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Work in Progress: ”When You Know Better, Do Better”: Measuring the Climates of University Computer Science Departments

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Work in Progress: "When You Know Better, Do Better": Measuring the Climates of University Computer Science Departments

Introduction

This WIP research paper explores how computer science (CS) students perceive and experience postsecondary CS department environments. University CS departments have long attributed a lack of diversity to perceived "deficits" (e.g., lack of access to physical devices, preparatory K-12 computing courses, computational thinking skills, self-efficacy, and interest) in students from groups that are historically underrepresented in computing by race, gender, socioeconomic status, and/or disability status. However, a growing body of literature [1], [2], [3], [4], [5], [6], [7], [8] calls attention to departmental policies and practices that impact students' sense of belonging and abilities to successfully navigate/complete CS majors.

This work was motivated by two challenges with existing computing climate surveys. First, departments often develop/distribute organization-specific surveys [9], [10], [11]. These often have no large-scale, cross-organization distribution, analysis, and comparison. Second, the most-used climate survey that provides cross-organization comparison, [the Data Buddies Survey, distributed by the Computing Research Association's Center for Evaluating the Research Pipeline (CERP) [1]] has a long completion time, removes responses from demographics with less than five responses per item, and does not allow for open-ended responses. While the removal of small response rates reduces the risk of de-identification, it simultaneously "erases" students who are the least represented and most marginalized in a department, and likely discipline; eliminates opportunities for data disaggregation; and reinforces hegemonic department cultures that do not value these nuanced and often very different experiences.

This paper addresses the research question "how do postsecondary CS students perceive department cultures?" through the development, testing, and preliminary distribution of an instrument that measures student experiences in CS departments. It is important to note that this instrument is (and was advertised as) a supplement to the Data Buddies Survey that specifically captured some of the more nuanced experiences of students from groups that are historically underrepresented in computing. After determining the infeasibility of incorporating the items into the Data Buddies Survey, the survey was distributed according to a timeline that allowed interested departments to participate in both without risk of survey fatigue.

Statement of positionality

While we both identify as women who are born and raised in the southern United States, our ethnoracial identities (Black and white), disciplines (computer science and higher education), career levels (senior faculty and postdoctoral researcher), and postbaccalaureate institutions (historically Black college & university and historically white college & university) situate the knowledge we bring to this work.

Methods

Instrument design

The original instrument (developed in the 2020-2021 academic year for distribution at Duke University) included 16 closed-ended items (requiring Yes/No responses) and two open-ended

items. Items were organized by department constituents (i.e., leadership, faculty, advisors, staff, undergraduate/graduate teaching assistants, and peers):

- (All) Do you think *CONSTITUENT* promote and foster an equitable/inclusive environment? (Yes/No)
- (All) Do you have any *CONSTITUENT*-related concerns regarding department culture? If so, please note your three biggest concerns? (Yes/No)
- How comfortable are you directly discussing your concerns with (Leadership, Faculty, Advisors, and Staff)? (1=Not at all, 5 = Extremely)
- (Leadership, Faculty, Advisors, and Staff) Do you feel like the (Leadership, Faculty, Advisors, and Staff) listen to and work to address your concerns?
- Is there anything you think the department is doing well to create a more equitable and inclusive environment? (Y/N, text)
- Do you have any suggestions for improving the department culture to create a more inclusive and equitable environment for diverse identities? (Y/N, text)

Following distribution in the spring 2021 semester and feedback, the survey was reviewed for gaps, clarity, and potential for broader distribution to the greater CS discipline. Key updates included items related to disability accommodations provisions and one's physical presence in spaces (e.g., classrooms, labs, and buildings) being questioned. The latter aimed to capture student experiences being policed in physical spaces where they were perceived by others to not "belong" there (similar to reports of badge policing in the tech industry by Black and Latine computing interns and employees [12]). The second version of the instrument was finalized in the fall 2023 semester, with all items organized into three constructs: perspectives on departmental efforts, departmental impact on sense of belonging, and comfort discussing concerns. Table 1 lists all survey items, by construct.

Table 1. Survey items, by construct.

Construct #1: Perspectives on Departmental Efforts
1. The following groups within the department actively promote an equitable and inclusive environment for all students: (Subitems: Department Leadership, Faculty, Advisors, Staff, Undergraduate TAs, Graduate TAs, Classmates)
2. If I have disability accommodations, I am confident that all faculty in my department will provide them upon request with no issues.
3. I am pleased with the overall department effort to create a more inclusive environment for all students.
Construct #2: Departmental Impact on Sense of Belonging
1. I have experienced a lack of inclusion from the following groups within the department: (Subitems: Department Leadership, Faculty, Advisors, Staff, Undergraduate TAs, Graduate TAs, Classmates)
2. I have been asked by faculty, staff, and/or students if I am supposed to be in a campus building, room, or office because they did not think I belonged there.
3. I have considered changing my major because of negative experiences in the department.
Construct #3: Comfort Discussing Departmental Concerns
1. I am comfortable discussing concerns related to my experiences in the department with the following: (Subitems: Department Leadership, Faculty, Advisors, Staff, Undergraduate TAs, Graduate TAs, Classmates)
Open-Ended Responses
1. Is there anything you think the department is doing well to create a more inclusive environment for students of all identities?
2. Is there anything you think the department can improve upon?
3. Is there anything else you'd like to briefly note/clarify based on your responses?

Survey items across all three constructs were closed-ended, and responses were collected on a five-point Likert scale (where 1 corresponds to Strongly Disagree and 5 corresponds to Strongly

Agree). Item 1.2 included a "N/A" option for students without disabilities. Three items collected open-ended responses. Demographic data collected included race/ethnicity, gender, disability status, first-generation status, and classification (i.e., graduate/undergraduate).

Participants were recruited via the research team's website, social media, and listservs such as the ACM Special Interest Group on CS Education (SIGCSE), Black in Computing, and NSF INCLUDES National Network. Interested faculty/department leadership completed the organization registration form and were provided a recruitment letter, informed consent form, and link to the survey to distribute to students. An incentive was provided in the form of a $20 gift card for 100 randomly selected participants. Institutional Review Board approval was provided via Duke University.

Demographics

A total of 750 respondents completed the survey across 13 institutions. Five institutions held minority-serving designations (one HBCU, two HSI, and four AANAPISI, with one institution holding both HSI and AANAPISI designations). Approximately 42.1% of all respondents were Asian, 24.2% white, 8.8% Black, 7.3% Latino/a/x/e, 2% Middle Eastern or Northern African, 0.4% Native Hawaiian or Pacific Islander, 2.4% multiple races (no group historically underrepresented in computing), 4.4% multiple races (one group historically underrepresented in computing), 1.2% multiple races (two or more groups historically underrepresented in computing), and 7.2% did not disclose. Ethnoracial groups that are considered historically underrepresented in computing are Black, Native American, Native Hawaiian, Pacific Islander, and Latino/a/x/e [13]. Approximately 61% were men, 31% women, 3% non-binary, and 5% did not disclose. Approximately 10.2% reported a disability, 82.3% reported none, and 7.5% did not disclose. Approximately 23.6% were the first in their families to attend college, 71% were not, and 5.3% did not disclose. Approximately 76.9% were undergraduates, 20.7% were graduate students, and 2.4% did not disclose.

Instrument testing

Cronbach's α, the Kaiser-Meyer-Olkin (KMO) test, Bartlett's test, and exploratory factor analysis (via RStudio) were used to determine internal reliability, factorability, and underlying constructs, respectively. Cronbach's α's for the overall instrument (excluding demographic and open-ended items) and Constructs 1-3 were 0.932, 0.934, 0.957, and 0.95, respectively. For factorability, KMO tests results indicated an overall measure of sampling adequacy (MSA) of 0.91 (which is in the range of marvelous). The MSAs for 19 of the 25 items were in the range of marvelous, and the remaining six were in the range of meritorious. Next, Bartlett's test returned a $p < 0.05$, indicating the instrument was suitable for factor analysis. Finally, exploratory factor analysis was performed using orthogonal (varimax) and oblique (promax) rotations with two, three, and four factors. The eigenvalues (Table 2) and scree plot (Figure 1) indicated that two factors were optimal, accounting for 69.2% of the cumulative variance.

Table 2. Variance of two factors using promax rotation.

	PC1	**PC2**	**PC3**	**PC4**
Eigenvalues	3.2387	2.6077	1.22825	1.09781
Proportion of Variance	0.4196	0.272	0.06034	0.04821
Cumulative Variance	0.4196	0.6916	0.75192	0.80013

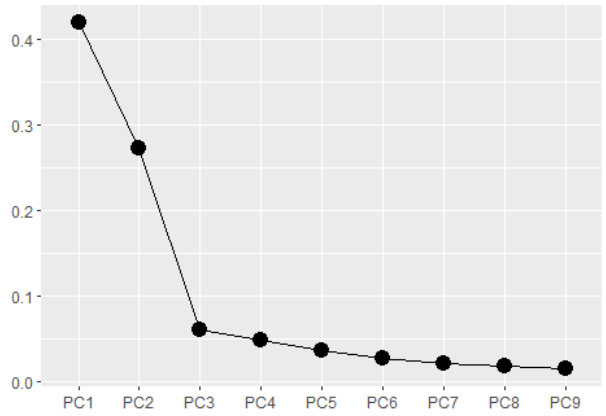

Figure 1. Scree plot

All items were maintained and organized into two factors: 1) Perceptions of the department, and 2) Departmental experiences discouraging participation (Table 3).

Table 3. Final instrument and factors.

Factor #1: Perceptions of the department
1. The following groups within the department actively promote an inclusive environment for all students: (Subitems: Department Leadership, Faculty, Advisors, Staff, Undergraduate TAs, Graduate TAs, Classmates)
2. I am comfortable discussing concerns related to my experiences in the department with the following: (Subitems: Department Leadership, Faculty, Advisors, Staff, Undergraduate TAs, Graduate TAs, Classmates)
3. If I have disability accommodations, I am confident that all faculty in my department will provide them upon request with no issues.
4. I am pleased with the overall department effort to create a more inclusive environment for all students.
Factor #2: Departmental experiences discouraging participation
1. I have experienced a lack of inclusion from the following groups within the department: (Subitems: Department Leadership, Faculty, Advisors, Staff, Undergraduate TAs, Graduate TAs, Classmates)
2. I have been asked by faculty, staff, and/or students if I am supposed to be in a campus building, room, or office because they did not think I belonged there.
3. I have considered changing my major because of negative experiences in the department.
Open-Ended Responses
1. Is there anything you think the department is doing well to create a more inclusive environment for students of all identities?
2. Is there anything you think the department can improve upon?
3. Is there anything else you'd like to briefly note/clarify based on your responses?

Data analysis

Quantitative analysis

Demographic information was reviewed in detail to prevent de-identification of respondents. First, for each institution, the Longitudinal Degree Completion App [14] was used to determine if ethnoracial and gender identities with less than five responses were representative of department demographics. The Longitudinal Degree Completion App provides a cohort-based analysis of an institution's number of graduates (by race, gender, and CIP code). Ethnoracial and gender groups (i.e., Black, Native Hawaiian and Pacific Islander, Native American, and Latino/a/e/x women and non-binary people) with less than five graduates in the prior year were collapsed into *Groups Historically Underrepresented in Computing*. If there were not enough demographics present to accomplish this, responses were collapsed into "Undisclosed." Students selecting multiple ethnoracial identities were collapsed into Multiple Races (0) Multiple Races (1), and Multiple

Races (2+), based on the number of identities from a group that is historically underrepresented in computing.

All Likert-scale responses were coded as 1(Strongly Disagree), 2(Somewhat Disagree), 3(Neither Agree Nor Disagree), 4(Somewhat Agree), 5(Strongly Agree), and NA(Not Applicable; Item 1.2 only). Three items related to experiencing exclusion, presence in physical spaces questioned, and considered changing majors were reverse coded to ensure all "Strongly Agree" responses indicated positive responses and "Strongly Disagree" indicated negative ones. Descriptive statistics were determined via RStudio for all closed-ended items. Institutions were provided institutional and aggregate (across all participating institutions, per distribution year) results.

Qualitative analysis

Responses from all participants were compiled for each open-ended question (i.e., Table 1). Responses were reviewed using thematic analysis [15], with inductive coding methods [16] utilized per question. After initial codes were created, they were reviewed to identify initial themes and patterns. Throughout coding, attention to respondent demographics was centered to understand if patterns were specific to identity groups. Themes were then reviewed, condensed, defined, and finalized for each open-ended question.

Results

Quantitative results

Tables 4 and 5 present the mean scores across all items in Factors 1 and 2.

Table 4. Mean scores for all closed-ended items, by department constituent.

	Leaders	Faculty	Advisors	Staff	Undergrad TAs	Grad TAs	Peers
Promote Inclusion	4.10	4.19	4.19	4.15	4.10	4.10	4.02
Did NOT Experience Exclusion From	3.99	3.99	4.12	4.06	4.04	4.03	3.88
Comfort Discussing Concerns With	3.85	4.02	4.19	4.00	3.97	3.97	4.23

Table 5. Mean scores for closed-ended items.

Confident Accommodations Would Be Provided	4.22
Presence in Spaces is NOT Questioned	4.4
Have NOT Considered Changing Majors	4.43
Satisfied with Department Efforts	4.05

Preliminary results show that although students indicated faculty and advisors promoted inclusive environments the most, students were split with respect to experiencing exclusion from these same groups. Specifically, students indicated experiencing the least exclusion from advisors, while faculty and classmates were responsible for the most exclusion. Black, Latino/a/x/e, Middle Eastern or Northern African, Native Hawaiian or Pacific Islander, and multiracial (2+) students reported their physical presence was questioned the most in campus spaces.

Students without disabilities, those who are not the first in their families to attend college, and the most overrepresented ethnoracial identities in computing (i.e., Asian and white) indicated the strongest beliefs that all members of the department fostered an inclusive environment. Subsequently, these demographics (along with men) expressed the most satisfaction with

departmental efforts. Conversely, students with disabilities; those who are the first in their families to attend college; Black, Native Hawaiian or Pacific Islander, and Middle Eastern or Northern African students; and students of undisclosed gender indicated the least satisfaction with their department's efforts. Further disaggregation indicated students with disabilities who are non-binary, women, and undisclosed gender were the least satisfied. Students with disabilities were the least confident that accommodations would be provided, if requested, with non-binary and undisclosed gender students with disabilities the least confident.

Qualitative results

Aggregate themes emerged for each open-ended item. Overall, students recognized departmental efforts to create equitable and inclusive environments, including sharing resources and promoting events featuring speakers from minoritized identities; events hosted by student organizations serving those with minoritized identities; and research, professional networking, and other technology-related opportunities.

However, students also reflected on the need for more proactive approaches to creating and fostering inclusive computing environments within their department (e.g., curricula considerations, addressing the underrepresentation of gender and ethnoracial identities, and consistent provision of disability accommodations). Students sought more community building, feedback opportunities to share their experiences, and consistency across departmental policies and programs that centered DEI.

Discussion

Student perceptions of and experiences with advisors explain their comfort discussing departmental concerns with them more than any other employee group. Specifically, students usually are assigned one advisor, which allows for a closer relationship than with overall faculty in the department (even when department advisors are faculty). An interesting contrast was observed between students and their classmates. Specifically, students indicated their classmates fostered inclusive environments the least, while also being the group they were most comfortable discussing concerns with. This contrast was likely attributed to being more comfortable with a small subset of classmates with whom they have closer relationships versus the larger student body. There are also no power differentials and concerns of retaliation, as with leadership, faculty, advisors, and staff. This is evidenced by students being least comfortable with department leadership. These results indicate an important point for leadership: Student concerns are less likely to be shared with the community members (i.e., department leadership) who are most able to enact change. This demonstrates a potential disconnect between what department leadership perceive as student perceptions and experiences and students' actual perceptions and experiences.

Open-ended responses highlighted examples of this disconnect, as students reflected on the inconsistency with provisions of disability accommodations and curricula. While students requiring accommodations noted they were provided, their overall experience using them was negative and alienating. Additionally, students noted that curricula felt outdated not only in content, but also in technology resources and instructor delivery. These examples can be addressed by department leadership. However, organizational cultures that constrict students' comfort sharing these experiences will limit the amount of feedback shared and inclusion that is ultimately fostered.

As previously noted, the original purpose for Item 2.2 (*I have been asked by faculty, staff, and/or students if I am supposed to be in a campus building, room, or office because they did not think I belonged there*) was to capture any differential experiences with respect to how students navigate physical computing spaces (e.g., buildings and classrooms), especially those from ethnoracial groups that are historically underrepresented in computing. Results confirmed that students who identified as Black, Latino/a/x/e, Middle Eastern or Northern African, Native Hawaiian or Pacific Islander, and multiple races (2+) experienced this questioning the most, while also experiencing the most exclusion. This correlates to not only experiences in the tech industry of overpolicing employees from specific ethnoracial identities [12], but also the overpolicing of these same identities historically in communities across the U.S. [17]. It is important to note that these groups were also the least comfortable discussing concerns with department leadership, faculty, or advisors. Based on the significant underrepresentation of these ethnoracial identities in computing [18], it is highly likely that department leadership lacks awareness of the actual "pain points" of the groups that are the least represented. Open-ended responses showed that women, specifically ethnically and racially minoritized women, were hyperaware of the underrepresentation of their gender and ethnoracial identities. Some students articulated feeling outnumbered and lacking community in their departments. As previously noted, if department surveys remove responses from groups with smaller response rates or do not include open-ended responses, then these voices are silenced and their experiences erased, with the groups who are most represented dominating any analysis. These results demonstrate the importance of retaining responses from those with the broadest perspective on department successes and areas for improvement.

Limitations

There were a few limitations that impacted this study. First, there was low participation from HBCUs and no participation from TCUs. Given these are the only minority-serving institutions that were founded for the purpose of serving students from minoritized ethnoracial identities (i.e., Black and Native American students), it is important to understand the experiences of students at these institutions, especially since not all HBCU computing departments are dominated by faculty who identify as Black or from the African Diaspora. Second, not all institutions received open-ended responses from their participants. To address this, all open-ended responses were aggregated for analysis and provided to all institutions. Given the common challenges across the broader computing discipline, the overarching themes were considered beneficial for all institutions to reflect on organizational cultures and growth opportunities.

Conclusions

This study explored the design, testing, and distribution of a computing environment instrument that captured more nuanced student experiences, with special attention focused on ensuring the experiences of students from groups that are historically underrepresented in computing (and often the least represented in their departments) are not only maintained, but also meaningfully interpreted to understand departmental experiences. The instrument was designed to supplement the popular Data Buddies Survey, and preliminary results indicate the instrument provides not only additional information on departmental experiences, but also a "voice" for those who are often the most silenced (i.e., the least represented), due to low demographic populations resulting in dropped responses. The survey will be distributed on an annual basis, and future distributions will focus on recruitment from more minority-serving institutions that were created with the mission of serving Black and Native students especially (i.e., HBCUs and TCUs).

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