What Makes a "Computer Science Person"? Minoritized Students' Sense of Identity in AP CSP Classrooms

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***Abstract*—The CS for All Movement is making great strides toward increasing access to quality computer science (CS) education, particularly for minoritized youth from communities historically underrepresented in computing fields. However, it can be both mentally and emotionally challenging to enter fields of expertise where people do not look like you, and where your culture and experiences are seen as foreign or "different." If we want to see students engaging with computing in their varying academic/career pathways, they must feel a sense of belonging and "rightful presence" in computing classrooms [1]. In an effort to prioritize students' voices and ideas about what matters most for their sense of belonging in CS, this study administered end-of-year surveys to 860 students across Advanced Placement Computer Science Principles classrooms in a large west coast urban school district serving majority low-income students of color. This study describes students' levels of engagement with CS, whether or not they identify as "computer science people," and the factors impacting their sense of belonging with the field. These findings will be important to consider when shaping both curricula and professional development opportunities geared at broadening participation in computing, by informing ways to support students' sense of belonging and engagement with computing.**

***Keywords*—Equity, K-12 education, Advanced Placement Computer Science Principles, Identity, Student Engagement**

I. Introduction

The Computer Science for All Movement seeks to ensure that all students have access to high-quality, rigorous, and engaging computer science (CS) education. A focus on equity guides this effort, as parents, educators, researchers, administrators, and policymakers challenge the ways youth have had differential access to computing education based on race/ethnicity, gender, and socioeconomic status [2]. There is also a desire to diversify our highly segregated CS workforce: in 2018, only 26% of the U.S.'s computing workforce was female, and of those women only 6% were Asian American, 3% African American, and 2% Latina [3]. Projecting forward in the U.S., there will be more computing jobs available than there will be Americans qualified to fill those positions [4]. And as the U.S. demographically moves toward becoming a majority-minority country, it would be problematic if the CS workforce creating the technological innovations impacting all our lives continues to represent only White and certain Asian males. As others have argued, diversity in the CS workforce is needed to not only ensure that innovations have equal positive impact across our diverse communities, but also so that a greater variety of solutions are shared to solve the future problems we cannot currently foresee [for example, 5, 6].

Of course, this CS for All Movement is fueled by more than a desire to prepare minoritized youth, who have been historically underrepresented in computing, for participating in the CS workforce. CS is valuable for all students to learn because of its potential to shape the futures of all fields. For many, there is a hope that youth can be instilled with an appreciation for computing and its problem-solving practices because it can inform the thinking and work students do across all areas of interest. Equity at the heart of the CS for All movement does not mean simply creating future computer scientists, but supporting all youth to be our communities' future innovators and problem-solvers in any personal pathway.

Yet if we want to see students either pursuing CS or engaging computing in their own academic/career pathways, great shifts must happen in students' sense of belonging and identity with computing beyond simply having access to learning CS. It can be mentally and emotionally challenging to enter a world where people do not look like you or where you do not feel like you "fit in." This is especially true in STEM and CS classrooms where, historically, minoritized youth's expertise and knowledge have been positioned as "different" and unwelcome while Eurocentric views of the world have been upheld as "correct" [7]. In such contexts, youth are often denied "rightful presence," or "legitimate and legitimized membership in a classroom community because of who one is (not who one should be), where practices of that community support re-structuring power dynamics towards more just ends through making both injustice and social change visible" [1, p. 5-8].

In an effort to learn directly from youth about what it takes to feel a sense of "rightful presence" toward engaging and identifying with computing, this paper will explore how high school students—enrolled in Advanced Placement Computer Science Principles (AP CSP) across a large west coast district—articulate what it means to be "computer science people." Through the perspectives and words of high school students coming from communities historically underrepresented in CS, this paper shares what impacts their interest with computing, and how they do or do not identify with the field.

We believe it is particularly important to hear from AP CSP contexts, because the number of historically underrepresented students enrolling in AP CSP (i.e., students of color, young

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women, etc.) have been steadily increasing since the launch of the course in 2016-17. More specifically, in the state of California in 2018, for example, the percentage of girls enrolled in AP CSP was higher than in either introductory CS courses or AP CSA [8]. And while Latinx students are still under-represented in AP CSP compared to their enrollment in public schools, they are participating in AP CSP at higher percentages than AP CSA [8]. There are no differences in passing rates between male and female students on the AP CSP exam, however more than 75% of White and Asian students pass the exam, compared to only 40% Latinx and 39% Black students [8]. While increasing enrollment of students of color is promising for AP CSP contexts, we still have much to learn from the students' perspectives about their own sense of engagement and identity with computing when deciding to take and persist through the course. As such, this paper seeks to answer the following research questions:

1) To what degree do minoritized youth feel engaged with computing in AP CSP classrooms, and how does this compare to their sense of belonging in the field of CS?

a) Do minoritized youth coming from communities historically underrepresented in CS feel that they are, or can be "computer science people"?

b) What characteristics/features of "computer science people" do minoritized youth believe they can or cannot identify with?

Our exploration of student engagement and belonging is informed by research revealing how high school students often have misconceptions about what CS involves, and therefore choose not to pursue computing [9], but that after taking introductory CS courses such as Exploring Computer Science, they would recommend CS to friends because of its value to their futures and ability to achieve personal college/career goals [10]. Also, students' motivation to pursue computing is particularly influenced by the encouragement they receive, especially for women and people of color [11]. Such research serves as a diving board into our exploration of how youth in this study described their own relationship to the field of CS.

II. Methods

A. *Student Surveys and School District Context*

Student surveys were administered online to 861 AP CSP students after completion of the AP CSP exam during the 2018-19 school year in a large urban school district on US's west coast. This district is 73.5% Latinx, 10.5% White, 8.2% Black, 4.2% Asian, and ~80% of students receive free/reduced lunch.

Surveys built upon validated questions created by the Outlier's project surveying high school CS students [12], Haynie and Packman's surveys for AP CSP students [13], and the BRAID initiative's surveys for college CS students [14]. CS teachers and students from the district tested and provided feedback on the questions prior to administration. The survey covered background information (grade level, prior CS experience, etc.), self-rated knowledge level of AP CSP curricular topics, degree of CS interest, CS identification and belonging, beliefs about whether CS ability is innate or learned, CS alignment with educational and career goals, ideas for using CS in the world, and demographic information. We sought to understand students' end-of-year perceptions of CS, while also trying to surface their voices about what matters most for their engagement, identity, and agency with computing. Likert-scale questions were rated on a 0-10 scale, where 0 corresponded with "strongly disagree," 5 corresponded with "neither agree nor disagree," and 10 corresponded with "strongly agree."

We analyzed all likert-scale questions using SPSS. Answers were separated by respondent's race/ethnicity and gender. Racial/ethnic groups were all-inclusive, meaning if students were mixed-race, we counted those students in all the groups that they identified as. For example, an Asian-Latinx student's answers counted in both the Asian and Latinx group analyses. We believe this was important to ensure that students were represented as they chose to be identified, rather than making assumptions about their primary race/ethnicity. In likert-scale analyses, responses of groups whose total numbers were less than 30 people were not included to prevent potentially skewing statistical analyses (specifically: non-binary/non-conforming, Indian/South Asian, Middle Eastern, and American Indian students). Students who did not mark a race/ethnicity or gender identity were also excluded from likert-scale analyses.

Within each ethnic/racial group, we conducted independent two-sample t-tests to determine the statistical significance between male vs. female responses. We also explored the degree to which males vs. females varied around mean responses (by calculating the coefficient of variation), to ensure that p-values were not impacted by variance around the mean; there was little to no difference in the variation from the mean for males vs. females in the different groups for each question. Finally, we conducted an analysis of variance (ANOVA) to compare differences in responses between racial/ethnic groups.

For open-ended questions, we used MaxQDA to analyze students' explanations for why or why not they considered themselves "computer science people." This was conducted through two rounds of coding. The first round of coding surfaced specific codes that fell into larger themes. For example, codes such as "likes computer science," "likes programming," and "likes technology" fell under the larger theme of "likes CS/technology." This first round of coding helped identify potential "outliers" among students' responses that did not fall under clear categories. In the second round of coding, we looked more closely within categories to identify shared meaning across answers, as well as which responses carried nuance that required further investigation. In particular, close attention was paid to responses in which students used words such as "but" or "however" that signified ways youth wanted to express their engagement with CS despite not identifying as CS people.

III. Findings

A. *Engagement with Computing – Overall Positive Ratings*

By the end of the 2019-20 school year, **students from all racial/ethnic and gender groups had positive views of CS** according to mean likert scores across statements such as "I like computer science" or "I think computer science is interesting." ANOVA analyses of responses related to engagement/interest with computing showed **no statistically significant differences**

based on race/ethnicity. However, there were statistically significant differences between females/males within racial/ethnic groups regarding degree of engagement.

For example, while all student groups agreed with the statement "I like computer science," Asian males agreed most (8.16 out of 10), with a statistically significant difference from Asian females (6.97; p-value = 0.001). Latino males also rated this statistically significantly higher than Latina females (7.82 vs. 6.36, p-value < 0.001). There was no statistically significant difference in rating between males and females in other racial/ethnic groups (Blacks: 7.14 vs. 7.38; Whites: 7.69 vs. 6.79, males vs. females respectively). It is important to understand that while there were differences along gender lines, average ratings were "agree" to "strongly agree" for all groups to the statement "I like computer science." See Table I below.

TABLE I. STUDENTS AGREE THAT THEY LIKE COMPUTER SCIENCE

Race / Ethnicity	**"I like computer science."**		
	Gender Identity	***Mean Likert Score***	***P-Value***
Latinx	Male (n = 199) Female (n = 176)	7.82 6.64	< 0.001
Asian	Male (n = 63) Female (n = 39)	8.16 6.97	0.001
White	Male (n = 71) Female (n = 34)	7.69 6.79	0.066
Black	Male (n = 28) Female (n = 21)	7.14 7.38	0.719

For the statement, "I think computer science is interesting," again, all students, on average, agreed. However, Asian males rated this statistically significantly higher than Asian females (8.43 vs. 7.15, p-value = 0.001), Latino males rated this statistically significantly higher than Latina females (8.15 vs. 6.14, p-value < 0.000), and White males rated this statistically significantly higher than White females (8.11 vs 6.15, p-value = 0.007). Latino and White males rated this question similarly to one another, challenging the notion that Latinx students are not as interested in CS as White students. There was no statistically significant difference between Black male and female students (males: 7.18 vs. females: 8.05), although Black females agreed more to this statement than Black males. See Table II below.

TABLE II. STUDENTS FIND COMPUTER SCIENCE INTERESTING

Race / Ethnicity	**"I think computer science is interesting."**		
	Gender Identity	***Mean Likert Score***	***P-Value***
Latinx	Male (n = 199) Female (n = 175)	8.15 6.86	< 0.001
Asian	Male (n = 63) Female (n = 39)	8.43 7.15	0.001
White	Male (n = 71) Female (n = 34)	8.11 6.85	0.007
Black	Male (n = 28) Female (n = 21)	7.18 8.05	0.220

For another engagement statement, "I am interested in learning more computer science either on my own or in school," similar trends persisted: Asian, Latino, and White males all rated this statistically significantly higher than their female counterparts (males vs. females respectively: Asian: 7.70 vs 6.10, p-value = 0.001; Latinx: 7.16 vs 5.22; p-value < 0.000; White: 6.68 vs. 5.29, p-value = 0.030). Importantly, Latina and White females rated this more neutral than agree. Latino males agreed more with this statement than White males, although there was no statistical significance in difference. There was no statistical significance in difference between Black male and female responses (5.79 vs. 6.48), but females did rate this higher than males. See Table III below.

TABLE III. STUDENT DESIRE TO LEARN MORE COMPUTER SCIENCE

Race / Ethnicity	**"I am interested in learning more computer science either on my own or in school."**		
	Gender Identity	***Mean Likert Score***	***P-Value***
Latinx	Male (n = 199) Female (n = 174)	7.16 5.22	< 0.001
Asian	Male (n = 63) Female (n = 39)	7.75 6.10	0.001
White	Male (n = 71) Female (n = 34)	6.54 5.62	0.123
Black	Male (n = 28) Female (n = 21)	6.37 6.76	0.650

B. Belonging in the Field of CS –Males vs. Females

Students also rated agreement/disagreement to a series of statements related to sense of belonging in the field. Students were asked to consider whether they felt that people with their same racial/ethnic background or gender did CS, whether they felt they could become computer scientists, and whether they thought they would be accepted in the field if they chose to pursue it. There were statistically significant differences in opinion between males and females across all racial/ethnic groups, but ANOVA analyses revealed statistically significant differences for only one statement (between Latinx and Whites).

All student groups agreed that people of their race/ethnicity did CS. However, Asian females rated this statistically significantly lower than Asian males (females 6.76 vs. males 7.70, p-value = 0.045). This statement resulted in the only statistically significant difference between racial/ethnic groups using ANOVA analyses, with Latinx students agreeing with this statement slightly less than White students (p-value = 0.006). See Table IV below.

TABLE IV. PERCEPTIONS OF RACE/ETHNICITY IN COMPUTER SCIENCE

Race / Ethnicity	**People with my same racial/ethnic background do computer science.**		
	Gender Identity	***Mean Likert Score***	***P-Value***
Latinx	Male (n = 190) Female (n = 166)	6.52 6.24	0.383
Asian	Male (n = 61) Female (n = 37)	7.70 6.76	0.045
White	Male (n = 71) Female (n = 32)	7.66 7.16	0.398
Black	Male (n = 26) Female (n = 20)	6.31 6.50	0.834

Answers were more varied to the statement that people of one's own gender do CS (Table V below). Both male and female Latinx students agreed with this statement, and had no statistically significant difference in response (males 7.16 vs. females 6.67). However, for White, Black, and Asian students, male vs. female agreement varied significantly. White males agreed that men do CS (8.15) whereas White females rated near neutral (5.94, p-value < 0.001). Similarly, Black males agreed that men do CS (8.46), but Black females agreed much less that women do CS (6.90, p-value = 0.033). Asian males agreed that men do CS (8.29), but Asian females barely agreed that women do CS (5.84, p-value < 0.001).

TABLE V. PERCEPTIONS OF GENDER IN COMPUTER SCIENCE

Race / Ethnicity	People with my same sex or gender do computer science.		
	Gender Identity	*Mean Likert Score*	*P-Value*
Latinx	Male (n = 190) Female (n = 164)	7.16 6.67	0.117
Asian	Male (n = 62) Female (n = 37)	8.29 5.84	< 0.001
White	Male (n = 72) Female (n = 32)	8.15 5.94	< 0.001
Black	Male (n = 26) Female (n = 20)	8.46 6.90	0.033

Interestingly, all students believed they could pursue CS if they wanted to, reflecting a sense of confidence in ability with CS (Table VI below). However, there were statistically significant differences between male vs. female agreement (with males agreeing more) among Latinx, White, and Asian students. Black males agreed almost the same amount as Black females.

TABLE VI. CONFIDENCE WITH COMPUTER SCIENCE

Race / Ethnicity	I have what it takes to become a computer scientist one day if I want to		
	Gender Identity	*Mean Likert Score*	*P-Value*
Latinx	Male (n = 191) Female (n = 163)	7.39 6.58	0.004
Asian	Male (n = 63) Female (n = 37)	8.37 6.30	0.001
White	Male (n = 72) Female (n = 32)	8.22 6.38	0.943
Black	Male (n = 26) Female (n = 20)	7.46 7.40	< 0.001

Regarding sense of belonging in the field of CS if one were to pursue it, Asian and White females felt neutral to this statement (5.00 and 5.19 respectively). Latina females and Black males barely agreed with the statement (5.93 and 5.92 respectively). Asian, White, and Latino males agreed with this statement with statistically significant differences within racial/ethnic groups between genders: Asian males (7.36, p-value < 0.001); White males (7.92; p-value < 0.001); and Latino males (7.03; p-value < 0.001). Interestingly, Black females believed they would be accepted more readily in the field of CS if they pursue it when compared to Black males (7.26 vs. 6.92), but with no statistical significance (See Table VII below). After comparing all questions with one another, this question had the most positive correlation with students' responses to 1) students' beliefs that they could be a computer scientist if they want to, 2) commitment to working through challenging problems even without teacher/peer support, and 3) belief that anyone is capable of improving one's CS abilities. This emphasizes how identity in CS may be correlated with students' commitment to persisting with CS and beliefs that all people are capable of excelling in CS, regardless of external pressures or stereotypes.

TABLE VII. SENSE OF BELONGING IN THE FIELD

Race / Ethnicity	If I wanted to pursue a career in computer science, I would be readily accepted by people in the field.		
	Gender Identity	*Mean Likert Score*	*P-Value*
Latinx	Male (n = 190) Female (n = 163)	7.03 5.93	< 0.001
Asian	Male (n = 63) Female (n = 36)	7.35 5.00	< 0.001
White	Male (n = 72) Female (n = 31)	7.92 5.19	< 0.001
Black	Male (n = 26) Female (n = 19)	5.92 7.26	0.676

C. *Identifying or Not Identifying as a "CS Person"*

In addition to the above likert-scale questions, students were asked open-ended questions seeking to surface their views on identity and CS. More specifically, one question asked if students identified as "a computer science person" and to explain why or why not. "Computer science person" was left undefined so that youth had the space to express the characteristics/features that made up CS people, and how they aligned or did not align with such characteristics/features.

Initial analyses of whether or not students did or did not identify as CS people reveal that a little more than half (n = 439) identified as "CS people," whereas a little less than half (n = 422) did not. A table showing the breakdown of students who said yes or no by race/ethnicity and gender is shown below.

TABLE VIII. STUDENT IDENTIFICATION AS "CS PEOPLE"

Race / Ethnicity	Do you consider yourself a computer science person?		
	Gender Identity	*Yes (%)*	*No (%)*
Latinx	Male (n = 199) Female (n = 176)	132 (66%) 63 (36%)	67 (34%) 113 (79%)
Asian	Male (n = 142) Female (n = 70)	86 (61%) 29 (41%)	56 (39%) 41 (59%)
White	Male (n = 72) Female (n = 34)	41 (57%) 12 (35%)	31 (43%) 22 (65%)
Black	Male (n = 28) Female (n = 21)	10 (36%) 11 (52%)	18 (64%) 10 (48%)

Over half of all Latino, Asian, and White males considered themselves CS people, but less than half of Black males identified as such. The majority of Latina, Asian, and White females did *not* identify as CS people, whereas nearly half of the Black females *did* (52%).

But why did students identify as CS people? As one might expect, the majority (305 of 439 students; 70%) explained that they **loved the subject, enjoyed programming, found CS to be fun, and/or really liked technology and computers**. They stated things such as, "I consider myself a 'computer science' person because I like working with computers and would love to learn more about how they work" and "I have a passion for coding" and "Because I like Comp Sci and I also really like to code, I also really love critical thinking."

Additionally, 70 students described that they felt they were CS people because they had the **knowledge and experience** backing this identity. For some students, this involved having the ability to not only code, but also teach others to program: "I consider myself a computer science person because I can code and I know how to use a computer and I can teach others on how to use one or code." Others wrote how they were able to learn and this made them CS people: "I consider myself a computer science person because I can do things now that I couldn't do before." Or yet others described how the knowledge they had was beyond what most people understood: "I know more about computer science than the average person." Interestingly, when breaking down this group by race/ethnicity and gender, there were almost equal numbers of Latino males and Latina females citing knowledge/experience as the reason why they identified as CS people (23 males; 20 females). Among Asians, 7 males described having knowledge/experience, but no Asian females cited this as a reason. Only 1 White male and 2 White females fell into this category. No Black males or females cited their knowledge/experience as reasons for identifying as CS people. [Note: While these numbers are small, we believe it important for these students' voices to be heard].

However, 5 Black students (4 male, 1 female) did cite that their **skills and abilities** with computing were reasons why they identified as CS people. 8 Asian males and 3 Asian females also cited their skills/ability as reasons for identifying as CS people. Among Latinx students, 20 Latino males cited skills/ability, but only about half that number (9 Latina females) identified as CS people because of their skills/ability. 5 White males and 3 White females described their skills/abilities. Overall, 67 students described their skills and ability with computing as reasons to be considered CS people, stating things such as: "I consider myself a computer science person because I can find solutions to problems and I can create algorithms for a program" or "[I] can understand new commands fairly quick" or "I have the strategic skills in which to be able to figure out hard and unique codes."

Twenty-seven students who identified as CS people explained that they had **plans to pursue computing in either college or their future careers**. Of those students, 10 were Latino males, 5 Latina females, 5 Asian males, 2 Asian females, 1 Black male, 1 Black female, 2 White males, 2 White females.

Interestingly, another category that emerged for why students identified as CS people was because they felt that they **could help others with computing or contribute to the larger world with their skills**. While only 12 students fell under this category, their statements around this idea were notable, including: "I actually get to contribute to the digital world by providing programs of my own" or "my classmates were asking me for help and most of the time I was able to help them" or "in my household, I am usually the one everyone goes to when they are seeking help with a program."

D. Reasons for Not Identifying as "CS people"

Interestingly, reasons why students did not identify as "CS people" despite enrolling in an AP CS course were not as simple as merely disliking the subject. Almost a third **(124 of the 422) of "non-CS people" cited a dislike of CS or technology** (this included 16 Black, 14 Asian, 72 Latinx, and 13 White students), writing things such as: "Throughout the whole year, computer science did not excite me very much and my passion for it never grew" or "I understand everything because it is simple but I do not like doing computer science." Additionally, **21% (n = 90) explicitly described feeling more excited about different subject areas** (without necessarily saying they disliked CS), and **almost 10% (n = 35) of non-CS people actually noted that they really enjoyed or are interested in CS.**

Beyond these categories, 63 students (15%) cited that they found **CS too stressful or frustrating and struggled** too much to be considered CS people. Students wrote things such as, "It is something that I struggle with and have a difficult time learning and understanding," or "I feel like I would get frustrated easily when a program doesn't work," or "I feel like I would stress too much when I don't get the right code." More females than males cited this as a reason why they didn't identify as CS people (37 females vs. 21 males). Latina females (n = 27) described frustration/difficulty with CS more than Latino males (n = 13). No White, Black, or Asian males cited this as a reason for not identifying as CS people, but 2 White females, 2 Black females, and 4 Asian females did.

The next largest category of non-CS people were students who felt they **still had more to learn** before calling themselves CS people (n = 54). This category of responses suggested that there was a possibility of becoming a CS person in the future, and that identity was not set in stone. A typical response in this category included: "I don't fully consider myself a 'computer science' person because I have a lot more to learn about computer science. I may have learned about the basics, but I feel that I would have to study more about computer science and understand the deeper meaning it has on society as a whole, in order to consider myself a 'computer science' person." Interestingly, males outnumbered females in this category (33 males vs. 21 females), with Latino males (n = 21) being nearly twice in number compared to Latina females (n = 12). Among other racial/ethnic categories: 1 White male, 4 Asian males, 2 Black males, 1 White female, 3 Asian females, and 0 Black females cited this reason for not identifying as CS people. The difference between males and females, and Latino males vs. Latina females, suggests that males felt more confidence and room for growth to eventually become CS people with increased experience, knowledge, or skills.

The next largest category included students who were not CS people because they **did not plan on pursuing careers or studies in computing** (n = 37). Of these students, females outnumbered the males (28 females described pursuing non-CS futures, compared to only 9 males). No Asian males shared this as a reason for not being CS people, but 5 Asian females described wanting to pursue non-computing fields/majors. Similarly, Latina females (n = 19) stated this as a reason for not being CS people more than Latino males (n = 7). 1 White male and 1 White female, as well as 1 Black male and 2 Black females cited this as reasons for not being CS people.

Of course, some students also believed that they couldn't be CS people because **they didn't think they were "good at" computer science** (n = 28). These students wrote things such as "cause I can't code" or "I am not skilled in that particular subject." Interestingly, no Black students chose this as a reason for not being CS people, and nearly equal numbers of Latinx males and females chose this as a reason for not being CS people (7 females vs. 5 males). Again, while only 6 Asians fell into this category, it is notable that 5 Asian females believed they were not good enough at CS, compared to only 1 Asian male. No White males cited lack of ability, but 2 White females did.

Relatedly, 9 people described that since **they weren't "the best" at CS**, they couldn't consider themselves CS people. For this small group of students, there was a sense of comparing oneself to others, where one had to be at the top of the class to be considered a CS person. Respondents in this group included 2 Asian females, 2 Latina females, 1 Black female, 1 White female, 1 Asian male, and 1 Latino male.

While stereotypes may have informed the ways that youth identified themselves as being or not being CS people, **only 4 students explicitly referenced stereotypes about what CS people are.** More specifically these students wrote that they are not "the type of person to do this," "don't fit the stereotype of one. I'm a girl in a mostly male class and I feel very out of place here," "Not really a tech guy," and "not much of a computer science guy." Almost no students explicitly referenced the stereotype of CS identity requiring one to be "smart" or "nerdy."

E. *"I'm not a CS person **but**..." – CS Identity as Possibility*

While the above themes offer a window into students' beliefs about what characteristics, skills, and features make up CS people, another trend appeared among students' explanations for why they were not CS people that is also illuminating. Ninety-one students (22%) used words such as "but," "however," or "although" in ways that **suggested there was either room for growth to become CS people**, or that denying such an identity did not necessarily mean they disliked CS. These "but statements" were written in conjunction with many of the categories described above, including: liking CS but wanting to pursue other interests, liking CS but feeling like they had more to learn, and recognizing that CS was relevant to their future and the world. "But statement" examples reflect how teenagers saw possibilities for CS identification: "I don't consider myself a computer science person YET…there are several things I have to and want to learn before I can consider myself an exemplary computer science person," and "Although computer science is an interesting topic for me, I find myself lacking in this field…If I continue to study and engage in this field, I will definitely learn a lot more and someday consider myself a computer science person." Interestingly, more females than males fell into the "but statement" category (54 females vs. 35 males). Asian females used "but statements" twice as much as Asian males (14 vs. 7), and Black females outnumbered Black males (6 vs. 2). Latinx females and males were close to equal (24 vs. 19) as were White males and females (5 vs. 4).

IV. Discussion

A. *Complexifying Perceptions About CS Engagement for Students of Color and Females*

The findings in this paper help complexify stereotypical beliefs that students of color and young women are disinterested in CS. Of course, the overall positive engagement with CS across all student groups in this study might be expected because students presumably chose to enroll in AP CSP, which is not required for graduation. However, it is compelling to see that **there were no statistically significant differences in engagement between racial/ethnic groups**, with general agreement across all students to statements such as "I like computer science" and "I think computer science is interesting." The fact that all racial/ethnic groups enjoy CS, yet are not equally represented in the field of CS, both challenge racist beliefs about who wants to engage with CS, while highlighting the fact that something is happening to motivated CS students after high school, resulting in differential representation in CS.

Still, while Latina, Asian, and White females all stated that they like CS and find it interesting, they did not do so to the same degree as their male peers. Furthermore, Latina and White females felt closer to neutral about whether or not they would pursue further CS coursework, despite their interest and engagement with the subject. Importantly, these differences did not exist between Black male and female students whose agreement with statements about engagement and future CS learning were nearly equal to one another and yielded no statistically significant differences in responses.

This raises new questions: Why would students who enjoy a subject feel unsure about taking more courses in that subject? Why are young Latina, Asian, and White women (with Asian and White females more highly represented in CS careers than Black females) rating lower engagement than their male peers, yet Black males and females are rating engagement so similarly?

We believe that the similarities in answers between Black males and females, that were all quite positive about CS engagement in general, is something worth recognizing as a potential counterpoint to the belief that young women like CS less than young men. Regarding differences between genders in the other racial/ethnic groups, we believe that these findings are not simply reinforcing stereotypical notions that young women are disinterested in CS. On the contrary, female responses to questions about belonging help reveal that there is something else influencing how they rate their sense of interest and future engagement with computing. This is explored further below.

B. *Relationship between CS Engagement and Belonging*

When examining engagement scores in relation to students' sense of confidence in being able to excel in CS or feel welcome in the field, correlation values reveal that **lower engagement with CS for Latina, Asian, and White females is related to the fact that these same groups of young women did not feel as strongly that their race/ethnicity + gender do CS, or that they would be accepted in the field if they chose to pursue CS** (rating near neutral among all groups). Latina, Asian, and White females were also less likely to consider themselves CS people than their male peers. Meanwhile, their male peers who rated a higher agreement to feeling like their race/ethnicity + gender do CS and that they would be welcomed into the field if they pursued it, had higher levels of engagement with CS.

It seems to make sense that students, who feel they are unwelcome in a field, would report lower engagement with that field, simply because there must be recognition of the hurdles one must overcome in order to pursue and be accepted by that specific field. And with this same logic, if one does not anticipate rejection by a field of study, then one might feel greater desire to engage with that field. Of course, additional research is needed to address assumptions about causality: it is unclear whether or not lower engagement is what made these groups feel less welcome in the field of CS, or if feeling like one couldn't fully belong resulted in lower engagement with CS.

However, looking at differences between Black male and female experiences may offer a window into this very issue. While there was no statistically significant difference between Black male and female responses to statements about CS belonging, we wonder why Black males, on average, agreed less than Black females about being welcomed in the field of CS (rating the statement just above neutral, similar to Latina, Asian, and White females). Also, why were Black males less likely to consider themselves CS people than Black females?

For this, we believe it is important to explore research literature regarding the experiences of Black males in school. More specifically, Black males face institutional racism that disproportionately impacts their educational, psychological, and emotional well-being compared to other racial/ethnic + gender groups [15, 16]. Black males are disciplined more in school than all other groups [17] and face more negative teacher attitudes, expectations, and behavior [18, 19] despite valuing academic success and school [20]. And while all students generally begin their school experiences identifying with academics, Black males' academic identification drops significantly lower than other racial/ethnic + gender groups from 8th to 12th grade [21], and lower than Black females or White males/females in college [22]. This research suggests that Black females may have a more positive academic identity by high school compared to their male peers, as Black males experience higher rates of school dropout [23] while also being tracked into a school-to-prison pipeline at higher rates [for example, 24, 25]. Thus, while we may want to celebrate that both Black females and males show engagement with computing at similar rates (in contrast to the gender-based differences in other racial/ethnic groups), there is a complexity here regarding engagement in relation to feelings of belonging in CS that must be explored. Further research is needed regarding the racism that Black males experience at the intersection of race/ethnicity and gender in CS and school.

C. Emphasizing the Potential for Change and Growth

While not all students considered themselves CS people, the category of students who saw potential to be CS people one day was a particularly important group to explore more closely (22% of non-CS people). More females than males were represented in this category. These students did not actually dislike CS, but saw their identity as either reflecting more than their appreciation of CS, or they saw a positive potential to become computer science people in the future. These students' perspectives offer an important reminder about how identity is not a fixed feature, and how teenagers, in particular, see the potential in themselves to change and grow with experience and time. But how can curricula and instruction provide the positive supports necessary for youth to feel like they can be CS people when they are on the verge of becoming one? A closer look at students' perspectives regarding qualities that make a CS person can inform our answers to this question.

D. Qualities of Computer Science People

Of course, it is not surprising that students who considered themselves computer science people cited their love of computing and technology. However, it is notable that only 29% of students who did not identify as CS people described disliking the topic or technology, and that 10% of non-CS people actually described liking CS. Also, it is important to recognize that many of the non-CS people described liking another subject more, *not disliking* CS. This suggests that, again, there is room for growth or change in perception of CS as students continue to learn and experience the world around them. The students who had other interests or actually like CS may have wiggle room to change their minds about computing and or find themselves identifying as CS people one day, with appropriate supports to feel that they have the ability and the right to excel with the subject.

But even more importantly, we should take into consideration those students who explained that they did not identify as CS people because the subject was too stressful, challenging, or frustrating. These students—that included mostly females—most likely experienced struggles that felt insurmountable. These students may also have felt pressure to get good grades in either the course or on their AP exams, and that added stress may have colored their feelings about computing at a particularly influential time when they are first exploring CS in high school.

Another fairly large group of students emphasized that they could not be CS people because they had more to learn. These students sit in interesting contrast to the students who identified as CS people because of their skills/abilities (e.g., ability to code) because many of these non-CS students who said they had more to learn may have known as much about CS as their peers who considered themselves CS people. While there are always varying abilities in every course, the perspective of having more to learn as a barrier to being a CS person vs. not seeing that as a barrier is interesting to take into consideration for the ways that we encourage youth in subjects that are new to them, like CS.

Finally, for students who said that they are not CS people because they are not pursuing careers in CS, we must question why they do not see how their future careers are impacted by and relate to computing. All fields are impacted by CS—from the arts to agriculture to medicine to sports—and for youth to feel that their career trajectories do not relate to CS suggests that we still have a ways to go in showing youth why computing is relevant to their lives, no matter their career pathways.

V. CONCLUSION

This paper emphasizes the importance of learning directly from youth—and especially minoritized youth coming from communities historically underrepresented in computing—about their sense of engagement, feelings of belonging, and identification with CS. Their ideas about what makes up a CS person can powerfully inform what the CS for All movement needs to focus on to better support all youth in feeling like they can pursue CS if they want to, or that they can engage CS in whatever career pathways they follow. More specifically, we believe that curriculum developers and professional development providers must consider the following to ensure that minoritized youth feel they can have a rightful presence and meaningful learning experience in computing:

1) CS classrooms should openly discuss issues of discrimination in the field of computing, and ways that youth can disrupt learning and career contexts that do not welcome their intersecting identities of race/ethnicity, gender, etc. We must ensure that youth, who do not feel like they would be welcomed into CS fields, find ways to counter discrimination *and build new communities. We must find ways to discuss difficult issues without discouraging students, while providing supports/resources/encouragement for youth who like CS but don't feel they are welcome in the field.*

2) CS classrooms should openly address the feeling of stress and frustration that youth face when solving challenging computing problems. We must encourage youth to persist and accept that they don't have to know the answers immediately all of the time. How can computer science be demystified so that youth can see that even expert computer scientists struggle too?

3) We must encourage youth to see connections between CS learning and their personal passions and visions for the future. For youth who do not feel like there are connections between what they learn in AP CSP and their academic or career pathways, we must make learning more relevant so they can feel empowered to be computer science people.

4) We must build better supports for youth who are on the boundaries of computing—students who enjoy CS but do not think they can yet be considered CS people.

Building on these ideas, we believe that curricular and pedagogical shifts can be made to ensure that youth feel they have a rightful presence in CS classrooms and fields, and that their contributions can help shape a better future for all. And while this study has limitations—more specifically, we cannot draw definitive claims about Black students' experiences because the total number of Black survey-takers was small, and came from a select number of segregated schools in the district—we believe important insight can still be learned from all the youth perspectives shared in the survey responses. Yet further research is needed to dig deeper into the nuances of CS identity and engagement. We believe qualitative data sources from interviews with students can help fill the gaps in our knowledge about what students want and need in order to feel they have the right to pursue CS and belong in the field. We are pursuing such ethnographic efforts today, but invite others to join us in this exploration. We need to hear more from students' voices directly about what could have the greatest positive impact on their CS learning experiences to ensure that all youth have access to rigorous and meaningful CS education.

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