Defining a "Computer Science Person" and the Pedagogical Practices Supporting Positive Identification for Minoritized Youth

Jean J. Ryoo
CS Equity Project, UCLA
Los Angeles, CA, USA
jeanryoo@ucla.edu

Kendrake Tsui
Google
San Jose, CA, USA
tsui.kendrake@gmail.com

ABSTRACT

This paper explores the relationship between high school students' shifting computer science (CS) identity and engagement over the course of one school year in both Advanced Placement Computer Science Principles and Exploring Computer Science classrooms in a large US west coast urban school district. Through an analysis of over 500 pre- and post-surveys administered during the 2018-19 school year—with an intersectional analysis comparing Latina and Latino perspectives in this primarily low-income, Latino/a/x school district—this paper answers the following research questions: (1) Who identifies as "CS people" and what does that mean to them? and (2) Which teaching practices seem to have the greatest relationship with CS identification and engagement?

CCS CONCEPTS

• Social and professional topics • Professional topics • Computing education • K-12 education

KEYWORDS

Equity, Student Engagement, Student Identity, Pedagogy

ACM Reference format:

Jean J. Ryoo & Kendrake Tsui. 2023. Defining a "Computer Science Person" and the Pedagogical Practices Supporting Positive Identification for Minoritized Youth. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE 2023), March 15-18, 2023, Toronto, ON, Canada.* ACM, New York, NY, USA, 7 pages. https://doi.org/10.1145/3545945.3569794

1 INTRODUCTION

The Computer Science for All movement (originally supported by President Obama in 2016) was created to increase diversity in the field of computing with the recognition that, despite technology's importance in our everyday lives and all career pathways, Students of Color, women, and low-income youth in the U.S. are tracked or self-select *out* of computer science (CS) classes based on stereotypes about who excels with technology [16]. Thus, new curricula and pedagogical tools, both in and out of schools, have been created to elevate youth identities and sense of belonging with computing toward encouraging participation and engagement with CS (e.g., Digital Divas, Compugirls, Exploring Computer Science, Girls Who Code, etc.). Yet how do youth see themselves in relation to CS learning, and what supports their sense of identification and belonging with computing? This paper explores the relationship between student identity and CS engagement, specifically in public high school contexts for students historically underrepresented in the field. Through students' perspectives, we describe how youth articulate a sense of connection to CS after taking their first CS classes—more specifically, Exploring Computer Science (ECS) or Advanced Placement Computer Science Principles (APCSP)—and what pedagogical practices most correlate with CS identification.

This work is licensed under a Creative Commons Attribution International 4.0 License.

SIGCSE 2023, March 15–18, 2023, Toronto, ON, Canada.
© 2023 Copyright is held by the owner/author(s).
ACM ISBN 978-1-4503-9431-4/23/03.
https://doi.org/10.1145/3545945.3569794

2 LITERATURE REVIEW

When we think about the subjects or activities we love—what we dedicate many hours to learning or participating in—our reasons for such engagement usually include: "I like it," "I'm good at it," "It's who I am," or "It's where I belong." When we think about what we don't enjoy learning or doing, we often say: "It's just not my thing." Positive engagement with learning often goes hand-in-hand with a positive personal identification with specific topics and skills, just as disengagement is often grounded in disidentification and distance.

Sociocultural theories of learning help to explain this relationship between identity and learning: Since we learn through social interactions with others within specific cultural and historical contexts over time, we internalize and perform behaviors based on those social experiences that impact our day-to-day activities [35]. In this way, learning involves shifts in both thinking and participation in communities of practice that become part of who we are as we understand and embody new cultural activities [14, 23, 24]. As such, identity becomes central to learning engagement, not only in what we choose and try to do, but also in how people with more power or knowledge invite or deny us entry to communities of practice; one's identity with a specific field can either support or constrain access to learning opportunities and success [e.g., 6, 7, 10, 11, 17, etc.].

This relationship between identity and learning is particularly important for efforts seeking to increase diversity in computing segregated by decades of institutionalized racism and sexism influencing who can access the quality CS education experiences that prepare learners for computing interests, hobbies, and careers [16]. While the field was once represented by large numbers of women and Black women, today's computing fields dominated by white and certain Asian cis-men have created spaces that are most often unwelcoming and hostile toward those who do not match their culture, belief systems, and identities [16, 21]. Understandably in this clash of identities and power, few women and People of Color are willing to withstand the discrimination and outsider-status that is often applied to them if they choose to pursue computing.

Efforts that counter this unwelcoming CS culture include liberatory, culturally responsive, and student-empowering CS curricula and pedagogical approaches that elevate students' funds of knowledge [18], center intersectional identities [21], and improve students' understandings of how their place in the world relates to technology's direct impacts on our daily lives [8, 26, 27, 30]. Rather than treat student identity as irrelevant to what it means to learn and create with technology [30], many of these new programs actively consider "who creates, for whom, and to what ends" [30, 34]. In these ways, CS education can become culturally sustaining [19], ensuring that what students learn with computing celebrates students' views of self, interests, concerns/needs, etc. Furthermore, justice-oriented approaches often explore power dynamics and equity in relation to students' identities/experiences and CS content by acknowledging racism in CS, creating inclusive spaces, encouraging sociopolitical critique and student agency, and seeing community cultures as assets to learning while introducing youth to diverse role models [12, 33].

These approaches show promising impacts for minoritized youth. For example, Compugirls found that by supporting young women to explore their identities in relation to computing, youth engage meaningfully with CS to challenge racist/sexist stereotypes and develop projects for social justice [29]. Digital Divas' use of narrative stories connecting to youth STEM interests/identities when creating digital artifacts in both virtual and real-world community contexts led to increased interest and identity in computing and STEM for young women [20]. Indeed, curricula and teaching practices that focus on uplifting youth identity in relation to computing learning can have meaningful impacts on youth views of the field [e.g., 13, 28, 31, etc.].

Yet despite these efforts, women, Students of Color, and other minoritized populations continue to be underrepresented in computing and STEM more broadly. Stromholt and Bell [32] note that this happens when distinctions are made between "right" and "wrong" kinds of "science-linked identity" that suggest such identity can only be achieved through participation in specific practices and experiences defined by Eurocentric history and culture. This "culture of power" [4] that prioritizes dominant Western and colonizing notions of STEM phenomena, while ignoring the achievements and interpretations of the Equatorial South, Africa, Asia, and indigenous people, ultimately discourages participation in STEM [e.g., 1, 2, 5, 9, etc.]. Consider, for example, biology prioritizing Western notions of medicine while denying holistic Eastern medicine approaches.

Additionally, education exists in a context where there is "pressure and expectation to properly create 'scientific people' for the global marketplace" in ways that encourage educators to prioritize Western notions of science, research, "best practices," and competition in the classroom that are central to current academic and career markets dominated by middle/upper-class white men [3]. Efforts to connect to non-white students' sense of identity, self, and agency do not necessarily align with dominant STEM and CS culture centered in universities and corporations.

It is within this complex context—the push and pull between competing purposes for computing education, and challenging relationships between identity and power—that this paper explores what a CS identity means, but specifically from the perspective of those whose voices are often unheard: minoritized CS students. More specifically, our research questions center how youth understand identity and teaching practice as follows: 1) Which students identify as "CS people" and what does that mean to them? 2) Which teaching practices seem to have the greatest relationship with CS identification and engagement?

3 METHODS

3.1 Study Context

This study was conducted in a large, urban, west coast school district that is 73.4% Latino/a/x, 10.5% White, 7.5% Black, 3.9% Asian, 2.0% Filipino, and less than 1% Native American, Hawaiian, Alaskan, or Pacific Islander. The majority of students come from low-income communities with approximately 81% of students receiving free/reduced lunch. Almost 20% are learning English as a second language and with 94 different languages being spoken at home. Students were enrolled in Advanced Placement Computer Science Principles (APCSP) and Exploring Computer Science (ECS) during the 2018-19 school year. This school year was chosen because it reflected an entire year of in-person schooling—uninterrupted by the pandemic—during which higher numbers of youth had the time and capacity to complete surveys.

3.2 Data Sources & Analysis

Data sources included online pre-surveys administered in September 2018 and post-surveys in May 2019 (aligning with the beginning and end of the school year). Over 3000 students responded to the pre-survey and 1980 students responded to the post-survey, but this study focuses on 522 students who were successfully matched pre-to-post with anonymized ID codes, gender identity, race/ethnicity, family members who attended college, and grade level. Of the 522 students included in this study, 289 were APCSP students, 215 ECS students, and 18 enrolled in a non-Advanced Placement CSP course (Table 1 below; all race/ethnicity and gender identity categories were developed with teacher/student input).

The total number of individuals identified by race/ethnicity in the table (n = 532) adds up to more than the total number of students included in this survey analysis (n = 522) because our racial/ethnic categories were all-inclusive: mixed-race students were counted in all groups they identified with. For example, an Asian-Black student's answers counted in both the Asian and Black group analyses. This was important for representing students as they chose to be identified, and not making assumptions about their primary race/ethnicity.

There were no students who identified as Native American or Indigenous, and very few who identified in all other categories besides Latino/a/x. As a result, intersectional analyses comparing different gender group's responses within racial/ethnic categories were limited to Latino/a/x students since other racial/ethnic groups were too small to yield statistically significant comparisons. Furthermore, since few identified as non-binary, intersectional analyses between racial/ethnic and gender groups were limited to young men and women. However, non-intersectional correlational analyses and open-ended responses included all students.

Table 1: Student survey respondent demographics

Race/Ethnicity*		Male	Female	Nonbinary
Latino/a/x	APCSP (n=197)	103	84	10
	ECS (n=202)	90	103	9
White	APCSP (n=41)	26	14	1
	ECS (n=7)	3	3	1
Black/African American	APCSP (n=13)	7	5	1
	ECS (n=5)	4	1	0
Asian/Pacific Islander	APCSP (n=39)	24	14	1
	ECS (n=7)	3	3	1
Indian	APCSP (n=10)	8	2	0
	ECS (n=0)	0	0	0
Middle Eastern	APCSP (n=11)	6	3	2
	ECS (n=0)	0	0	0
Native American	APCSP (n=0)	0	0	0
	ECS (n=0)	0	0	0

Quantitative analyses of the eleven questions below were conducted using chi-squared tests to determine if there were significant differences between how young women vs. men within each racial/ethnic group identified with CS. Paired sample t-tests were used to determine if there were any significant changes in students' self-perceptions from pre- to post-survey. Correlation tests were conducted to see if pedagogical practices were in any way correlated with students' CS identity and engagement. R was used to conduct these analyses, with csv files in Python 3.7.4 created using Jupyter Notebook for ANOVA analyses. The survey questions analyzed included "Do you consider yourself a 'computer science person'? Why or why not?" and all other questions analyzed using quantitative methods were likert-scale questions on an 11-point scale from 0-10, with 0 being "strongly disagree," 5 being "neither agree nor disagree," and 10 being "strongly agree"; some questions were drawn from BRAID CS surveys (https://momentum.gseis.ucla.edu/research/braid/) and Outlier ECS student surveys (https://outlier.uchicago.edu/basics/).

The following questions were analyzed because they relate to students' sense of identity and experiences with classroom teaching practice: (1) I have what it takes to become a computer scientist one day if I want to; (2) If I wanted to pursue a career in computer science, I would be readily accepted by people in the field; (3) I like computer science; (4) Learning computer science will help me achieve my educational and/or career goals; (5) Learning computer science is beneficial to me in my life outside of school; (6) I had opportunities to be creative or express myself; (7) I had opportunities to be a leader; (8) I had opportunities to work on something that I find important or meaningful; (9) I had opportunities to see how lessons were relevant to my own life or the real world; (10) My teacher made learning fun; (11) I had the opportunity to help other students figure things out.

Additional frequency analyses were also conducted in the Latino/a/x group specifically, to see if there were any differences in pedagogical experiences for those who did or did not identify as CS people. First students were separated into two groups, those who identified as CS people and those who did not. Then within each group, students were further separated based on whether or not they experienced pedagogical practices described in statements 6-11 listed above. We then compared the proportion of those who agreed to those who disagreed with experiencing each pedagogical practice along race, gender, and course categories. For example, 86% of Latina young women who identified as CS people in the ECS course experienced pedagogy that supported them to be leaders in the classroom. In comparison, only 39% of Latina young women who did not identify as CS people in the ECS course were encouraged to take on leadership roles. This nearly 50% point difference offers insight into teaching practices that may encourage or discourage identification as CS people.

We also analyzed open-ended responses using MaxQDA analysis software: (1) Why do/don't you consider yourself a "CS" person? (2) Why do/don't you feel that what you learned in this CS class is useful to your educational goals? (3) Why do/don't you feel that what you learned in this CS class is useful for your career goals? (4) How have your thoughts about CS changed, if at all, as a result of this class? [Post survey only].

The authors went through several rounds of coding open-ended responses. In round one, both authors coded the same third of student responses about why they considered themselves "CS people" to develop a coding scheme with shared definitions. In round two, the authors split up the remaining responses and reviewed each other's coding in order to discuss any disagreements in codes or questions that came up. After developing a coding scheme, one author coded all responses to why youth did not identify as CS people and the other coded responses across all open-ended questions to see if there were shifts over time. Authors discussed emerging findings following each round of coding.

4 FINDINGS

The findings below explore: 1) how many students did or did not identify as CS people and why; and 2) correlations between pedagogical practices and student CS identification and engagement. Following an overview of key findings in the sections below, we explore the complexities of what this means for students' CS identity in high school, as well as potential implications of this work for teacher practice to better support and sustain minoritized students' engagement with computing.

4.1 Identifying as a "computer science person"

Students were asked to answer "yes" or "no" to the question "Do you consider yourself a 'computer science person'?" then explain "Why or why not?" Among APCSP students, the largest number (108 total; 37.37%) both began and ended the school year considering themselves computer science people (CS people). A little fewer than this (101 students; 34.94% of survey responses analyzed) began and ended the year *not* identifying as CS people. The next largest group (45 total; over 15%) shifted from "no" to "yes" by the end of the school year, with the smallest number shifting from "yes" to "no" on this question (35 total; 12.11%; Table 2 below).

Table 2: Responses from beginning to end of the school year: "Do you consider yourself a 'computer science person'?"

	APCSP Students (n=289)	ECS Students (n=213)
Yes-yes	108 (37.37%)	42 (19.72%)
Yes-no	35 (12.11%)	19 (8.92%)
No-no	101 (34.94%)	107 (50.23%)
No-yes	45 (15.57%)	45 (21.13%)

Among ECS students—who were mostly younger with less prior CS experience (68% of ECS students had no prior CS compared to 59% of APCSP students)—a smaller number (42; almost 20%) began and ended the school year considering themselves CS people. Over half the ECS students' (107 total) began and ended the year *not* identifying as CS people. However, over twice as many students (42 total; nearly 20%) shifted from "no" to "yes" CS identification by the end of the year compared to "yes" to "no" (19 total; 9%).

The fact that APCSP students were older and had more prior CS experiences may explain why a larger percentage of them identified as CS people than ECS students. Furthermore, ECS can be a graduation requirement whereas APCSP students usually self-select into the course.

4.1.1 Intersectional analysis of Latino/a/x students. While most groups were too small to draw statistically significant intersectional conclusions from, we were able to compare Latino vs. Latina responses and found that for APCSP students, Latinos identified as CS people more than Latinas, with a statistically significant difference of 3% at the beginning of the year and 9% by the end of the year (Figure 1 below).

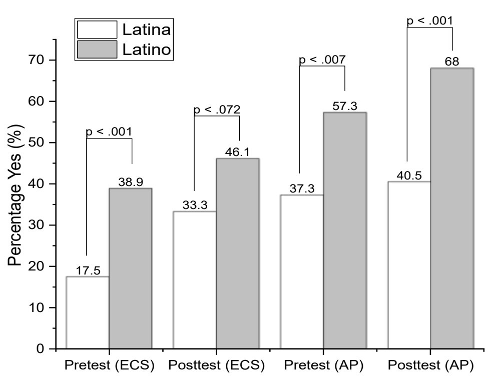

Figure 1: Intersectional Analysis - "CS Person" Identification

For ECS, a statistically significant difference between how Latinos and Latinas identified with CS was seen during the pre-survey, but *not* in post-survey responses (Figure 1). Latina students identifying as CS people increased by roughly 16%, closing the gender difference seen in the pre-survey responses. While the difference still existed by the post-survey, it was no longer statistically significant.

These findings show that the number of CS-identifying Latinos and Latinas both increased, yet the difference in CS identification between young men and women persisted. Still, ECS was beginning to close this gap. Yet why did youth identify or not as CS people? This is further explored below.

4.2 Reasons for/against CS identification

The following analyses include all students—not separated by race/ethnicity, gender, or course—because there were no significant differences in response to the open-ended questions about CS identification based on these categories. The reasons why youth identified as CS people were mostly related to their interest in STEM and programming, as well as belief that they excelled in these fields (see Table 3 below). The largest number of students 53.47% of the 245 total CS identifying students (n=133; 96=APCSP students; 35=ECS students) described some connection to ability or interest in math, science, and/or programming. Most students in this category (n=56) noted that they found coding or programming was enjoyable or fun and that this meant they were CS people. A little over a quarter of CS-identifying students (25.71%) cited also enjoying spending time with actual technology and computer hardware, while just under a quarter (22.04%) described that they enjoyed learning CS. For example, students wrote: "I enjoyed working on the code," and "I consider myself a 'computer science' person because I love working with different codes and whenever an issue is presented, I love the challenge of solving problems," and "because i like working with technology and learning more about coding and designing websites and apps," and "I consider myself a 'computer science' person since I like coding and robotics." Students also described that they were CS people because they saw a use for CS in their futures (12.65%) or they enjoy creating CS projects (10.20%).

Students who did not identify as CS people in both courses described the other side of the same proverbial coin (Table 4 below). The largest group, 53.45% of the 275 non-identifying students, cited that math, science, and programming/coding were *not* something they enjoyed or found easy to do (n=147 (73=APCSP; 67=ECS). Twenty percent noted that they simply do not have an interest, some did not enjoy physically engaging with tech and computers (10.91%), and 10.18% did not see how CS related to their future career/college pathways. For example, students wrote, "i had a hard time understanding the code lingo," and "Because I don't understand it a lot of the time," and "It was hard picking up on things and I was very slow when it came to learning new things," and "I do not really understand the subject."

Still, almost half of this same group of students who did not identify as CS people actually described enjoying CS, wanting to learn more, or feeling greater confidence with computing (45.82%). For example, students wrote:

- "[I] can't wait to learn more about [CS] during college";
- "In the beginning I had no idea how to code…I thought it would be very difficult, but now I can do things on my own";
- "When I began this class I didn't want to be a part of it, mostly because I thought I needed prior knowledge of computers to be able to understand it, but the concepts were relatively easy to grasp and I actually enjoyed learning how to code. I would say I enjoyed computer science much more than I assumed I would and I have more respect for it now";
- "my thoughts on computer science have changed extensively. at first i was scared to embark on learning this subject. i no longer fear what i do not know."

This means that *almost half* of the students who did *not* identify as computer science people actually really enjoyed computing and/or were engaged with their computer science classes.

Finally, jobs/career interests were also tied to identification for both CS-identifying and non-identifying students.

Table 3: Frequency of themes among CS identifying students

Theme	Frequency (%) (n=245)
Connection to ability or interest in math, science, and/or programming	53.47
Programming was enjoyable / fun	42.11
Enjoyed spending time with actual technology and computer hardware	25.71
Enjoyed learning CS	22.04
Saw a use for CS in their futures	12.65
Enjoyed creating CS projects	10.20

Table 4: Frequency of themes among non-CS identifying students

Theme	Frequency (%) (n=147)
Math, science, and programming/coding was not enjoyable or easy	53.45
Not interested in CS	20.00
Did not enjoy engaging with technology and computer hardware	10.91
Did not see how CS related to their future career / college pathway	10.18

4.3 Pedagogical relationships to CS identification

Did CS-identifying students experience different pedagogical practices than non-identifying students? Returning to Latino/a/x intersectional responses specifically (since other groups were too small for such analyses), clear trends exist regarding the teaching practices experienced by CS-identifying students.

While APCSP Latino and Latina students who did or did not identify as CS people felt they had equal opportunities to be creative, ECS students had an over 20% point difference between Latinos identifying as CS people who had opportunities to be creative vs Latinos not identifying as CS people, and over 30% point difference between Latinas identifying and not identifying as CS people. In other words, both Latino and Latina ECS students who did not identify as CS people had less opportunities to be creative.

This was also true for opportunities to be leaders across both APCSP and ECS students (see Figure 2 below). There was an over 20% point difference in the ratio of those who agreed vs. disagreed that they had opportunities to be leaders in their CS classrooms for APCSP Latinas, Latinos, and ECS Latinos identifying or not identifying as CS people. There was an over 40% point difference for ECS Latinas: those who identified as CS people felt they had much more opportunity to be leaders than those not identifying. There was an over 20% point difference for APCSP Latinos and Latinas in terms of opportunities to work on CS projects that were meaningful or important to them, with CS non-identifying students citing lower opportunities (Figure 3). This jumped up to an over 40% point difference between CS-identifying and non-identifying student experiences in ECS for both Latinos and Latinas.

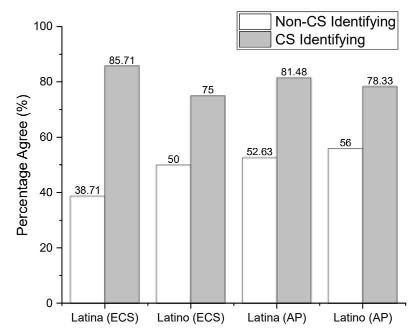

Figure 2: ECS & APCSP Latino/a/x average agreement: "opportunities to be a leader"

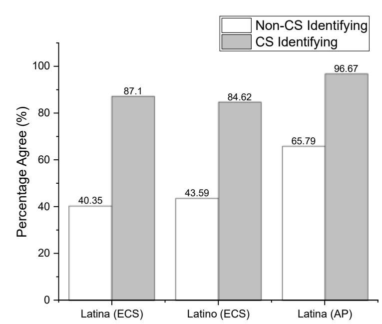

Figure 3: ECS & APCSP Latino/a/x average agreement: "opportunities to work on something meaningful"

Regarding opportunities to see the relevance of CS in their lives, APCSP Latinos had an over 20% point difference between those who did and didn't identify as CS people, with non-identifiers citing less opportunities to see CS's relevance (Figure 4 below). This jumped up to over 40% points of difference for ECS Latinos and Latinas, with non-CS-identifying students citing less opportunities to see the relevance of CS in their everyday lives.

In terms of opportunities to have fun and enjoy learning CS, the percentage point difference between CS-identifying and non-identifying APCSP Latina students was over 20, and this jumped up to over 30 and 40% points for ECS Latino and Latina students respectively. Those who did not identify as CS people were not experiencing many opportunities to see how CS is fun.

And when it came to opportunities to help peers and, therefore, contribute meaningfully to the classroom community as an expert in the space, there was a 20% point difference between CS-identifying and non-identifying APCSP Latina and ECS Latino students. This jumped up to nearly 40% point difference for ECS Latina students.

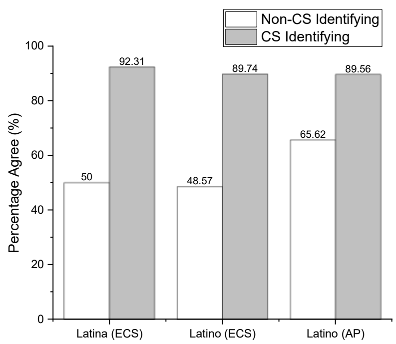

Figure 4: ECS & APCSP Latino/a/x average agreement: "I had opportunities to see how lessons were relevant to my own life or the real world"

4.4 Pedagogy correlation with CS engagement

Pearson correlation matrix analyses were conducted between Latino/a/x students' likert-scale responses to teacher practice and CS engagement statements (e.g., "I like computer science," etc.) in order to understand if there were any trends in specific pedagogical approaches that may impact CS interest. For Latinos in APCSP, liking CS was highly correlated (Pearson correlation > 0.6) with teachers creating opportunities to work on meaningful projects and connect to the real world. ECS Latinos had the same correlations, with an additional correlation between liking CS and helping peers.

In addition to the above correlations, APCSP Latinas also had high correlation between liking CS and pedagogy supporting creativity and having fun (Pearson correlation > 0.6). ECS Latinas also had high correlations between liking CS and teaching practices supporting leadership, with highest correlations between liking CS and creating meaningful projects and teachers making learning fun.

It is notable that liking CS for all groups was highly correlated (Pearson correlation > 0.7) to believing that CS would support achieving educational and/or career goals, as well as seeing how CS could be beneficial for life outside of school. For ECS students, these last two statements were highly correlated with pedagogy supporting work on meaningful projects and showing connections to everyday life. For APCSP students, pedagogy showing how CS was relevant to students' lives or the real world was highly correlated with believing that CS was beneficial to life outside of school. Overall, these correlations show that youth engage with and enjoy CS most when provided experiences that allow them to see how computer science personally affects their lives and worlds.

5 DISCUSSION & CONCLUSION

These findings remind us that identity is flexible and rooted in cultural values [22]. For example, cultural stereotypes of tech "boy geniuses" may explain why male-identifying Latinos could more easily consider themselves CS people over Latinas in both ECS and APCSP [15]. Yet the fact that more students identified with CS by the end of courses like ECS (that centers cultural relevance, inquiry, and equity) or APCSP (that focuses on creativity) is promising, illustrating how identity can shift with positive CS experiences.

Importantly, CS identity is not the only marker of engagement as evidenced by the large number of non-identifying students who described enjoying CS and wanting to learn more. This highlights why we must offer numerous CS opportunities along students' pathways as CS interest may grow even as identification does not.

The specific pedagogical moves encouraging engagement and experienced most by CS identifying students—offering leadership opportunities, showing the relevance of CS, ensuring projects are personally meaningful, allowing youth to support peers, making learning fun—are features of previously documented effective CS teaching practices [e.g., 13, 25, etc.]. But it is notable that youth who do *not* identify as CS people or like CS are *not* experiencing such pedagogy in their classrooms.

Importantly, CS-identifying Latinas had more opportunities to be leaders and help peers. If teaching practices focused more on supporting youth to be agentive leaders in their learning community, would more students say they identify with CS and be able to envision being leaders in computing? If diversity is treated as an asset to computing and valuable for leadership vision, how might diversity at tech design tables shift?

One surprising finding was that non-identifying CS students did not have opportunities to see the relevance of CS to their lives or future careers. How is this possible when *all* fields are touched by technology today? These data why pedagogy must emphasize how CS can be a creative tool for fulfilling visions in all fields, and not just be about programming for programming's sake. CS engagement can increase if youth see why CS is important and how it impacts our social and political worlds.

While the findings shine a light on why youth identify as CS people and which teaching practices support such identification, more studies are needed that elevate youth voices and address how language (verbal and body), teaching practices, and curricula potentially support or challenge stereotypes about who can be good at CS across K-12 into higher education and tech work spaces where prevailing cultures do not currently uplift non-dominant identities.

ACKNOWLEDGMENTS

This work was made possible through collaboration with district leaders, educators, and students through generous funding from the National Science Foundation (#1743336; 2030935), and Bill & Melinda Gates Foundation.

REFERENCES

[1] Lucy Avraamidou. 2020. Science identity as a landscape of becoming: rethinking recognition and emotions through an intersectionality lens. *Cultural Studies of Science Education* 15, 323-345. DOI: https://doi.org/10.1007/s11422-019-09954-7

[2] Megan Bang and Douglas Medin. 2010. Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Learning in Everyday Life*, 94, 6, 1008-1026. DOI: https://doi.org/10.1002/sce.20392

[3] Nancy W. Brickhouse and Jennifer T. Potter. 2001. Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching*, 38, 8, 965-980. DOI: https://doi.org/10.1002/tea.1041

[4] Angela Calabrese Barton and Kimberley Yang. 2000. The culture of power and science education: Learning from Miguel. *Journal of Research in Science Teaching*, 37, 8, 871-889. DOI: 10.1002/1098-2736(200010)37:83.0.CO;2-9

[5] Heidi B. Carlone. 2004. The cultural production of science in reform-based physics: Girls' access, participation, and resistance. *Journal of Research in Science Teaching*, 41, 4, 392-414. DOI: https://doi.org/10.1002/tea.20006

[6] Gilberto Q. Conchas. 2001. Structuring failure and success: Understanding the variability in Latino school engagement. *Harvard Educational Review*, 71, 3, 475-504. DOI: https://doi.org/10.17763/haer.71.3.280w814v1603473k

[7] Anne Locke Davidson. 1996. Making and Molding Identity in Schools: Student Narratives on Race, Gender, and Academic Engagement. State University of New York Press, Albany, NY.

[8] Ron Eglash, Juan E. Gilbert, Valerie Taylor, and Susan R. Geier. 2013. Culturally responsive computing in urban, after-school contexts: Two approaches. *Urban Education*, 48, 5, 629–656.

[9] Margaret A. Eisenhart and Elizabeth Finkel. 1998. *Women's Science: Learning and Succeeding from the Margins.* The University of Chicago Press, Chicago, IL.

[10] Ann A. Ferguson. 2000. *Bad Boys: Public Schools in the Making of Black Masculinity.* University of Michigan Press, Ann Arbor, MI.

[11] Signithia Fordham and John U. Ogbu. 1986. Black students' school success: Coping with the "burden of acting White." *The Urban Review,* 18, 3, 176–206. DOI: https://doi.org/10.1007/BF01112192

[12] The Kapor Center. 2021. *Culturally Responsive-Sustaining CS Education: A Framework.* The Kapor Center, Oakland, CA.

[13] Michael Lachney, Ron Eglash, Audrey Bennett, William Babbitt, Lakisha Foy, Matt Drazin, and Kathryn M. Rich. 2021. pH empowered: Community participation in culturally responsive computing education. *Learning Media & Technology, 46*(3), 333-354. https://doi.org/10.1080/17439884.2021.1891421

[14] Jean Lave and Etienne Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation.* Cambridge University Press: Cambridge, UK.

[15] Jane Margolis and Allan Fisher. 2001. *Unlocking the Clubhouse: Women in Computing.* MIT Press, Cambridge, MA.

[16] Jane Margolis, Rachel Estrella, Joanna Goode, Jennifer Jellison-Holme, and Kimberly Nao. 2008. *Stuck in the Shallow End: Education, Race, and Computing.* MIT Press, Cambridge, MA.

[17] Ray McDermott and Hervé Varenne. 1995. Culture as disability. *Anthropology & Education*, 26, 3, 324-248. DOI: https://doi.org/10.1525/aeq.1995.26.3.05x0936z

[18] Luis C. Moll, Cathy Amanti, Deborah Neff, and Norma Gonzalez. 1992. Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory Into Practice,* 31, 2, 132-141. DOI: https://doi.org/10.1080/00405849209543534

[19] Django Paris and Samy Alim. 2017. Cultural Sustaining Pedagogies: Teaching and Learning for Justice in a Changing World. Teachers College Press, New York, NY.

[20] Nichole Pinkard, Sheena Erete, Caitlin K. Martin, and Maxine McKinney de Royston. 2017. Digital Youth Divas: Exploring narrative-driven curriculum to spark middle school girls' interest in computational activities. *Journal of the Learning Sciences, 26*(3), 477-516. https://doi.org/10.1080/10508406.2017.1307199

[21] Yolanda A. Rankin and Jakita O. Thomas. 2002. The intersectional experiences of Black women in computing. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education.* ACM Press, New York, NY, 199-205. DOI: https://doi.org/10.1145/3328778.3366873

[22] Sarah L. Rodriguez and Kathleen Lehman. 2017. Developing the next generation of diverse computer scientists: the need for enhanced, intersectional computing identity theory. *Computer Science Education, 27*(3-4), 229-247.

[23] Barbara Rogoff. 1993. Children's guided participation and participatory appropriation in sociocultural activity. In R. H. Wozniak & K. W. Fischer (Eds.), *Development in context: Acting and thinking in specific environments.* Lawrence Erlbaum Associates, Inc., Mahwah, NJ, 121–153.

[24] Barbara Rogoff. 2003. *The Cultural Nature of Human Development.* Oxford University Press, Oxford, UK.

[25] Jean J. Ryoo. 2019. Pedagogy that Supports Computer Science for *All. ACM Transactions on Computing Education, 19*(4). DOI: 10.1145/3322210

[26] Jean J. Ryoo, Tiera Tanksley, Cynthia Estrada, and Jane Margolis. 2020. Take space, make space: How students use computer science to disrupt and resist marginalization in schools. *Computer Science Education*, DOI: 10.1080/08993408.2020.1805284.

[27] Jean J. Ryoo, Alicia Morris, and Jane Margolis. 2021. "What happens to the *Raspado* man in a cash-free society?": Teaching and Learning Socially Responsible Computing. *ACM Transactions on Computing Education, 21*(4). Special Issue on Justice-Centered Computing Education, DOI: 10.1145/3453653.

[28] Kristin A. Searle and Yasmin B. Kafai. 2015. Culturally Responsive Making with American Indian Girls: Bridging the Identity Gap in Crafting and Computing with Electronic Textiles. In Proceedings of the Third Conference on GenderIT (GenderIT '15). Association for Computing Machinery, New York, NY, USA, 9–16. https://doi.org/10.1145/2807565.2807707

[29] Kimberly A. Scott and Mary Aleta White. 2013. Compugirls' standpoint: Culturally responsive computing and its effect on girls of color. *Urban Education, 48*(5), 657–681. https://doi.org/10.1177/0042085913491219.

[30] Kimberly A. Scott, Kimberly M. Sheridan, and Kevin Clark. 2014. Culturally responsive computing: A theory revisited. *Learning, Media, and Technology,* DOI: 10.1080/17439884.2014.924966

[31] Mia S. Shaw, Deborah A. Fields, and Yasmin B. Kafai. 2019. Connecting with Computer Science: Electronic Textile Portfolios as Ideational Identity Resources for High School Students. *International Journal of Multicultural Education.* 21, 1 (Mar. 2019), 22–41. DOI:https://doi.org/10.18251/ijme.v21i1.1740.

[32] Shelley Stromholt and Philip Bell. Designing for expansive science learning and identification across settings. *Cultural Studies of Science Education*, 13, 1015-1047. DOI: https://doi.org/10.1007/s11422-017-9813-5

[33] Sepehr Vakil, 2018. Ethics, identity, and political vision: Toward a justice-centered approach to equity in computer science education. *Harvard Educational Review*, *88*(1), 26-52.

[34] Shirin Vossoughi and Sepehr Vakil. 2019. Toward what ends? A critical analysis of militarism, equity, and STEM education. In A. Ali & T.L. Buenavista (Eds.), *Education at war: The fight for students of color in America's public schools.* Fordham University Press, New York, NY, 117-140.

[35] Lev S. Vygotsky. 1978. *Mind in Society: The Development of Higher Mental Processes.* Harvard University Press, Cambridge, MA.