The Role of Student Characterization in Teachers' Approaches to Culturally Responsive Computer Science Instruction

Abstract

Despite growth in computer science (CS) education, females and racially minoritized populations remain underrepresented in the field. Integrating culturally responsive pedagogy (CRP) in CS education is critical to reducing these disparities. In this work, we investigate how teachers employ student characterizations to support their approaches to CS and CRP integration following participation in professional development (PD) designed to support the integration of CS and CRP in content area instruction. Qualitative interview data were collected from 15 elementary teachers who attended the PD. Findings indicate that teachers referenced academic and demographic student characteristics to support their stances toward CS and CRP integration. Implications are drawn regarding the design of PD programs that help elementary teachers consider student identities when designing culturally responsive CS instruction.

Introduction and Purpose

Computer science (CS) skills have become integral to navigating the world around us (Wing, 2006). Despite significant growth in CS education, females and racially minoritized groups continue to have fewer opportunities to engage in computing (Code.org et al., 2023). Providing CS education that is culturally responsive can play a major role in combating underrepresentation by making CS more equitable and inclusive.

While CS courses are increasingly common in secondary schools, CS education is less prevalent in elementary settings (Google & Gallup, 2020). CS education at a young age has been shown to promote positive attitudes towards CS (Ching et al., 2018; Tran, 2019). However, few elementary school teachers have the CS content and pedagogical knowledge or the time to provide CS instruction (Rich et al., 2021). For example, teachers at the elementary level often spend most of their instructional time on literacy and math, where there is stricter accountability (Century et al., 2020).

Research shows that integrating CS into content area instruction is an effective way to bring CS into elementary schools (Waterman et al., 2020). When integrated at the elementary level, CS education is often taught to all students, potentially making CS instruction more equitable (Code.org et al., 2023; Ryoo, 2019). Nonetheless, not all CS instruction is equally effective. For instance, culturally irrelevant CS education plays a major role in the underrepresentation of females and minoritized populations in CS (Scott & White, 2013). In contrast, culturally responsive pedagogy (CRP), which focuses on understanding students' unique cultural identities (Gay, 2018; Ladson-Billings, 1995b), is critical to addressing disparities in computing. Thus, professional development (PD) that integrates culturally responsive principles in the teaching of CS is essential to preparing teachers to provide rigorous and equitable CS instruction (Authors, 2021; 2022).

This work is situated in the context of a PD program designed to prepare elementary educators to integrate CS and CRP into content area lessons (Authors, 2022). In this paper, we explore how teachers conceptualize student identities to support their approaches to CS and CRP integration. Specifically, we investigate the following questions:

1. How do teachers characterize their students when discussing their intent to integrate CS tools and/or CRP strategies in their content area lessons?
2. In what ways do teachers apply student characterizations to support their stances about whether and/or how to integrate CS tools and/or CRP strategies in their lessons?

Literature Perspectives

In recent years, the growing interest in CS education for K-12 students has been reflected in policy initiatives, such as *CS for All*, and new standards developed by the Computer Science Teachers Association (2017) and the International Society for Technology Education (2016).

Lack of access to CS education is a primary impetus for integrating CS instruction in elementary schools, where these opportunities are disproportionately lacking (Google & Gallup, 2020). Broadening participation in CS, however, requires both increasing access to computing and providing culturally relevant computing instruction (Yadav et al., 2022) to address the persistent underrepresentation of females and minoritized populations in computing. Yet, research has shown that CS-related PD focuses mostly on increasing overall participation in CS and teaching foundational CS skills (Goode et al., 2021), with fewer efforts responding to the need for culturally relevant instruction (e.g., Authors, 2021). Although multiple factors contribute to the underrepresentation of females and racially minoritized populations in CS-related careers, a lack of culturally relevant CS education plays a major role (Scott & White, 2013). Therefore, integrating CRP in CS education is key to combating disparities.

Students' cultural identities are foundational to culturally responsive teaching and learning (Gay, 2018; Ladson-Billings, 2009). Specifically, Ladson-Billings (1995b) proposed three components of CRP: academic excellence, cultural competence, and critical consciousness. These dimensions of CRP are reflected in instruction that maintains high expectations for all students, builds on students' cultural competence by drawing on their cultural funds of knowledge and connecting to their lives, and prepares students to think critically about the world around them.

Teachers who practice CRP maintain an assets-based perspective that values the role of culturally specific knowledge in the learning process (Ladson-Billings, 2006). This assets-based approach can counter deficit-based perspectives often held by teachers about the appropriateness of CS education for minoritized populations (Margolis et al., 2017). Challenging deficit-based

perspectives is key to combating disparate opportunities for CS education and underrepresentation of these populations in the CS field.

The integration of CRP in CS has the potential to increase the engagement of females and racially minoritized students in CS education (Madkins et al., 2019). Successfully integrating CRP in CS education, however, requires teachers to identify, develop, and affirm students' identities relative to CS in order to build on their cultural assets (Goode et al., 2021). Indeed, research has shown that teachers who integrate CRP in CS education employ instructional practices that make CS learning relevant to students' lives, thereby increasing their interest and confidence in CS (Madkins et al., 2019). Thus, this work focuses explicitly on helping teachers integrate CRP in CS teaching and learning to support efforts to broaden participation in computing.

Context of this Work: PD Program

The PD program that served as the foundation for this work is designed for teachers interested in integrating CS into existing curricula and includes a dual focus on CS content knowledge and applications of CRP in computing. The objective is for teachers to plan and implement lessons that integrate CS and CRP in content area instruction. The program includes a week-long Summer Institute followed by on-going PD and support as teachers implement their lessons during the academic year. This work focuses on outcomes from one Summer Institute.

PD sessions were facilitated by university faculty members from CS and education, graduate assistants, and teacher leaders consisting of previous PD participants who demonstrated excellence in CS integration. Throughout the week, facilitators modeled lessons, introduced teachers to unplugged activities that integrate CS without technology, and provided opportunities

for active learning with various CS tools (e.g., Scratch[1], Micro:bits[2]). Sessions focused on CRP introduced teachers to core themes and accompanying strategies for integrating CRP in the design of CS-integrated lessons. The PD also included time for teachers to develop lesson plans with feedback from facilitators. Table 1 provides an overview of the PD schedule.

Table 1

Overview of Summer Institute Elementary Track PD Schedule

Time	Tuesday	Wednesday	Thursday	Friday
9:00-10:15	Introductions; Program Purpose & Overview; CS Unplugged* Icebreaker	Introduction to Google CS First Curriculum**	Introduction to CS Tools for Robotics***, Game Playing, and Physical Computing: Bee Bots, Ozobots, Edison Bots, board games, Makey Makey	CSTA: CS careers, societal impacts, and broadening participation
10:15-10:30	*Break*			
10:30-11:45	Introduction to Culturally Responsive Pedagogy (CRP)	Scratch****: making games with events, sensing/reacting to user mouse clicks and keyboard inputs	Scratch: practice exercises and Google CS First lessons	AI & Ethics
11:45-12:30	*Lunch*			
12:30-1:00	Getting Started with Scratch: overview, teacher and classroom account set-up	CRP in Practice	Lesson Planning with CRP (Part I)	Lesson Planning with CRP (Part II)

[1] Object-oriented visual programming tool.
[2] Pocket-sized computers used for coding.

1:00-2:15	Beginning Scratch: environment, sprites, movement and drawing with sequences, repetition and conditionals	CS Unplugged: algorithms and precise instructions in coding (Marching Orders; Harold the Robot; Variation for Physical Exercise Routines; Code.org card sequencing activity)	Lesson Planning Time	Cybersecurity
2:15-2:30	*Break*			
2:30-3:45	Scratch: storytelling with conversations and animation with different costumes	Introduction to Lesson Planning Structure; Lesson Planning Time	Introduction to Micro:bits & Micro:bits Curriculum	Lesson Plan Sharing
3:45-4:00	Reflection & Sharing			

CS Unplugged*: A collection of free teaching material that teaches Computer Science without technology
CS First**: An introductory CS curriculum based on Scratch
Robotics***: Tools that support CS teaching using physical materials
Scratch****: Object-oriented visual programming tool

Methods

Participants

The Summer Institute included an Elementary Track (K-5), an Integration Track (Grades 6-8), and a CS Principles Track (CS Advanced Placement). This work focuses on teachers who participated in the Elementary Track (N=26). All teachers in the Elementary Track were invited to participate in an interview at the end of the week-long Summer Institute. This study includes 15 teachers who volunteered to participate in interviews. Table 2 provides an overview of participants.

Table 2

Participants

Participant[3]	Position	Grade Level(s)[4]	School Type	Racial/Ethnic Identity	Gender Identity	K-12 Teaching Experience (Years)
Adam	Math	4-5	Public	White	Male	11
Brittney	Across subjects	K-5	Charter	Black or African American	Female	4
Brooke	Across subjects	K-3	Public	White	Female	4
David	Special education	K-5	Public	Black or African American	Male	2
Elizabeth	Across subjects	4-5	Private	White	Female	16
Erica	Librarian	K-5	Public	White	Female	15
Jasmine	Across subjects	K-3	Public	Black or African American	Female	2
Katie	Across subjects	K-3	Charter	White	Female	3
Lindsey	Math	4-5	Charter	White	Female	9
Margaret	Librarian	K-8	Charter	White	Female	22
Maxine	Librarian	K-2	Public	Black or African American	Female	20
Patricia	Librarian	K-5	Public	White	Female	19
Sonia	Special education; across subjects	4-5	Public	Hispanic; American Indian or Alaska Native; White	Female	20
Susan	Talented and gifted	K-5	Public	White	Female	22
Vanessa	Across subjects	K-3	Public	Black or African American	Female	28

[3] A total of 17 participants completed interviews. However, two interviews were removed from the data set, including one interview conducted with a school administrator, who primarily observed the PD and did not plan a lesson, and one interview for which the audio recording was incomplete.

[4] In their PD applications, teachers selected from several options to indicate the grade level(s) at which they taught, including K-3, 4-5, 6-8, and/or "Other (please specify)."

Data Collection

Semi-structured interviews (Merriam, 2009) were conducted face-to-face on the final day of the Summer Institute and lasted approximately 30 minutes. Interviews were conducted by professionals from an education research center with no PD organizers or facilitators present to allow participants to freely express their thoughts and opinions regarding the PD. The interview protocol included 12 questions that focused on: (a) PD effectiveness; (b) CRP PD sessions; (c) integration of CS and CRP in content area lessons; (d) overall PD takeaways; and (e) follow-up support (see Appendix). Interviews were recorded and transcribed for analysis.[5]

Data Analysis

One researcher employed first and second-cycle coding methods to conduct iterative coding cycles (Saldaña, 2021). Analytic memos were written throughout each coding cycle and focused on code evolution, analytic processes, and emergent patterns and themes (Saldaña, 2021). In between each coding cycle, the researcher met with another member of the research team to discuss and refine codes.

During the first coding cycle, structural coding was used to identify larger segments of texts aligned with primary components of the research questions. The question-based structural coding scheme included three primary codes: (1) student characterizations; (2) CS integration; and (3) CRP integration. The semi-structured interview protocol was used as an additional guide to identify relevant segments of data.

During the second coding cycle, the same researcher employed open coding to look for similarities and differences across corresponding segments of all interview data (Saldaña, 2021).

[5] While data collected during the PD also included observation notes, lesson plans, and other artifacts, this paper analyzes only interview data to understand how teachers themselves characterized their students and described their stances toward CS and CRP integration in their lessons.

Preliminary codes were developed, organized into tentative categories, and recorded in a codebook. The researcher utilized Dedoose software (SocioCultural Research Consultants, LLC, 2023) to apply codes to all interview transcripts. Reports generated via the software were used to determine the frequency of different student characterizations and instances in which student characterizations overlapped with participants' discussions of CS and CRP integration. The researcher continued to revise the codebook based on this ongoing analysis. Iterative rounds of coding were used to refine and apply the coding scheme and clarify emergent themes. Table 3 provides excerpts from the final codebook.

Table 3

Codebook Excerpts

Parent Code	**Child Code**	**Definition**	**Example**
Student Characterization: Academic	Asset-focused language	Teacher refers to academic achievement levels, skills, and/or abilities in a way that frames them as student assets	"I could definitely see some of these skills as an enrichment option for students who get the content, are looking for something more challenging."
	Deficit-focused language	Teacher refers to lack of/deficit in academic achievement levels, skills, and/or abilities	"Many of us who teach in inner-city or in a certain zip code, our students are not talking. They're talking, but they're not reading."
	Classification	Teacher identifies students as ELL, special education, gifted, etc.	"This coming year I'll have an inclusion class, so I'll have special education and general education."
Student Characterization: Demographic	Racial/ethnic identity	Teacher refers to students' racial/ethnic identity/identities	"I work in a predominantly African American community, some Latinos, but the majority of it are Black."
	Gender identity	Teacher refers to students' gender identity/identities	"The little coding club we had, I think there were 16 kids. There were two females."
	SES	Teacher uses terms such as "Title I" or "low-income" to indicate students' and/or school's socioeconomic status	"With my school being a Title I school and the neighborhood that it's in, I have a lot of students of color."

	Diverse	Teacher uses the term "diverse" in reference to students and/or school without clarifying meaning	"My classroom is so diverse and our school is."
Stances Toward CS Integration	Adaptations	Teacher describes specific adaptations included in lesson to address challenges and meet needs of students	"...we're going to use CSFirst, because it has that component that… they could click on the voice, and…the ones that aren't readers, they can hear it."
	Benefits	Teacher identifies ways in which integrating CS will be beneficial to students	"...the kid I had this year that had autism and he was high functioning, emotionally he was low. He would've loved scratch. It would've been a good way for him to get in touch with his emotions, with different characters."
	Challenges	Teacher identifies perceived/anticipated challenges and/or barriers to CS integration	"They're still working on basic communication skills… Anything abstract or hands on, it's not always going to work for them."
Stances Toward CRP Integration	Best practices	Teacher equates CRP with "best practices" or "just good teaching"	"I've heard all the ideas and it's all just best practices for teaching."
	Cultural identities	Teacher connects students' cultural identities to CS integration in their lesson	"You give them an identity, what to say, you put speech in there, and then create your own environment…a student is able to write a story from his own point of view, using Scratch."
	Underrepresentation	Teacher identifies need and/or how to combat underrepresentation of minoritized groups in the field of CS	"There was a video on code.org that I loved because…it showed exactly how many jobs there are, and it addressed how there's very few minorities, there's very few females. And so I just want them to be aware that this is a great resource."

Results

In this section, we present our results organized by research question.

Research Question 1: How do teachers characterize their students when discussing their intent to integrate CS tools and/or CRP strategies in their content area lessons?

We found that participants characterized students using academic and/or demographic descriptors when discussing their intent to integrate CS and CRP in their lesson plans. Table 4

indicates the frequency of student characterizations across interviews. Teachers utilized these characterizations to support their approaches to integration; however, the characteristics they referred to when discussing CS integration were different from the characteristics they referred to when discussing CRP integration.

Table 4

Frequency of Student Characterizations Across Interviews

Type of characterization	Number of references across interviews
Academic	51
Asset-focused	10
Deficit-focused	19
Classification	22
Demographic	23
Racial and/or ethnic identity	12
Gender identity	4
Socioeconomic status (SES)	5
Diverse	2
Total	74

Academic Characterizations

Teachers' academic characterizations of their students fit into three categories: 1) asset-focused; 2) deficit-focused; and 3) classifications (see Table 5). Asset- and deficit-focused language most often manifested as teacher perceptions or subjective assessments of students' academic abilities or achievement levels. Teachers were approximately twice as likely to characterize students using deficit-focused language compared to asset-focused language. Examples of asset-focused characterizations included references to "the *other* [emphasis added] kids who could fly with this right away," "very high students," and "students who get the content

[and] are looking for something more challenging." Deficit-focused academic characterizations were offered primarily as broad generalizations, whereas teachers used asset-focused characterizations primarily to distinguish a smaller subset of their students from deficit-focused characterizations of their general student population. Teachers who focused on perceived academic deficits frequently used the term "low/lower" to characterize their students to contrast with a subset of students they identified as "high/higher." Other teachers referred to students as "non-readers," "already far behind," and "underperforming."

Table 5

Examples of Academic Characterizations

Asset-focused language	Deficit-focused language	External classifications
"Kids who could fly with this right away" "Very high students" "Students who get the content [and] are looking for something more challenging"	"Lower learners" "Non-readers" "Already far behind" "Underperforming"	"ELLs" (English language learners) "TAG kids" (talented and gifted) "Special education"

When teachers described students according to academic assets or deficits, the characterizations were assigned by the teachers, and it is difficult to ascertain the level of subjectivity that informed their assessments. For example, characterizations of students as "high" or "low" could be based on standardized achievement data or simply based on teachers' observations. On the other hand, nearly two-thirds of participants referenced external classifications, identifying students as English language learners (ELLs), students who require special education services in accordance with their individualized education plans (IEPs), and/or students who have been designated as gifted/talented (e.g., TAG). While teachers may play some

role in the process, students are generally assigned these designations based on the assessments of external evaluators, such as school district personnel.

Although these classifications are often associated with assets or deficits, an important distinction emerged between teachers who independently characterized students using deficit-focused language and teachers who connected perceived deficits to classifications. Teachers who referenced students' externally assigned classifications, particularly students receiving special education services, connected these classifications with student deficits. However, when teachers identified deficits within the context of classifications, they focused primarily on how they planned to adapt their lessons to make them accessible to all students. On the other hand, teachers who characterized students as academically deficient independent of any classification were more likely to simply focus on the ways that integrating CS would be challenging or not feasible.

This way of framing student characterization may suggest that teachers feel more comfortable ascribing "negative" (deficit-focused) academic characteristics to students when they view those characteristics as a natural and justified consequence of an externally assigned academic classification. Because students are assigned classifications by external actors, teachers may feel that characterizing students using deficit-focused language is more objective. In other words, they might feel that their characterizations of students are more acceptable and/or less reflective of their beliefs about students. This could be a conscious and/or subconscious internal feeling and/or awareness of how their comments may be perceived. It is also possible that existing expectations that teachers provide accommodations to students classified as special education, ELL, etc. informed their approach to adapting their lessons. In contrast, teachers who identified deficits that were not extensions of classifications were less likely to discuss

adaptations and more likely to direct their focus to challenges.

Demographic Characterizations

Teachers' characterizations of students according to demographics included references to: 1) racial and/or ethnic identity; 2) gender identity; 3) socioeconomic status (SES); and 4) general references to "diversity," in which the teacher did not explain their conceptualization of "diverse" (see also Table 4). In some cases, teachers recognized the intersectionality of students' identities by combining more than one demographic characteristic. Across these demographics, teachers' characterization of their students revealed an emphasis on racial and/or ethnic identity.

With one exception, all participants who made references to demographics (10/15) included characterizations of their students according to race and/or ethnicity. In more than half of the references to race and/or ethnicity, teachers specifically characterized students as Black and/or African American. While we do not have classroom-level data that would allow us to determine whether all students of a particular teacher were Black and/or African American, at a minimum, it is notable that the teachers only offered characterizations of their students as Black and/or African American.

Though references to students' SES were the next most frequent after race/ethnicity, the combined number of references to SES, gender identity, and "diversity" was still fewer than the number of references to race/ethnicity. This focus on race/ethnicity may indicate the primacy of race in teachers' existing conceptualizations of "demographics."

Research Question 2: In what ways do teachers apply student characterizations to support their stances about whether and/or how to integrate CS tools and/or CRP strategies in their lessons?

In this section, we present results related to the second research question.

Teacher Stances Towards CS Tools Integration

Our analysis revealed that teachers supported their stances regarding CS integration by offering academic characterizations of their students. However, teachers primarily focused on academic deficits, rather than assets, when discussing how they integrated CS into their lessons. No teacher stated in their interview that they did not intend to integrate CS in their classrooms. This finding is not surprising, given that CS integration was the explicit purpose and expected outcome of the PD. However, many teachers clearly stated their intent to utilize CS while also characterizing their students academically using deficit-based language. This is notable because teachers combined what could be a justification for *not* using CS with clear statements that they *will* indeed use CS in their lessons.

At the same time, teachers framed their use of deficit-focused characterizations in two different ways. These two ways of expressing the same outcome suggest that teachers may be implying different issues/concerns via their use of deficit-based language although they all ultimately state that they *will* implement CS. The different ways that teachers contextualize their characterization of students using deficit-based language seem to give different weight to their intent to use CS vs. deficit-based student characterization. Their explanations illustrate a contrast between which of the two considerations they foreground as they discuss how they will use CS.

Adaptations to Address Challenges and Benefits

For some participants, characterization of students using deficit-focused language was secondary to their intent to integrate CS. Their intent to use CS was primary – literally mentioned before and/or more heavily emphasized – despite references to student deficits. In these cases, *the intent to use CS was foregrounded*, while the need to adapt CS integration based on student characteristics and perceived deficits was a necessary, but consequent, consideration.

Specifically, teachers referenced perceived academic deficits to contextualize their approaches to designing a CS-integrated lesson.

Maxine characterized a subset of her students according to their lack of reading proficiency to support her approach to CS integration, explaining how she intentionally selected a CS tool to accommodate her students' needs: "We're going to use CSFirst, because it has that component that, if [students] don't understand, they could click on the voice and it can be read to them, [so] the ones that aren't readers can hear it." Though Maxine focused on student deficits, she did so to explain her choice of a tool that would benefit her students by making CS accessible. Maxine was not the only teacher who selected CS tools based on the available read-aloud function, a feature that was highlighted during the PD. Several teachers referenced the read-aloud function of one of the CS tools as an element that would make the CS integration accessible for students who were not yet proficient readers.

Katie also pointed out the need to adapt her lesson to accommodate non-readers in her classroom, referring to these students as her "lower learners," but also used the focus on student deficits to contextualize her approach to CS integration. Her lesson included small group instruction for students who might not be able to read the text in Scratch. In both cases, the teachers' identification of student deficits prompted an approach to CS integration that included lesson adaptations to address the deficits."

Teachers who foregrounded adaptations for CS instruction in their lesson designs did not express, or even imply, that perceived student deficits would prevent them from successfully integrating CS. In fact, at times, teachers stated explicitly that using CS would be beneficial to students who they characterized using deficit-based language. Erica reflected on how the CS tools might have benefited a particular former student whom she characterized as "emotionally

low":

> I always think of the kid I had this [past] year that had autism and he was high functioning, emotionally he was low. He would have loved Scratch. It would've been a good way for him to get in touch with his emotions, with the different characters.

In this case, Erica didn't talk about why CS integration might not be feasible, or even how it might need to be adapted, based on academic deficits – she talked about how CS could be used to overcome perceived deficits and benefit students.

Given these teachers' focus on adaptations and accommodations, it is not surprising that they identified student classifications in conjunction with deficit-based characterizations. Overall, these teachers focused on *how they planned to adapt their lessons to overcome challenges* their students might face in engaging with CS, despite characterizing students as having academic deficits.

Challenges to CS Integration

In some interviews, characterization of students using deficit language occurred before and/or was more heavily emphasized than the intent to use CS. Teachers used deficit-focused characterizations to explain why using CS integration was either difficult or potentially not feasible with their students, though they later followed up by clarifying that they still intended to integrate CS. In these cases, teachers communicated that they would integrate CS without expanding on how their lessons were designed to overcome the challenges they cited.

Susan, for instance, spoke at length about her students' perceived academic deficits and accompanying challenges for CS integration: "[I] have students who aren't mastering basic reading and writing and math," she shared. However, when asked how she integrated CS into the lesson she designed during the PD, she returned to the challenges posed by students' deficits. As

she continued, Susan began to express reservations about implementing CS-integrated lessons in general: "You have to say to yourself, 'What are the priorities here?' How can [I] infuse [CS] when I have non-readers?" Despite her focus on the challenges posed by perceived student deficits, Susan concluded by simply stating, "but I think that comes back to the craft of being an educator. … [my] lesson is, it's asking students to code." Unlike the first group of teachers, participants who foregrounded student deficits rarely followed up by explaining how they would address their students' perceived deficits to successfully integrate CS in their lessons.

One possibility is that teachers felt the need to clearly articulate their intent to use CS after realizing that their focus on challenges stemming from student deficits may suggest otherwise. Given that the expected outcome of the PD was that participants design a CS-integrated lesson, they may have felt a need to communicate to the interviewer that they were committed to fulfilling the PD expectations. Across all the interviews, no teachers explicitly stated that they would not utilize CS following the PD; these teachers may have recognized that their comments could imply a lack of intent to integrate CS and subsequently clarified that they did intend to do so. Another possibility is that teachers may have determined that their focus on student deficits did not accurately reflect their internal beliefs or decided that their characterization of students does not project an "acceptable" stance.

Teacher Stances Towards CRP Integration

When compared to their stances regarding CS integration, teachers were significantly less likely to include any student characterizations in their discussions about CRP integration (see Table 4). However, teachers who did offer student characterizations to support their stances toward CRP integration were equally likely to reference academic and demographic characteristics.

Our analysis revealed that teachers' stances toward CRP integration differed depending on whether and how they characterized their students. Teachers who did not characterize their students at all demonstrated a limited conceptualization of CRP. Not surprisingly, these teachers did not integrate CRP in culturally responsive ways.

Amongst those who offered student characterizations, teachers who used academic characterizations to support their approaches to CRP integration often described lessons that were not responsive to students' cultural identities. On the other hand, teachers who used demographic characterizations to support their approaches to CRP integration designed lessons that accounted for a range of student identities. These teachers were also more likely to explicitly connect CRP to CS education, particularly the underrepresentation of females and racially minoritized groups.

Teacher Conceptualizations of CRP: "Best Practices"

No participants indicated that CRP was something completely new to them that would substantially transform their teaching. However, participants described their broader conceptualizations of CRP in different ways. Those conceptualizations, in turn, impacted how teachers described both their stances toward and approaches to integrating CRP into their lesson plans.

Out of the 15 participants, five stated in their interviews that CRP is "just good teaching" or "best practices." Adam, for example, said that he was "still trying to figure out what the difference [is] between culture [*sic*] responsive pedagogy and just best practices." Another teacher went a step further, explicitly stating that there *was* no distinction between CRP and best practices. When asked how they integrated CRP into the lesson plans they designed during the PD, several of these teachers focused instead on how they already employed CRP in all of their

instruction. One teacher said: "These are practices that are good teaching practices that I'm familiar with and already do." Margaret pointed to her general expertise regarding CRP, sharing that she was on a committee responsible for creating a database of culturally responsive teaching strategies for her school. These teachers did not address how CRP related to CS or how they applied CRP specifically in the context of their CS-integrated lessons. By equating CRP with "just good teaching" and neglecting the foundational role of students' cultural identities, the teachers demonstrated a limited understanding of the concept of CRP.

Nonetheless, in a few cases, teachers exhibited a deep understanding of CRP and the integral role of students' identities in culturally responsive instruction. When asked how she viewed the connection between CS and CRP, Erica expanded on her conceptualization of culture and the primary role it plays in CRP, while also acknowledging that employing CRP involved an ongoing process of getting to know students:

> I think [CRP and CS] go hand in hand. I think honestly [CRP] goes with everything, not just computer science. I think with computer science specifically, it's just a matter of putting your feelers out in the beginning of, 'okay, what is it that you like to do, what is it that you want to learn how to do, and how can I help with that?' Because culture…could be anything. It's not just the way that a person looks, it's also their belief system, it's also what they want to accomplish. So it's really first getting to know your kids…and it's a work in progress. It's not something you can put on a paper and follow; you just have to keep growing and learning with them.

Her description of what constitutes "culture" is notable given the heavy focus on race/ethnicity in teachers' characterizations of students throughout their interviews. Erica's conceptualization of

CRP included an acknowledgment that it is deeply contextual and informed by multiple facets of students' cultural identities, rather than "something you can put on a paper and follow.".

Student Characterizations and Cultural Identities

When speaking more specifically about the integration of CRP in their lessons, teachers revealed varying levels of cultural responsiveness. The ways in which they characterized – or did not characterize – their students when discussing CRP integration provided a useful frame for gauging these levels of cultural responsiveness.

CRP requires that teachers attend to students' personal and cultural backgrounds, identities, and lived experiences (Gay, 2018; Ladson-Billings, 1995b). Although oversimplified student characterizations can be counterproductive, recognition of and attentiveness to students' multiple and overlapping identities are prerequisites for culturally responsive instruction. Some instructional strategies, such as collaboration and choice, can be reflective of CRP, but are not inherently culturally responsive. Many can be used without thinking deeply or intentionally about students' cultural backgrounds.

At the most superficial level, teachers identified CRP strategies but described them in a way that indicated a lack of cultural responsiveness in the application of these strategies. In other words, their lack of references to student characteristics suggested that teachers may not be attending to students' unique identities despite their integration of CRP strategies. Notably, teachers who integrated CRP strategies in ways that were not culturally responsive were most likely to be the same teachers who equated CRP with "just good teaching."

Teachers who characterized their students academically tended to integrate CRP strategies in ways that were not culturally responsive. While these teachers responded to students' needs, they did not leverage students' cultural identities to do so. For instance, when

Lindsey was asked how she integrated CRP into her lesson, she described her general practice of grouping students heterogeneously by academic ability. She explained that CRP was part of her lesson due to the "collaborative nature of working in a group." Interestingly, as Lindsey talked through her approach to CRP integration, she seemed to come to a different conclusion about the presence of CRP in her lesson. Ultimately, she concluded: "So yes, [there's] not a ton relating to cultures." Though strategies such as student choice and collaboration are frequently observed in culturally responsive classrooms, they are not inherently culturally responsive. When implemented in culturally responsive ways, these strategies are informed by students' identities.

Another teacher, Susan, referenced her students' academic classification as gifted when asked how she integrated CRP in her lesson. She explained:

> As a teacher with gifted students, you always give kids choice. …providing opportunities for kids to self-select what they're going to do, to choose who they're going to sit with, to choose where they're going to sit, to choose the pacing. So, that's embedded within my lesson.

Unlike the teachers who referred to student demographics, Susan supported her approach to CRP integration by assigning a single academic characteristic to all students, rather than considering their individual identities. Other teachers commonly made vague references to "making learning accessible" and "accessing students' prior [academic] knowledge." Despite these vague references, it is possible that the teachers planned to integrate CRP strategies in culturally responsive ways that they simply didn't address during their interviews.

Though some teachers integrated CRP strategies in ways that were not truly culturally responsive or were responsive to teachers' characterizations of their students as a monolithic group, other teachers clearly communicated their awareness of student identities and how they

leveraged CRP strategies to respond to students' cultural identities. Teachers who characterized their students demographically tended to integrate CRP strategies in ways that were culturally responsive. In fact, they contextualized their CRP integration by referencing demographic characteristics such as racial/ethnic and gender identities, demonstrating their consideration of students' cultural identities.

For instance, David explained how integrating CRP alongside CS was informed by his students' varying identities. His lesson provided opportunities for students to incorporate their identities and experiences in their work:

> Well, [my lesson] gives [students] hands-on experience in terms of creating your own character, giving them an identity and stuff like that, because you're not just given a character. Now you have to create the character for yourself. You give them an identity, what to say, you put speech in there and then you kind of create your own environment, which I feel like, instead of me just reading a story, a student is able to write a story from his own point of view, using Scratch.

David further explained how he considered students' varying interests and experiences as he thought about making his lesson relevant to students' lives:

> I'm pretty sure some of my students have never been to Disney World. So if I'm going to create a story about Disney World, I'm not going to give them much to go off of... I'm looking [at], what are things that these kids see in the neighborhood often? Can we create a story based on that? So they're not just sitting there thinking, 'Where's Disney, what is this?' And it doesn't have to be Disney, but just something that they can easily relate to.

David considered how his students might not be able to relate to real-world scenarios, while also considering how to make his lesson relevant to students' own lives and responsive to their cultures and backgrounds.

Jasmine's stance toward CS integration reflected careful consideration of her students' SES and the implications for their access to technology. She created a lesson that reserved physical computing for classroom activities while providing unplugged activities to be completed at home. Jasmine supported this decision by referring to the variation in SES amongst her students and the knowledge that some of them may not have access to a computer outside of school.

Teachers who characterized their students demographically while discussing CRP were more likely to have integrated the CRP strategies in ways that demonstrated cultural responsiveness. Often, however, teachers described how they integrated CRP, but did not discuss any ways that they considered students' individual identities, implicitly characterizing students as a monolithic group. Although all teachers mentioned CRP, their simultaneous reticence to discuss the characteristics or identities of individual students runs counter to the core tenet of CRP, which requires that students are treated as individuals with a variety of backgrounds, cultures, and lived experiences.

Importance of CRP in CS Education: Underrepresentation

Some teachers spoke specifically about why CRP is critical in CS education, most often by connecting CRP to the underrepresentation of females and racially minoritized groups and disparate opportunities for CS education. Addressing underrepresentation in the field of CS is inherently tied to demographic characteristics, specifically racially minoritized individuals and females. Teachers who raised this issue made comments ranging from simply acknowledging

their awareness to describing their plans to actively combat underrepresentation through their instruction.

During their interviews, several teachers made passing references to their awareness of the underrepresentation of minoritized groups within the field of CS. One teacher made a connection between a PD activity in which participants identified a stereotypical computer scientist as a white male and the demographics of students who participated in a coding club at his school:

> Another big takeaway is that when [PD facilitators] said that your typical computer science person is white male, and the little coding club that we had [at my school], I think there were 16 kids. There were two females. All of them were white males.

Though he did not specify how his lesson integrated CRP in a way that was responsive to the disparity he observed, the teacher indicated his understanding of why CRP is critical in CS education.

Teachers who indicated their intent to leverage CS-integrated instruction to combat underrepresentation described different approaches. Maxine described a passive approach, stating her intent to:

> look for posters that have diversity, various people in computer science. And if I can show…students around their age doing [CS], I think that would be even better, so I'm going to hunt for that. Maybe some of the CS websites…will have some kind of posters that I could visually put [up]. [Students would] say, 'See, you don't have to be an old person. There are young people that are doing that.' So visually, I'm going to have to make that transition.

Maxine identified a need for students to see their own identities reflected in other computer scientists and specified her plan to facilitate opportunities for them to do so by hanging posters in her computer lab. However, she did not speak about how she planned to leverage the visuals to develop students' computer science identities.

Other teachers described a more active approach in which they planned to have open discussions with their students about these disparities, provide opportunities for students to see themselves reflected in examples of computer scientists who represent a wide range of identities, and educate students about various career opportunities in the CS field. For instance, Patricia identified her use of a resource shared during the PD:

> There was a video on Code.org that I loved because…you could click on [name of state] and it showed exactly how many [CS] jobs there are, and it addressed how there's very few minorities, there's very few females. And so I just wanted [students] to be aware that [CS] is a great pathway for [them].

Patricia extended her own understanding of disparities in CS to integrate an opportunity that helped make students aware of the disparities and identify opportunities for her female and racially minoritized students to develop identities as computer scientists.

Brittney even reflected on her own experience as a Black female as she thought about how to intentionally encourage her minoritized students to explore future CS opportunities:

> I feel if [CS opportunities] are more broadcasted and put out for all students, especially geared towards the students who like these things a lot, they will see like, 'This is a field for me. It's not just for an older person or just for a Caucasian person. I could get into this field. I could dominate this as well and not feel left out or like I can't be a piece of

> something.' … Because it's just that idea that, 'if I never saw someone who looks like me do it, what are the chances? What are the odds?'

Brittney characterized her students as primarily racially minoritized, and her reflection on her own shared identity informed her approach to providing CS-integrated instruction.

How teachers did or did not address the issue of underrepresentation is notable; these teachers demonstrated the potential for demographic characterizations to inform lessons that integrated both CS and CRP. Disparate opportunities for CS education is a key impetus for integrating CRP into CS education. Yet, teachers did not reference these disparities frequently, limiting their ability to design culturally responsive instruction to combat underrepresentation among key demographics. This points to our earlier finding that there were far fewer references to demographics when compared to academic characterizations in the interviews. Teachers' avoidance of discussing underrepresentation, however, may be a by-product of their general reticence to reference students' demographic characteristics.

Limitations

There are two main limitations associated with this work. First, all participants volunteered to attend the PD. As a result, teachers were already interested in integrating CS and CRP in their classrooms. Second, teachers' responses to interview questions may have been influenced by the explicit expectation that their lessons integrate both CS and CRP. Given this expectation, it is not surprising that all teachers stated their intent to do so. This work relied on interview data, because our goal was to explore how teachers themselves characterized their students and used those characterizations to support their stances toward CS and CRP integration. However, the use of interview data alone in this study limits our ability to understand

how teachers' stances may have manifested during classroom implementation of their lessons following their participation in PD.

Discussion and Conclusion

Findings from this work indicate that teachers cited the academic and demographic characteristics of their students to support their approaches to CS and CRP integration. This finding suggests that teachers successfully translated the ideas presented during the PD into their specific teaching contexts, albeit to varying extents. However, teachers' use of student characterizations to support their stances regarding CS integration was distinct from their use of student characterizations to explain approaches to CRP integration.

Across all interviews, references to academic characteristics appeared more than twice as often as references to demographics (see also Table 4). There are several possible explanations for this difference. It may simply be that teachers think of their students primarily in terms of academic characteristics, whether perceived or objective, which is a reasonable explanation given the traditional role of the educator as the person responsible for students' academic success. The disparate use of academic- and demographic-focused student characterizations could also reflect teachers' perceptions of socially and professionally "acceptable" ways to refer to their students. Given the significant focus on students' academic deficits as compared to academic assets, teachers may be even more reticent to connect student demographics to deficit-focused academic characterizations.

Most teachers supported their stances regarding CS integration with deficit-focused student characterizations; however, their focus on academic deficits was not inherently unproductive. In fact, attention to academic deficits prompted some teachers to adapt their lesson design to make CS accessible to all students. Future PD should explicitly address the challenges

identified by teachers according to their characterization of students' perceived academic deficits and provide strategies to ensure that CS-integrated lessons remain accessible to all students. At the same time, the limited focus on student assets relative to perceived deficits further suggests that additional emphasis on the centrality of an asset-based approach in CRP is warranted.

CRP does not simply encompass strategies employed by teachers but also requires that teachers view students' cultures and identities as assets for learning (Gay, 2018; Ladson-Billings, 2006). Our work suggests that PD should help teachers develop a culturally responsive mindset to prevent CRP strategies from being implemented in ways that are not culturally responsive. The prevalence of deficit-focused academic characterizations in teachers' stances toward CS integration suggests that they view perceived academic deficits as obstacles to be overcome to successfully integrate CS. Emphasizing the role of asset-based approaches in the context of CRP could provide a counterpoint to teachers' focus on the challenges of integrating CS and help to reframe stances toward CS integration, while simultaneously establishing a deeper connection between CS and CRP integration.

The limited frequency of student characterizations when discussing CRP integration suggests that teachers may need additional support to understand the central role of student identities in culturally responsive instruction. Our findings mirror prior research that shows that teachers often struggle to separate CRP from "just good teaching" (Ladson-Billings, 1995a). CRP encompasses both the mindset *of* and *actions* taken by culturally responsive teachers (Ladson-Billings, 2006). However, CRP is inherently contextual and requires teachers to adopt an assets-based mindset that considers their own students, rather than implementing a prescribed set of pedagogical practices. Given its contextual nature, focusing on CRP strategies can separate teaching practices from a culturally responsive mindset. While it is true that many best practices

are applicable to CRP, the way in which they are implemented can be either responsive or not responsive to students' cultural contexts (Au, 2009).

Scholars have noted the careful attention required for PD to equip teachers with knowledge of broadly applicable CRP principles while simultaneously communicating the foundational role of context in successful CRP integration (Dixson, 2021; Sleeter, 2012). Our findings confirm the challenges that PD facilitators can face when helping teachers integrate CRP without separating general CRP approaches from responsiveness to specific students and contexts. Future work should also explore the challenges of conducting PD during the summer, when teachers are inherently separated from the context of their classrooms and students, and how teachers can be effectively equipped with the skills to adapt lesson plans created during PD to be responsive to their students when returning to the classroom.

Additionally, our findings suggest that teachers may not fully understand the interconnected need for CS and CRP integration. Future PD should explicitly connect the underrepresentation of females and minoritized groups in CS to the roles of CS and CRP integration in reducing these disparities (Madkins et al., 2019). Finally, future research should explore how teachers' stances toward CS and CRP integration manifest during classroom implementation of their lessons following PD. Observations of teachers' lesson implementations in their classroom contexts could further inform our understanding of how teachers' characterizations of their students inform their stances toward CS and CRP integration.

References

Authors. (2021).

Authors. (2022).

Au, K. (2009). Isn't culturally responsive instruction just good teaching? *Social Education*, *73*(4), 179–183.

Century, J., Ferris, K. A., & Zuo, H. (2020). Finding time for computer science in the elementary school day: A quasi-experimental study of a transdisciplinary problem-based learning approach. *International Journal of STEM Education*, *7*(1), Article 20. https://doi.org/10.1186/s40594-020-00218-3

Ching, Y.-H., Hsu, Y.-C., & Baldwin, S. (2018). Developing computational thinking with educational technologies for young learners. *TechTrends, 62*(6), 563–573. https://doi.org/10.1007/s11528-018-0292-7

Code.org, CSTA, & ECEP Alliance. (2023). *2023 State of computer science education*. Retrieved from https://advocacy.code.org/stateofcs

Computer Science Teachers Association. (2017). *CSTA K-12 Computer Science Standards.* Retrieved from https://csteachers.org/k12standards/

Dixson, A. D. (2021). But be ye doers of the word: Moving beyond performative professional development on culturally relevant pedagogy. *The Educational Forum*, *85*(4), 355–363. https://doi.org/10.1080/00131725.2021.1957633

Gay, G. (2018). *Culturally responsive teaching: Theory, research, and practice* (3rd ed.). Teachers College Press.

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Aldine Publishing.

Goode, J., Ivey, A., Johnson, S. R., Ryoo, J. J., & Ong, C. (2021). Rac(e)ing to computer science for all: How teachers talk and learn about equity in professional development. *Computer Science Education*, *31*(3), 374–399. https://doi.org/10.1080/08993408.2020.1804772

Google & Gallup (2020). *Current perspectives and continuing challenges in computer science education in U.S. K-12 schools*. Retrieved from https://csedu.gallup.com/home.aspx

International Society for Technology Education. (2016). ISTE Standards. Retrieved from https://www.iste.org/standards/students.

Ladson-Billings, G. (1995a). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice*, *34*(3,), 159–165.

Ladson-Billings, G. (1995b). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465-491.

Ladson-Billings, G. (2006). "Yes, but how do we do it?" Practicing culturally relevant pedagogy. In J. Landsman & C. W. Lewis (Eds.), *White teachers, diverse classrooms: A guide to building inclusive schools, promoting high expectations, and eliminating racism* (pp. 29–42). Routledge.

Ladson-Billings, G. (2009). *The dreamkeepers: Successful teachers of African American children* (2nd ed.). Jossey-Bass.

Madkins, T., Martin, A., Ryoo, J., Scott, K., Goode, J., Scott, A., & McAlear, F. (2019). Culturally relevant computer science pedagogy: From theory to practice. In *2019 Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT)* (pp. 1-4). Minneapolis, MN, United States. https://www.doi.org/10.1109/RESPECT46404.2019.8985773

Margolis, J., Estrella, R., Goode, J., Holme, J., & Nao, K. (2017). *Stuck in the shallow end: Education, race, and computing* (updated ed.). MIT Press.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. Jossey-Bass.

Rich, P. J., Mason, S. L., & O'Leary, J. (2021). Measuring the effect of continuous professional development on elementary teachers' self-efficacy to teach coding and computational thinking. *Computers & Education, 168*, 104196. https://doi.org/10.1016/j.compedu.2021.104196

Ryoo, J. J. (2019). Pedagogy that supports Computer Science for *All*. *ACM Transactions on Computing Education*, *19*(4), 1–23. https://doi.org/10.1145/3322210

Saldaña, J. (2021). *The coding manual for qualitative researchers* (4th ed.). SAGE Publications.

Scott, K. A., & White, M. A. (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

Sleeter, C. E. (2012). Confronting the marginalization of culturally responsive pedagogy. *Urban Education*, *47*(3), 562–584.

SocioCultural Research Consultants, LLC. (2023). *Dedoose* (Version 9.0.107) [Computer software]. https://www.dedoose.com

Tran, Y. (2019). Computational thinking equity in elementary classrooms: What third-grade students know and can do. *Journal of Educational Computing Research*, *57*(1), 3–31. https://doi.org/10.1177/0735633117743918

Waterman, K. P., Goldsmith, L., & Pasquale, M. (2020). Integrating computational thinking into elementary science curriculum: An examination of activities that support students' computational thinking in the service of disciplinary learning. *Journal of Science Education and Technology*, *29*(1), 53–64. https://doi.org/10.1007/s10956-019-09801-y

Wing, J. (2006). Computational thinking. *Communications of the ACM, 49*(3), 33-35. https://doi.org/10.1145/1118178.1118215

Yadav, A., Heath, M., & Hu, A. D. (2022). Toward justice in computer science through community, criticality, and citizenship. *Communications of the ACM*, *65*(5), 42–44. https://doi.org/10.1145/3527203

Appendix

Interview Protocol

Effectiveness of PD

1. Why did you decide to participate in this professional development opportunity?
    a. What did you hope to gain from this experience?
    b. Had you participated in any PD with this University of Delaware team before?
2. What were the best aspects of this professional development?
3. What could be done to improve this professional development?
    a. Were any of your goals or expectations not met? What could have been done differently to meet those goals?

CRP PD Sessions

4. The professional development included ideas about culturally responsive pedagogies. What comes to mind when you hear this phrase? What does it mean to you?
5. How do you view the connection between culturally responsive pedagogies and computer science?

Lesson Planning Integration

6. What subject area did you write your lesson plan(s) for? Why?
    a. How does computer science/computational thinking fit into that subject area?
7. How did you incorporate computer science tool(s) and/or strategies into your lesson(s)?
    a. Why did you choose those specific tool(s) and/or teaching strategies?
8. How did you incorporate CRP strategies into your lesson(s)?

PD Takeaways

9. Are there any other ideas or strategies you discovered during the professional development that you might use in the future that we have not already discussed?
    a. How do you plan to incorporate these additional strategies into your instruction?
10. How do you feel about integrating subject area content, computer science, and CRP strategies all together in your planning moving forward?
    a. How confident do you feel in your ability to do this integration?
    b. How do you feel this integration will work in your teaching context?
        i. Probe for elementary context, if relevant

Follow-Up Support

11. Did the PD address the unique needs of the students in your own classroom? Why or why not?
    a. What are the needs of your students that were not adequately addressed in the PD?
12. What follow-up support would you need to maximize your success in teaching computer science/computational thinking next year and in the future?