Learning about the Experiences of Chicano/Latino Students in a Large Undergraduate CS Program

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ABSTRACT

At our large U.S. research-intensive university, Chicano/Latino and Black/African-American students have been disproportionately leaving the Computer Science and Engineering (CSE) majors at a higher rate than students without these identities. To uncover possible reasons for this, we invited students in these majors who identify as Chicano/Latino and Black/African-American to participate in focus groups. Twelve students, all identifying as Latinx/Hispanic, participated in the focus groups. We identify several themes related to challenging aspects of the student experience, spanning physical campus environment, department curriculum and policies, and connections between students. We triangulate these findings with results from a survey measuring sense of belonging, confidence, and obstacles for thousands of students across eight introductory CSE courses. We discuss how these themes relate to actions that departments can take to address these challenges.

CCS CONCEPTS

• **Social and professional topics** → **Computing education programs**; *Student assessment*; Race and ethnicity.

KEYWORDS

Student experience, broadening participation

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1 INTRODUCTION

The well-documented enrollment boom in Computer Science and Engineering (CSE) undergraduate programs continues to grow [25, 29, 34]. Alongside it, however, the disparities in representation of students identifying as Chicano/Latino, Black/African-American, Native American/American Indian, and Pacific Islander/Native Hawaiian[1] persist. Not only are the proportions of these students enrolling in undergraduate CSE programs lower than their respective representation in the U.S. population [13, 16, 24], but many programs see disproportionately lower retention rates for these students [16, 27, 33]. After noticing similar trends in our own large U.S. research-intensive university's programs (Table 1), we sought to better understand our students' experiences.

Using a combination of student surveys and semi-structured focus groups we highlight what students identify as their motivations, obstacles, and experiences in their first-year CSE classes and as they progress through the program. Surveys including questions about motivation, perceived obstacles, and sense of belonging were sent to thousands of students in eight classes ranging from the first introductory courses to advanced data structures. Focus group participants were recruited via email sent out to all CSE students identifying as Chicano/Latino, Black/African American, Native American/American Indian, and/or Pacific Islander/Native Hawaiian. The majority of respondents to the invitations identified as Chicano/Latino with some identifying as multi-ethnic. In this paper, we focus on students who identify as Chicano/Latino and report on themes we observed in the semi-structured focus groups with these students, triangulating these results with the survey data. In our qualitative analysis, we seek to answer the following research question:

RQ: What themes emerge from Chicano/Latino students' observations of their experiences in CSE?

2 RELATED WORK

Lehman et al. [14] caution that efforts to diversify undergraduate CSE programs cannot be relaxed even in the face of enrollment pressures. Indeed, Nguyen and Lewis find that some of the competitive major enrollment policies put in place to address overwhelming demand are associated with lower sense of belonging for students who do not have pre-college CS experiences [20], which disproportionately affects students from racial and ethnic groups that are historically minoritized [18]. Prior programming experience has been found to relate to student self-efficacy, performance in

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[1] We recognize that there is disagreement around appropriate and inclusive labels for some of these ethnic and racial characterizations. In this paper we use the terms adopted by our institution.

Identity	Changed major		Graduated	
Black/Afr. Amer.	<7.0%	<10	<2.0%	<30
Chicano/Latino	13.2%	18	5.4%	83
All		135		1525

Table 1: Demographics of students who switched out of a CSE major into another major at our institution and of graduates of CSE majors (2018-2021). Low absolute counts are shown as ranges to avoid de-anonymization. This does not include data on students who left the institution altogether.

classes, and interactions with peers [2, 28]. In our project, we see evidence of this relationship, and explore how students' experiences are impacted by these interactions.

Students come into first-year CSE courses with a wide range of CS preparation, and students' experiences in these initial courses may impact their beliefs in their ability to succeed in computer science in general [5, 7, 21, 26]. Best practices for introductory coursework have been proposed to work to mitigate this effect: offering multiple versions of the same course tailored to students' prior programming experience; contextualized curriculum design (such as Media Computation, using activities from the EngageCSEdu library, and open-ended projects); and structured collaboration in class (via integrated labs or Peer Instruction) and on assignments (pair programming) [4–6, 9, 15, 17, 19, 22]. Cohoon and Tyconievich report that implementing some of these strategies contributed to an increase in diversity of students: their program attracted Black/African American students at a rate of 1.2 times the national average and women students at a rate 1.6 times national rate, with improved retention in the first year.

As students continue to advanced undergraduate courses, gaps in gender and racial/ethnic representation may widen, both due to disproportionate attrition from CSE majors and to specialization of the courses, which may mean that fewer non-majors are in these classes. The widening gender disparity gap has been documented [3, 12] and may be associated with reported differences in student behaviors and self-efficacy [1, 11]. In this paper, we explore the impacts of widening gaps in representation of Chicano/Latino students throughout the undergraduate program.

Pre-pandemic, Chicano/Latino and Black/African American students were less likely to enroll in online classes than students from other racial and ethnic groups [32]. Recent work on the impacts of emergency remote instruction does not find gender or racial/ethnic differences in student perceptions of instructor and social support in remote classes [8] or online collaboration [31]. However, student college experience extends beyond coursework and classrooms; Williams et al. document how universities must be responsive to the cultural differences in which students navigate and access campus resources [30]. Indeed, our work finds that being physically on campus can lead to powerful observations of identity, inside and outside the classroom. We consider the impacts that these observations have on student sense of belonging and self-efficacy.

3 METHODOLOGY

We answer the research question using qualitative analysis of two primary sources of information: focus groups with Chicano/Latino CSE majors as well as open-ended questions from a survey completed by thousands of students across eight CSE classes at our institution in Fall 2021. The protocol was reviewed and certified exempt by our university's IRB.

Group (FG)	IDs (P#)	Admit Year (Y)
★	P1, P2, P3, P4	18, 18, 20, 18
●	P5, P6, P7	21, 21, 18
■	P8, P9, P10 (W)	19, 18, 21
▲	P11 (T), P12	21, 18

Table 2: Focus group participants are noted in the text by a triple ⟨P#, FG, Y⟩ indicating their ID, the group they were in, and the year they were admitted to our institution. All but one of the participants identify as men; P10 identifies as a woman (W). All but one of the participants started at our institution as a first-year student direct from high school; P11 transferred (T) from another institution.

3.1 Focus groups: data collection

At our research-intensive university in the western United States, we invited all CSE majors who identified as Chicano/ Latino, Black/ African American, Native American/ American Indian, and/ or Pacific Islander/Native Hawaiian to participate in focus groups to further our understanding of the experiences of students from marginalized groups. to help us make improvements in the program. Students were asked to self-select into focus groups based on ethnic and racial identities, so that we could center the experiences of these groups of students in each focus group. Eight percent of students who received emails responded (16/199).

The majority of respondents to the invitations identified as Chicano/Latino with some identifying as multi-ethnic. From these respondents, we assembled four focus groups with 12 total participants. Each group had two to four participants, and all were Chicano/Latino CSE majors. Additional demographics are summarized in Table 2.

For all participants, this was their first time participating in a focus group. Participants self-selected into in-person or virtual (on Zoom) focus groups. The focus groups lasted 45-60 minutes. The facilitator was a researcher who was not a course instructor and who worked to ensure the focus group environment was a safe space for sharing experiences.

In each semi-structured focus group, students were asked to share responses to four questions. These questions explored the experiences of the students in the first year in the major and beyond. The questions along with the full protocol are included in the supplementary materials.[2]

3.2 Focus groups: data analysis

A grounded theory, inductive coding process was adopted for the analysis of transcribed and anonymized focus group audio recordings [23]. The unit of analysis was defined as an entire segment (utterance) spoken by one individual before another spoke. The analysis started with one researcher analyzing the complete transcript of one focus group, to develop an initial set of codes. Each researcher then used these initial codes to analyze the same focus

[2] https://github.com/CSedResearch22/ITICSE_suppDocs.git

group. After this coding was complete, all researchers met and reviewed disagreements to revise and merge codes as needed. The codebook developed from this final consensus is Table 3. The codes reflect the seven themes that were identified, each of which could have a positive or negative sentiment. An utterance could have no codes, one code, or multiple codes.

The remaining focus groups were coded by each researcher independently. Segments were labeled with codes by majority vote. Any segment given a label by only one researcher was reviewed collaboratively to identify any potential subtleties or ambiguities in the codes, which occasionally led to minor updates or clarifications to codebook definitions.

3.3 Survey: data collection

The second data source for this project is a survey administered to eight undergraduate CSE courses for one term. The courses included programming and data structures classes, systems programming classes, and discrete math and algorithms classes. Over 6,000 responses were collected for analysis from over 2,750 unique students, 337 of whom identify as Chicano/Latino, 773 of whom are CSE majors, and 67 are Chicano/Latino CSE majors. Among CSE majors, six students chose to opt out from the research. Most CSE majors responding to the surveys were admitted after FA18. Survey response rates for each participating course are presented in the supplementary materials, with an average response rate of 82.6% across all courses for Chicano/Latino CSE majors and average 85% response rate for all CSE majors.

Each participating course collected responses to at least five survey questions at the beginning, middle, and end of the Fall 2021 term. The five questions asked about students' motivation, confidence in their ability to succeed in the course, sense of community in the course, and their anticipated challenges. All survey questions are provided in the supplementary materials. In this paper, we focus on responses to one of the survey questions: *What are barriers that might prevent you from taking the next course in this sequence?*

3.4 Survey: data analysis

Given the relatively low numbers of Chicano/Latino CSE majors in some of these classes, we used the responses from all participating CSE majors to analyze the *barriers* students anticipate as they progress through CSE classes and triangulate these with the results of the focus groups. The survey response rates were high both for all students enrolled in the courses (87.9% all/85.0% CSE majors) and for Chicano/Latino students (88.9% all/82.6% CSE Majors). We used the responses from all participating CSE majors to analyze the *barriers* students anticipate as they progress through CSE classes and triangulate these with the results of the focus groups.

One researcher analyzed all the survey responses by all participating CSE majors. For each participating CSE major, we concatenated all their responses (at any time of the term, in any class) to the *barriers* question and applied the same set of codes developed during analysis of the focus groups themes to this set of responses for the student. Each student's set of responses could have no code, one code or multiple codes. Results are reported in Table 4.

4 RESULTS

4.1 Student experience and barriers

Through grounded theory qualitative analysis, we identified seven themes in student experiences of Chicano/Latino CSE majors (Table 3). We coded the focus groups and survey responses based on these seven themes. The focus group responses mentioned more positive aspects of student experiences. We used survey responses for the prompt focusing on *barriers* to unpack nuances of negative experiences.

In both the focus groups and survey, the most frequently appearing code was "Perception of CSE/Campus **Inst**itution and Policies" (focus groups: 168, surveys: 232). In these segments, students discussed both positive and negative experiences with the policies, authorities, and institutions of the university. As an example of a positive policy, one student shared how a friend "*who was a commuter a lot of times would miss class because with the full bus they just pass by*," but the policies of the class allowed students to "*watch it on the [podcast/youtube] and then answer the review quiz and then you get your participation score back*" ⟨P1,★,18⟩. Waitlists and capped course sizes were mentioned by 134 students in the survey (23%) and were coded as negative aspects of institutional policies: for example, "*the waitlist of [the class] is long*" (P225) and the "*waitlist situation is absolutely awful please get more spots for [the class]*" (P31).

The codes "Perception of CS **Culture**" (focus groups: 76, survey: 12), "Sense of **Comm**unity" (focus groups: 70, survey: 5), and "**Self-Ef**ficacy" (focus groups: 76, survey: 107) were also quite common. Again, students in the focus groups were more likely to share positive experiences, like this example of a student noticing the benefits of seeing other students' asking similar questions to them *"[the online discussion forum] is actually very helpful, not only for the information there, but to see that other people are also struggling with this same assignment and grasping the concept"* ⟨P11,▲,21,T⟩. Survey respondents were more likely to focus on negative perceptions of their capabilities, culture, and community – perhaps natural given the framing of the question – such as the students who shared "*this course is running so fast and i feel so overwhelmed*" (P465) and "*at times I struggle to ask for help, or I feel out of place/experience something like imposter syndrome*" (P135).

"Sense of **Belo**nging" (focus groups: 33, survey: 4), "**Comp**arisons to Others" (focus groups: 25, survey: 7), and "Perception of **Iden**tities" (focus groups: 39, survey: 1) were less common in terms of total occurrences. Nevertheless, they were noticeably more common in the focus groups in comparison to the surveys, which highlights the importance of the focus groups in surfacing specific aspects of experience students may be unlikely to share in a brief survey. This is particularly true as these experiences can point to significant challenges to improving retention, as with one student who shared *"it's out of us always trying to feel like we have to prove ourselves to others. And that's where it was kind of tearing me down to where I was like, I don't know if I should do this anymore"* ⟨P1,★,18⟩. The survey responses triangulate the concerns raised by focus group participants and suggest that some of these student experiences generalize beyond the twelve focus group participants.

Code	Description
(Inst) Perception of CSE/ Campus Institution and Policies	Observations of (student relationships with the) policies, authority, workload, requirements, and institutions.
(Cultur) Perception of CS Culture	Observations of the people in the department where; or content of the major/discipline where; students have formed or are forming an opinion about "how CS is". Learning about the field and it not being negative is positive.
(Comm) Sense of Community	Descriptions of connections with other people in and out of CSE that go beyond specified job/title roles (e.g. TAs helping isn't community, it's institution). Connections existing and not being negative is positive.
(Belo) Sense of Belonging	Description of one's own sense of belonging and desire to be in CSE.
(Self-Ef) Self-efficacy	Student's belief and/or confidence in their own abilities/capabilities in CSE course work/material or decisions to pursue CSE majors or programs. Positive means an expression or experience of being capable, negative means an expression or experience of being incapable/worried about capability.
(Comp) Comparison to others' competence	Student's perspective on other students in CSE as it relates to their ability to succeed in CS.
(Iden) Perception of Identities	Observations of races, genders, ethnicities, socioeconomic status, and other identities in CSE.

Table 3: Codebook developed from focus group responses; each has a "positive" and a "negative" version, for a total of 14 codes. "Positive" meant occurrence of the code that was neutral or non-negative.

	Admit Year	#Utter	Inst		Cultur		Comm		Belo		Self-Ef		Comp		Iden	
			P	N	P	N	P	N	P	N	P	N	P	N	P	N
Focus Groups	Started FA18	146	61	44	22	18	31	14	11	6	31	10	2	12	8	12
	Started Later	112	51	12	28	8	23	2	14	2	29	6	4	7	13	6
	Total	258	112	56	50	26	54	16	25	8	60	16	6	19	21	18
Survey	Chicano/Latino	69	3	21	1	4	0	1	0	0	1	16	0	1	0	0
	Total	584	8	224	1	11	1	4	1	3	16	91	0	7	0	1

Table 4: Analysis of focus group utterances by admit year of participant, along with counts of the same codes from the survey question "What are barriers that might prevent you from taking the next course in this sequence?"

4.2 Differences Exposed by Pandemic Teaching

Throughout the focus group analysis, we noticed differences in experiences between two groups of students: those that enrolled in Fall 2018 and those that enrolled later. This observation gave us a new entry point for understanding student experience, which coalesced into three interrelated motifs: visible perceptions of diversity, physical lab environments, and changing experiences beyond introductory classes.

4.3 Motif: Visible Perceptions of Diversity

Across focus groups, we heard about elements of participants' identity that related to visible aspects of campus, their peers, and the course staff. When in person, students are often in classes with well over 100 other students and labs with 30-50, so trends in identities of the surrounding students may be immediately apparent.

Negative Sentiment Around Identity Observations. Several participants had negative things to say about experiences with their identity on campus, in a variety of ways:

- The visibility of lack of representation of their identity was jarring: *"Coming in this [year], because this is the first year that I've been in person. I felt a little like, not outcast, but when I would go into class, I would see not a lot of people of my ethnicity. And that was kind of shocking."* ⟨P10,■,21,W⟩
- Identity played a role in how one student felt about asking questions: *"I feel like asking questions to like a male or like a male white person or a male Asian student. I feel like they don't see me as an equal..."* ⟨P10,■,21,W⟩
- They also notice annoyances on a broader campus scale: *"We need more Hispanic food on campus. I don't know what's going on. They took the burrito place away already."* ⟨P9,■,18⟩
- It affects their perception of their place in CS: *"... when I started coming here since I had come from like a lower class... So at times I would feel like I'm very different than other people at times I'm like, oh yeah,* **I'm CS in name only** [3] *"* ⟨P1,★,18⟩,
- Class diversity appears to decrease over time: *"...starting out in the first year...I feel like there was a little bit more diversity. I'm just considering it as more of a general education...there's not many Hispanic students anymore. Yeah definitely not many females anymore."* ⟨P9,■,18⟩ For context: the student may be perceiving reduced diversity due to disproportionate attrition from the major; another factor is that while the CSE major at our institution allows only a limited number of students to join each year, most of the introductory courses are open to anyone on campus. Our campus as a whole has more representation of identities than the students in the CSE majors and so the population in introductory classes tends to be more diverse. This observation overlaps with other experiences of more senior students discussed in 4.5.

Positive Sentiment Around Identity Observations. Contrasting with students who've seen diminishing diversity, some participants in

[3] emphasis added by authors

their first term had a different experience: *"Like in my classes and things. I see people that look like me and people of other ethnicities too. So I'd say it's pretty diverse for the most part."* ⟨P5,●,21⟩

As an even more explicit positive experience around identity, another student noted: *"... there's this one tutor. I can only guess he was Hispanic...But he looked like me. Right. And I think that was someone I looked up to for awhile. And I was like, Ooh, this tutor's like me and I could be like him someday"* ⟨P12,▲,18⟩.

4.4 Motif: The Basement

In the basement of our CSE building, a collection of computer labs house approximately 200 computers in 6 rooms; students refer to the space as "the (CSE) basement," "the labs," and "the dungeon." These labs are used for required, scheduled, in-person lab sessions in some classes, and are also available for students to work and to access drop-in, on-demand tutoring for classes. Lab computers have course-specific accounts with course software pre-installed; the same machines are available remotely via SSH. During emergency remote instruction due to COVID, nearly all courses shifted their physical lab times and help hours to remote video call formats. We learned from focus groups that these may be an important new resource that may be valuable even as in-person instruction resumes.

Negative Sentiment Towards Lab Space. The participants who started in FA18 had specific negative things to say about the basement labs as a physical space:

- *"it was a little sad going to the basement"* ⟨P9,■,18⟩
- *"it was a bit, almost like claustrophobic in a sense where like, everything is like squeezed together and you're like everyone's like there for like hours at a time waiting for tutors to come by"* ⟨P2,★,18⟩
- *"I could not work at the labs. It feels so stuffy yeah. yeah, it was always warm. It felt like I couldn't breathe"* ⟨P4,★,18⟩

There was a notable absence of these negative comments from students who had a majority of remote instruction. One of these participants suggested that the availability of remote ways to access help was particularly useful: *"I currently don't know where the dungeon is. There's like [instructions], how to get there on our website, but like, it sounds confusing...So I don't want to get lost and like have to ask. So I currently have never gone over there...also the instructions kind of sound confusing when, how to like request a ticket. I've never like done that for in person. So I usually don't go to in person hours. I go to remote hours and I do it in my dorm"* ⟨P10,■,21,W⟩.

Policy, Community, and Physical Space. The physical space interacts with department policies and student community. Academic integrity policy and students being in close physical proximity play a role: *"Cause someone...got their code working. Cause like the output looked like it was expected. I'm like, oh, that's cool. You got it. The person instantly covered the code. I'm not trying to copy you. I'm just saying like, Hey, good job"* ⟨P1,★,18⟩. The workload and individual nature of some assignments leads students to feel like they have to isolate themselves from one another, even when they are in shared physical space: *"It definitely feels like [other students] keep to themselves. And a lot of these classes, like they try to grind out these 15 to 20 hour PAs and they're just like glued to that screen and ignore everything else. Like they box themselves off"* ⟨P2,★,18⟩.

Lessons, Strategies, and Further Questions. We can work to improve the physical space with more room per workstation and better ventilation. However, while there are negative sentiments towards the physical space, we conjecture that these may indeed be symptoms of other issues. Participants' reported negativity around academic integrity suggests physical proximity is a problem rather than an opportunity for connection. So, changes to policies, messaging, and curriculum around academic integrity may be quite impactful. Fincher et al. report that their lab space was primarily useful for fostering connections around creative group projects [15]. In addition, since students work from off campus locations, non-CSE campus locations, as well as their dorms [10], we conjecture that continuing and improving support for remote help hours and remote work may be an opportunity for improving student experience.

4.5 Motif: Changing Experiences Over Time

Focus group participants described noticing their experiences change as they progressed to more advanced classes.

Negative Sentiment Around Struggle. Some focus group participants describe the struggle involved in a CSE degree: *"...classes get harder, but you get better... People don't really know a computer sciences until they, they take it. Like there's a lot more math and theory involved than just programming...I haven't talked about was the amount of time courses take. I, I remember like living with my dorm people and like, they'd be going out having fun...I'd stay up late at night doing work and I'm like, Hmm, maybe it's, you know, this, maybe isn't how I should be spending my college years"* ⟨P12,▲,18⟩. Also, high-enrollment introductory classes can be intimidating places to ask for help. *"During my first year it was mostly Piazza. 'cause whenever I went to like the lab hours or TA Hours, it always seemed like it was like full. And...I had like one question when I went...by the time they got to me, I had already answered it by myself...So I just relied on Piazza from other posts.* ***I wasn't brave enough to ask my own questions.*** [4] *But then moving on more of the upper div classes, I think they had more time for students, like if I actually went to the TA and office hours, like they will help me out a lot...they would answer my question and I wouldn't really have to wait"* ⟨P4,★,18⟩.

Friends and Community are Important. Focus group participants matriculating in FA18 mentioned friendships and student organizations more than those who began later (and who had had primarily virtual experiences). Sometimes, a friend was helpful in navigating minoritized experiences: *"I was doing the coding challenge with my partner... We're like, oh, it looks like we're the only Hispanics in here. And there was like a couple hundred people more or less. Yeah, so it just felt very different"* ⟨P11,▲,21,T⟩. The Society of Hispanic Professional Engineers was specifically mentioned by two of the FA18 admits as providing a supportive community: *"...I feel more comfortable being around more Hispanic students"* ⟨P10,■,21,W⟩. Students who had been here longer also reported some negative experiences with student groups: *"The [student organization] seemed like. I don't know. I guess...kind of cliquey. Maybe it's different now, but I did try...a hackathon on highschoolers actually for underserved communities. That was pretty nice. I met a lot of good people there...that's where I met some other friends"* ⟨P12,▲,18⟩.

[4] emphasis added by authors

5 DISCUSSION

Focus groups with Chicano/ Latino CSE majors shed light on the ways in which campus and department policies, along with student perception of the CSE discipline, their place within it, and their comparison to others impact their experiences. We find that visible perceptions of identities can adversely impact experiences (by making minoritized status more salient) but can occasionally be useful in identifying role models. We also find that policies, physical limitations, and workload interact in important ways when students decide where and how to ask for help. Providing opportunities for risk-free collaboration and offering multiple modalities of accessing class help may work to address some of the challenges we learned about from students in this project. Collaboration can also promote stronger social connections, which we learned can be particularly impactful when they help students form communities.

In this project, we focused on the Chicano/Latino CSE major experience. Future work will provide similar analysis and insights for CSE majors with other racial and ethnic identities. Other dimensions of identity may also be important for student experience of the major: gender, first-generation status, and pathways including community colleges. Intersectional experiences where multiple of these identities interact should also be considered.

Limitations in this project arise from common challenges with invitation-based focus groups and surveys: relatively small focus groups and varying response rates across courses. Response bias and survivorship bias may influence some of our observations: students who responded wanted to talk about their experiences and only CSE majors were included. Future work will include the perspectives of Chicano/Latino students who left the major, along with students with other racial and ethnic background who are current and former CSE majors.

6 CONCLUSION

Through focus groups and course survey data, we uncovered challenges faced by Chicano/Latino CSE majors, along with the aspects of their experiences that motivate and energize them. CSE programs looking to support the success of their Chicano/ Latino students can work to foster an inclusive, pleasant lab environment where student collaboration is encouraged and where there are opportunities to build community. Students' experiences beyond the classroom are critical for their success, and lessons we learned from remote teaching during this pandemic can be leveraged to increase access and support for all students.

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