enrollment in CS1, CS2, and CS3 between Fall 2021 and Spring 2024.
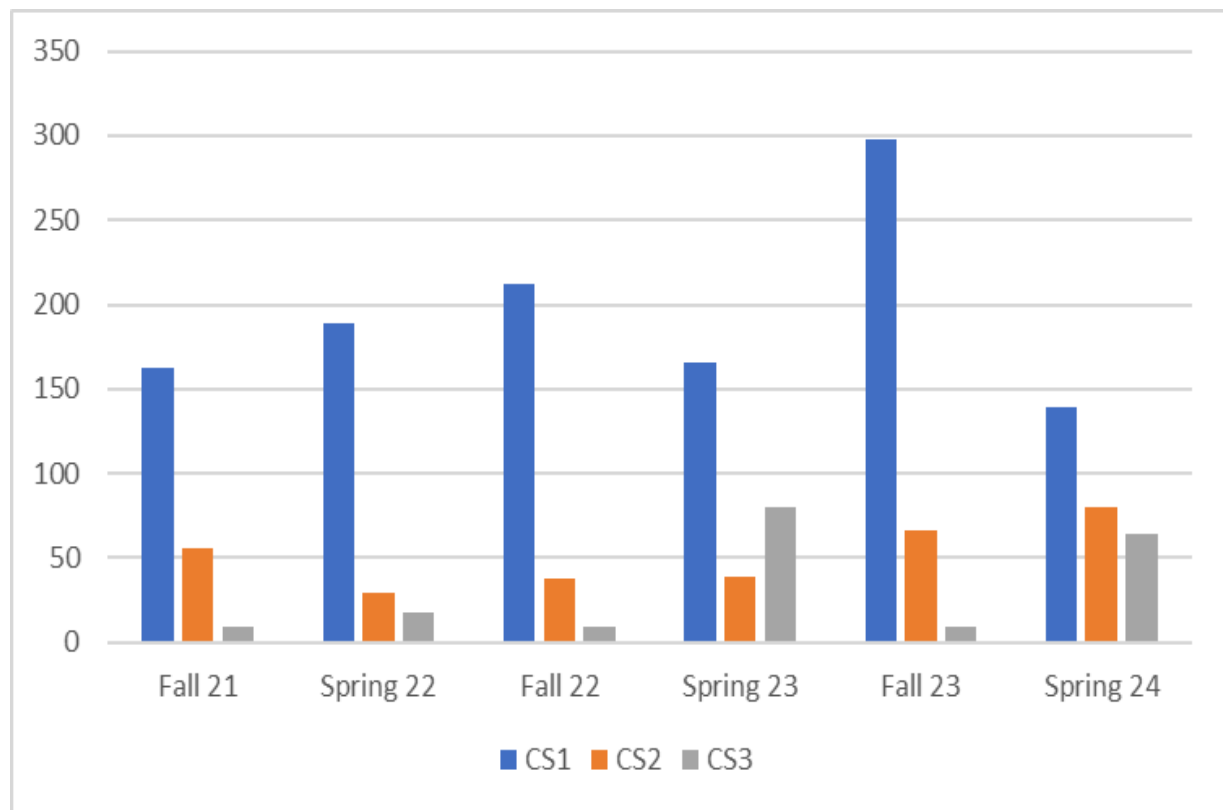
We collect the course outcomes, such as pass/fail/withdraw rates. Three courses, equivalent to CS1, CS2, and CS3, are selected to analyze the impact of the proposed initiatives on the academic performance of CS1, CS2, and CS3 in ELAC, respectively. After implementing a series of initiatives in Fall 2023, the pass rate of CS1 from the Mathematics Department increased significantly, from 50.37% on average before Fall 2023 to 75.65% in Fall 2023 and Spring 2024. The pass rate of CS2 from the Mathematics Department remained relatively stable: 80.13% and 79.95% before and after Fall 2023. The pass rate of CS1 from the Business Administration Department, however, dropped slightly from 61.47% before Fall 2023 to 56.50% after Fall 2023.

Figure 4. Pass Rates of CS1, CS2, and CS3 at ELAC
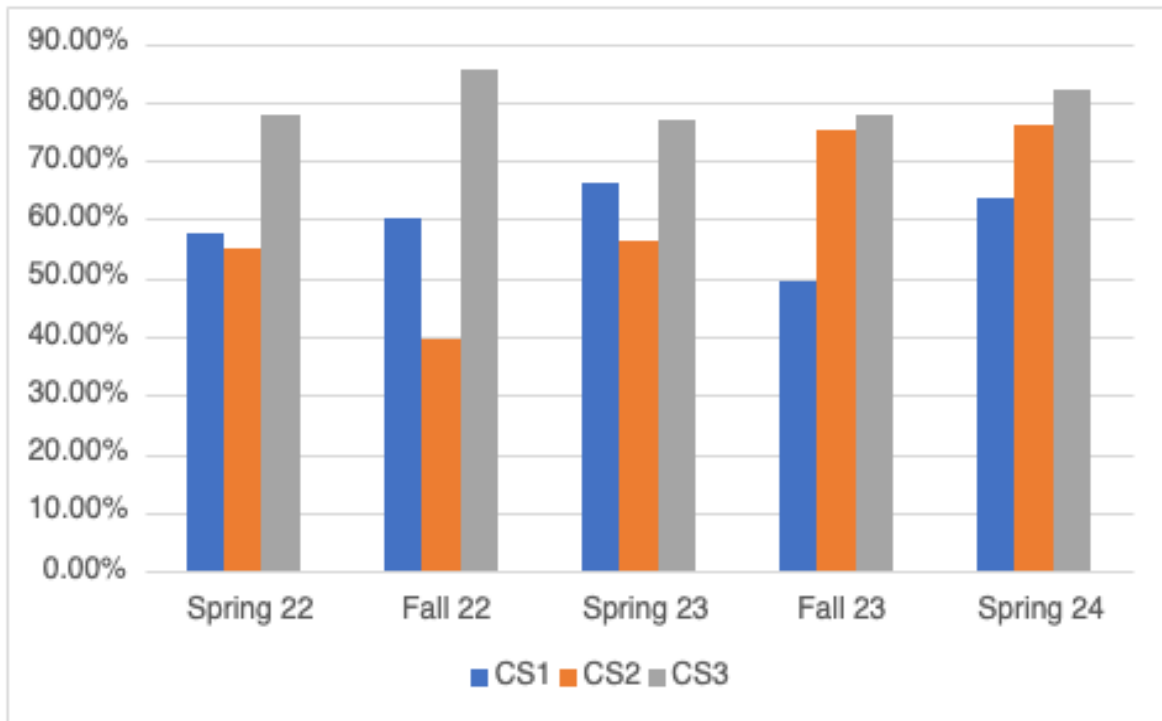
4. Discussion

In this study, we observed the following:

1. We observed that establishing transfer pathways and roadmaps yielded promising results for enrollment and success of CS transfer students from 2-year to 4-year institutions. Interventions addressed in Challenge 1 (insufficient or lack of information and advisement) lead to higher enrollment, particularly for female students. Clarity on the required coursework to complete to successfully transfer led to higher enrollment in the CS equivalent courses offered at ELAC.
2. Preliminary data indicate a significant increase in the number of female students transferred from ELAC to CSULA. To increase the percentage of female students in the CSULA CS department, we have conducted an in-depth data analysis of student enrollment, persistence, and performance in early programming courses (CS1, CS2, and CS3) from the Fall of 2019 to the fall of 2021. During this period, the department's female enrollment was less than 12%.
3. Through efforts in training CS instructors, the pass rates for CS equivalent courses at ELAC showed promising improvements. Better foundational preparation at ELAC is likely to improve student success post-transfer.
4. We also observed that embedding Socially Responsible Computing (SRC) components into the curriculum led to higher engagement levels.

While we believe that the clear transfer pathways, along with the holistic student support, benefitted both male and female students, the increase in the number of female students was notably significant. Furthermore, we believe that embedding SRC components enhances student engagement in introductory programming courses.

To confirm these findings and better understand the impact of these interventions, we will continue collecting data for each intervention, conducting a comprehensive data analysis, and refining our approach.

5. Conclusion

The project is still in its early stages. Nevertheless, significant progress has been made in addressing the challenges faced by transfer students moving from ELAC to CSULA. By implementing targeted interventions such as creating clear transfer pathways, aligning course content, fostering community support, and embedding socially responsible curriculum components, the project has begun to bridge the gaps that hinder transfer student success.

Preliminary data suggests that these efforts are yielding positive outcomes, with improved transfer rates, higher levels of student engagement, and increased retention. Notably, the emphasis on collaboration—between ELAC and CSULA —has fostered a culture of shared responsibility and innovation.

Moving forward, sustaining these interventions and building on transfer students' successes will require continuous assessment, feedback, and adaptation. Expanding initiatives like virtual tutoring, community-building activities, and socially responsible computing components will further enhance the educational experience for transfer students. With a firm commitment to supporting academic and personal growth, this project exemplifies the power of partnership in achieving equity and excellence in education.

As we look ahead, the lessons learned, and successes achieved through the project provide a valuable framework for addressing the evolving needs of transfer students and ensuring their seamless transition and success in higher education.

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