"What Happens to the *Raspado* man in a Cash-free Society?": Teaching and Learning Socially Responsible Computing

JEAN J. RYOO, University of California, Los Angeles
ALICIA MORRIS, Los Angeles Unified School District
JANE MARGOLIS, University of California, Los Angeles

The Computer Science for All movement is bringing CS to K-12 classrooms across the nation. At the same time, new technologies created by computer scientists have been reproducing existing inequities that directly impact today's youth, while being "promoted and perceived as more objective or progressive than the discriminatory systems of a previous era" [1, p. 5–6]. Current efforts are being made to expose students to the social impact and ethics of computing at both the K-12 and university-level—which we refer to as **"socially responsible computing" (SRC)** in this paper. Yet there is a lack of research describing what such SRC teaching and learning actively involve and look like, particularly in K-12 classrooms. This paper fills this gap with findings from a research-practice partnership, through a qualitative study in an Advanced Placement Computer Science Principles classroom enrolling low-income Latino/a/x students from a large urban community. The findings illustrate 1) details of teaching practice and student learning during discussions about SRC; 2) the impact these SRC experiences have on student engagement with CS; 3) a teacher's reflections on key considerations for effective SRC pedagogy; and 4) why students' perspectives and agency must be centered through SRC in computing education.

CCS Concepts: • **Social and professional topics → K-12 education**;

Additional Key Words and Phrases: Research-practice partnership, instructional pedagogy, socially responsible computing, student agency

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> "*So, can robots—and, by extension, other types of technologies—be racist? Of course, they can. Robots, designed in a world drenched in racism, will find it nearly impossible to stay dry.*" *[1, p. 62]*

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Authors' Addresses: J. J. Ryoo and J. Margolis, School of Education & Information Studies, University of California, Los Angeles, 1320 Moore Hall, Box 951521 Los Angeles, CA 90095-1521 USA; A. Morris, Felicitas & Gonzalo Mendez High School, 1200 Plaza Del Sol E, Los Angeles, CA 90033 USA.

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"The environment you grow up in shapes the way that you solve problems and think. So, if…there's only this one group [in computer science] who gets to think about things, and you have to solve problems the way that they want to solve it, and present apps and tools and data the way that they see it, then we're missing everyone else." [High school student, 2020]

1 INTRODUCTION – CONTEXTUALIZING SOCIALLY RESPONSIBLE COMPUTING EDUCATION IN TODAY'S WORLD

In December 2020, Dr. Timnit Gebru was fired from Google when she wanted to publicly share her research revealing the racist and sexist biases of the company's **Artificial Intelligence (AI)** systems [2]. Not only is Dr. Gebru one of very few Black women computer scientists studying AI with a focus on the ethical implications of computing, but she is also a vocal critic of the tech world's racist and sexist hiring and workplace practices. In a recent talk, Dr. Gebru reflected on her experiences in computing thus far, and what drives her to focus on issues of ethics in computing both now and into the future. She explained that she was never taught **computer science (CS)** within its social and political context. In fact, she was taught that "real scientists" are "neutral" and, in order to be accepted by the larger field that ostracized the Black female minority to which she belongs, she had to pretend that her work was separate from its ethical implications. However, she realized how tech creations are deeply influenced by the belief systems and values of their creators, as well as the great harms such tech are causing on vulnerable populations of low-income communities of color. And thus, she now refuses to wear that mantle of false neutrality as a computer scientist [3].

Indeed, a rich body of recent research has focused on the ways CS innovations can exacerbate the inequalities experienced by people of color and low-income communities. Buolamwini [4] recently testified to a U.S. Congressional Committee about gender and skin-color biases present in today's leading Artificial Intelligence systems used by police departments around the world to (inaccurately) identify and punish alleged criminals. O'Neil [5] has documented the ways "weapons of math destruction" in machine learning algorithms make biased decisions about college admissions, the length of prison sentences, employment, and access to loans or insurance. Eubanks has illustrated how such algorithms perpetuate the "digital poorhouse" as databases, computer algorithms, and risk models used to "rationalize and streamline benefits" deciding who should receive public assistance programs, homeless services, and child welfare, inevitably "profile, police, and punish the poor" [6, p. 38]. Eubanks notes how digital tracking and automated decision-making "give the nation the ethical distance it needs to make inhuman choices: who gets food and who starves, who has housing and who remains homeless, and which families are broken up by the state. The digital poorhouse is part of a long American tradition. We manage the individual poor in order to escape our shared responsibility for eradicating poverty" [6, p. 13].

Yet these are not the only things that CS tools have made invisible. Noble [7] has critiqued how Google search algorithms that appear unbiased and benign while navigating users to Wikipedia definitions or shopping websites actually reinforce racist and sexist biases due to the overvaluing of specific users' clicks and prioritization of paid advertisers. Thus, top results of Google Image searches for "black girl" show pornographic photos, searches for "beautiful" show photos of women in lingerie, and searches for "professor style" show photos of white men wearing blazers [7, p. 20-23]. This computing tool that people all over the world use every day hides such racism and sexism behind the veneer of "free" access to information while simultaneously collecting and selling user data. As noted by Ruha Benjamin's [1] quote at the start of this paper, even robots can be racist.

Such "algorithmic inequities" [described and analyzed by the scholars cited above as well as 8, 9, 10, etc.] have, time and time again, been designed by programmers who lack the experience, culture, and perspectives of marginalized communities. Most often, today's tech creators and programmers are white and certain Asian men with the preparatory privilege to access CS education that young women and students of color are denied. For example, the Silicon Valley tech workforce is less than 30% female with less than 1% Black women; the workforce overall is only 9% Black, Latinx, or Native American [11]. As expressed in the high school student's astute comment at the beginning of this paper, diverse ways of understanding the world, solving problems, and presenting ideas are missing in tech, to the potential detriment of communities who are underrepresented in the field.

The lack of diversity in tech, combined with employers prioritizing profit over consideration of the potential negative impacts of computing, has led to a "tech ethics crisis" where software engineers see ethics as a "specialty" rather than "foundation[al to] all design" [Zunger cited in 12, par. 3], and where "moral weight [is] not on the work of engineers but instead the ad hoc uses of engineered artifacts" [12, p. 2].

And we have seen the complexities of this during the past year plus. In 2020, following the murders of Breonna Taylor, George Floyd, and too many others, people in the U.S. and internationally came together to fight the injustice and inequality that African Americans and Black people have been experiencing for centuries. At the same time, the COVID-19 pandemic laid bare how people of color and low-income communities experience severe disparities in access to what all people fundamentally deserve as a human right—healthcare, housing, employment, and education—resulting in disproportionate numbers of deaths among low-income families, African American/Black, Latino/a/x, Native American, and other people of color. This was followed in 2021 by the January 6 insurrection of white supremacists and a rise of hate crimes against Asian Americans. During these times, CS creations have served to help fight these inequalities—personal smart phones have been used to document various events, social media has been used to organize activism, and computing has been central to the development of much-needed vaccines. But tech creations have also facilitated the rise of white supremacy, spread of disinformation, and continued oppression of people of color and low-income communities as described above.

As we become increasingly aware of the potential negative impacts of CS on our communities, and as CS education spreads into K-12 schools, to what degree are students learning about these harmful and ethical complexities of technological innovation? Are students being prepared to consider both the positive and negative consequences of how and what they create with computing? And are they learning about the relationship of technology to power in our new digital world? In this paper, we explore the intersection of all the above ideas, to examine why we must teach socially responsible computing in current CS classrooms. In what follows, we will define how we understand the concept of **"socially responsible computing" (SRC),** situated within current literature regarding CS education and ethics. We will then share examples of SRC teaching and learning that took place in an urban public high school classroom serving Latino/a/x students coming from communities underrepresented in computing. The examples we discuss will reveal a set of concerns and questions posed by the Latino/a/x students reflecting their personal experiences that are currently missing in today's tech world, and why their perspectives and sense of agency must be centered in an SRC approach to computing education. The examples will also highlight how an SRC approach deepens student engagement with computing, while supporting youth understanding of computing concepts related to issues that are important to them. The article ends with reflections on SRC pedagogy in relation to justice-centered CS education, followed by the implications of this work.

2 LITERATURE REVIEW

2.1 What is Socially Responsible Computing, and Why Do We Need to Teach It in K-12 Computer Science Classrooms?

Over the past decade, efforts have been made to address the systemic exclusion of students of color, women, and low-income students in computing through the Computer Science for All movement. As described by Margolis et al. [13], disparities in CS learning opportunities in schools often fall along race and socioeconomic lines. Factors contributing to these disparities include structural inequalities (such as lack of courses and teachers in schools with high numbers of students of color), biased belief systems about which students have the capacity to achieve in CS (usually white and certain Asian males are identified with success potential), educational policies (such as tracking), and lack of pedagogy specifically designed to welcome in and make CS meaningful for students traditionally marginalized in CS.

To address the lack of access to quality and rigorous CS education and the lack of pedagogy designed to create meaningful learning environments for young women and students of color, new CS curricula have been created, such as Exploring Computer Science and Advanced Placement Computer Science Principles, that are geared toward more culturally responsive and inquiry-based approaches to computing [e.g., 14]. Considering the role of technology within our larger society, as these newer courses are introduced, students need more authentic opportunities to critically engage with issues of ethics, the social impacts of computing, and what it means to both create and engage with computing in socially responsible ways. Toward such ends, we define **socially responsible computing (SRC)** as follows:

1. SRC challenges the notion that CS is neutral, objective, or apolitical by making visible the relationships between technological innovation, its creators, and the larger sociocultural and political contexts in which both exist. This includes attention to issues of race/racism, democracy and civic engagement, history, and cross-disciplinary intersections;
2. SRC acknowledges that computing is a form of power in today's society by critically examining how new technologies potentially reflect and reproduce existing inequities. SRC actively explores how the explicit and implicit biases computer scientists carry get built into their work;
3. SRC centers social impact and ethics throughout all computing design processes. As learners engage in designing and creating with technology, SRC encourages consideration of whose perspectives are dominating and whose are missing at the design table, who benefits and who is negatively affected by decisions made with new innovations, and what the ultimate impacts of computing creations will be on different communities;
4. In these ways, SRC takes a stand for equity, inclusion, and social justice and recognizes the importance of students developing critical consciousness and agency to not only create more ethical computing designs, but also to acquire the content knowledge and skills with which to address inequities in their worlds and improve the well-being of their\break communities;
5. Finally, in order to achieve SRC in the classroom, CS educators must regularly reflect on their own belief systems and biases, and seek to understand and respect students' perspectives, values, and cultural knowledge as assets to learning CS. This is especially important in regards to youth whose communities have been marginalized in society and by the field of computing.

This definition builds on a rich body of literature regarding ethics in engineering and CS, as well as equity in computing education, as detailed below.

2.2 Racist Robots, The New Jim Code, and Ethics in Computing Education

There is a tendency in our society to see current computer technology as separate from its creators in ways that steer the general population into believing that technology is value-free and unbiased. Much of this is due to the "black box" approach to technology development and use, that hides the thinking and processes that went into creating the various computing tools we use (from hardware to apps to algorithms), while diverting our attention away from the relationship between human production and technology [1, 15]. As Benjamin explains, "the notion that tech bias is 'unintentional' or 'unconscious' obscures the reality—that there is no way to create something without some intention and intended user in mind" [1, p. 28]. She shares the example of "Beauty AI" which was the first beauty contest to be judged completely by robots in which only one of forty-four finalists had visibly dark skin and the creators of the app even acknowledged that "the robots did not like people with dark skin" [1, p. 50]. In this case, the robots truly were being racist, and not because they went rogue and defined their own notions of beauty, but because the algorithm designed by computer scientists calculating "beauty" was biased in and of itself. While a beauty contest may not have huge consequences for the majority of people in the world, considerations of how machine learning used for democratic voting systems or healthcare services should make us all pause and wonder how checks and balances are being incorporated into decisions that are being increasingly automated [1].

Browne explores this idea, specifically in the ways that "racializing surveillance" negatively impacts communities—and particularly Black communities—in her work that challenges the "absented presence" of Blackness as part of surveillance studies [10, p. 17]. Browne builds on Fiske's [16] description of how technological surveillance of people has been racialized, inequitably subjecting Black men to disciplinary measures for engaging in the same activities performed by white men because of the ways that technological tools and public spaces are shaped for and by whiteness [10]. She also cites Lyon's [17] research regarding "digital discrimination" in which surveillance technologies employed to examine personal data for risk assessment—data marked by race, gender, socioeconomic status, etc.—inevitably privileges only those who are already in positions of power, rejecting others as illegitimate. Building on this and other bodies of work (Foucault, Fanon, Orwell, etc.), Browne [10] explores how Whiteness has branded the development of biometric information technology in ways that put the lives and culture of Black people at risk. Indeed, one cannot ignore that both technology and race are equally used as biased tools that organize the ways we interact in society, as well as who has the privilege to access the best education, healthcare, quality of life, or even be heard by voice recognition software [1].

Broussard [9] emphasizes that technological solutions are not always the best for the challenges we face in today's world. Greater attention must be paid to when and how technology is taken up as the answer to our problems because of the fact that "the outsourcing of human decisions is, at once, the insourcing of coded inequity" [1, p. 30]. As such, computer science students today must be made aware of the impacts that every decision makes in the process of creating programs, designing algorithms, and coding in what Benjamin calls "the New Jim Code." The New Jim Code is "the employment of new technologies that reflect and reproduce existing inequities but that are promoted and perceived as more objective or progressive than the discriminatory systems of a previous era" [1, p. 5–6].

In the field of engineering, a parallel concept has been described as the "neutrality problem" in which engineers view their actions and work as completely neutral [18, p. 2]. Banks and Lachney [18] cite the work of Nieusma and Blue [19] who point out that engineering education's historical relationship with the military has shaped the engineering educational approach to problem solving that does not allow room to question authority, and instead aims for utmost efficiency without thinking about larger social impacts. This same history is true of computer science and its uses

[e.g., 20]. As a result, there has been a pattern in the approach to teaching engineering and computer science that keeps programming practice divorced from active consideration of social impact and ethics, while limiting opportunities for students to take a stand on complex issues normally reserved for the humanities or social sciences.

Thus, it is not uncommon to hear engineers and programmers state: "I just build things; someone else can think about the ethics" [12, par. 7]. And while Fiesler [12], who has been researching ethics education in computing, notes that ethics is often a part of required curricula because CS programs in U.S. universities must provide students with such courses in order to earn accreditation, these courses are usually taught at the end of degree programs and siloed from students' other coursework. As such, students rarely experience hands-on CS problem solving woven together with ethics considerations—the two are taught separately so that the process of becoming a computer scientist does not intimately involve ethical questions about what it means to be a computer scientist.

Of course, the idea that CS students need to be taught about ethics and socially responsible computing in addition to programming or computational thinking is not new. This topic has been under consideration for university-level computing and engineering courses for decades. Fiesler et al. [21] note that Nielson made the suggestion at a 1972 **Special Interest Group in Computer Science Education (SIGCSE)** conference that computer science instructors "prepare the student to make better decisions." Computer Professionals for Social Responsibility, founded in 1981, questioned the military uses of technology. Its slogan, "Technology is driving the future…it is up to us to do the steering" countered the myth that computer science is neutral. This organization asked the hard questions about technology, not just "is it cool?" but "does it make our lives better or more just?" [22]. While the organization dissolved in 2013, these questions are still heard today. Later, others took up these efforts and tried to build ethics and socially responsible computing into their computer science courses in higher education. In 1988, Miller explored how ethics could, and should, be a part of computer science education, noting that technical issues would be best understood and student motivation to learn computer science would increase if taught in their social context [23]. In 1995, Huff and Martin published an article entitled, "Computing consequences: A framework for teaching ethical computing" where they shared their efforts in "Project ImpactCS" to define the core content and pedagogical approaches to "integrating social impact and ethics into computer science curriculum" [24, p. 76]. They explain that they began their effort because resources such as Computing Curricula 1991 and the Computer Sciences Accreditation Board Guidelines offered only high-level explanations about how the social consequences of computing technology should be incorporated into courses, but not what this means for content and pedagogy. They brought together a steering committee and developed a framework that took into consideration "levels of social analysis" (e.g., individuals, communities and groups, organizations, cultures, etc.) in relation to "topics of ethical analysis" that fell into two categories: "responsibility" (individual and professional) as well as "ethical issues" (quality of life, use of power, risks and reliability, property rights, privacy, equity and access, honesty and deception) [24, p. 76–77]. They also outlined ethical and social principles and skills that CS undergraduates should learn (for example, arguing from example, analogy, and counter-example, or understanding that power relations are central in all social interaction, or identifying and interpreting the social context of a particular implementation, etc.), all of which were meant to inform the ways people approach CS ethics curricula in higher education.

While less common in K-12 contexts where CS education opportunities are not yet widespread but are quickly proliferating, others have made the call for ethics and equity to be part of CS curricula and pedagogy. More specifically, using a participatory knowledge building process involving 26 New York City CS education stakeholders across informal and formal education, Vogel, Santo, &

Ching [25] developed a framework of seven key impact areas arguing for universal CS education. One of the seven impact areas included "Citizenship and Civic Life," articulating the importance of preparing youth to engage with technology as creators, not merely consumers, who are aware of social norms, ethics, privacy issues, and the potential to benefit their local communities for stronger civic, equity, and techno-social engagement. And in their report "CS for What?", Santo, Vogel, & Ching [26] also describe efforts from the field to support "ethicalCS" and learning the social impacts of computing. For example, they describe Compugirls' "techno-social activism" efforts that support girls of color to gain a critical perspective of how to use computing for social change [27], a precollege course exploring "tech for good," and BootStrap's data science curriculum focusing on the ways bias can play a role in data sampling and analysis in K-12 learning contexts. Vakil & Higgs [28] and Rankin et al. [29] also explore the importance of teaching ethics in computing courses, but they emphasize that this should not simply involve discussions of individual choice and responsibility, but also considerations of power dynamics and the ways that ethical issues sit within larger political and ideological contexts. Thus, ethics in computer science education must involve not only considerations of the social impacts of computing, but also a pedagogical effort to help students understand how systems of power and privilege (impacting people differentially by race, class, gender, etc.) function and are sustained in society [28, 30]. SRC in CS classrooms must contextualize learning within the broader socio-political world with which it is intertwined. And as Morales-Doyle et al. [31] explain about **science, technology, engineering, and math (STEM)** education more broadly, in ways that echo Dr. Gebru's sentiments shared at the beginning of this paper, these tech-related forms of education "can't pretend to be apolitical."

With the development of efforts such as EthicalCS [32], people are realizing that educators need support teaching CS not simply as a form of technical education in and of itself, but with consideration of what happens when technology is designed and used within the real political, social, and historical contexts that programmers are influenced by and influence. Just as schools have been organized so that students learn reading and writing skills in conjunction with social studies and critical thinking so that they may be able to tease apart the meaning of language in-situ and differentiate between fact and fiction, so too should computer science languages never be divorced from their relationship to society and the world within which they exist.

In particular, scholars including Rankin et al. [29] and Washington [33] emphasize that moving past the apolitical approach to CS education requires a focus on racial justice. Rankin et al. [29] note how dominant hegemonic beliefs are the "connective tissue of systems of power in CS education" that regularly oppress Black women in computing courses and pathways. The longstanding belief that computing is neutral and objective is part of the "wall of whiteness" that they describe as a "matrix of intersecting oppressions" that marginalizes students of color and females in the field [29, p. 807]. Relatedly, Washington [33] argues that elements of cultural competence are necessary to challenge the dominant hegemonic culture that results in few students of color and females participating in computing. Cultural competence for CS educators includes that they take a cultural self-assessment on their beliefs and potential biases, reflecting on how they value diversity, and on their ability to manage dynamics across student groups including an awareness of the historical context and impact of words and beliefs etc. [33, p. 2–3]. As such, CS courses must also be attuned to issues related to race and racism, democracy and civic engagement, history, and cross-disciplinary work [28].

It is from this body of research that we come to define SRC above. SRC must acknowledge computing as a form of power, challenge notions of neutrality and objectivity, situate CS learning within its sociocultural and political contexts, recognize the role that identity and bias play in the creation of new technologies, and directly question these issues of "CS for What," for whom, and why. However, the urgency of attending to inequities and ethics in the tech sector and CS

coursework are not only for the purpose of ensuring that computing creations are designed with consideration of their social impact and responsibility. This is also needed in order to make space for those who have been most marginalized in the field.

As such, SRC in the classroom not only must address that "wall of whiteness" with teachers' cultural competence, but also toward empowering students to do something positive with what they learn. In Robert Moses's work both in the Civil Rights Movement and the Algebra Project, he believed that youth must take lead in employing their learning toward social change [34]. Learning content or skills divorced from their application toward improving one's life takes meaning from learning itself. Similarly, on reflecting on the "Mathematics for All" movement, Danny Martin [35] expressed that if students are unable to use math knowledge/skills "to change and improve the conditions of their lives outside of school, they will continue to be marginalized even while mathematics educators and policy makers claim small victories like *Mathematics for All*" [35, p. 13]. In other words, simply focusing on access to CS courses and improved CS exam scores is not enough in the context of systemic inequality. A truly justice-oriented computing education ensures that youth are empowered with the ability to make positive impacts on their world. Thus, in our definition of SRC, youth must be given the opportunity to learn how to take a stand for equity, inclusion, and justice if they so wish, to address inequities in their worlds and improve the well-being of their communities. Student agency sits at the heart of SRC.

While there is growing attention being paid to ethics in computer science efforts more broadly (for example, Shilton [36] notes how a search for abstracts in the ACM Digital Library mentioning "ethics" included over 4,000 papers, most authored after the year 2000), there is a lack of examples of what this can look like in practice, specifically at the K-12 level. What pedagogical strategies can K-12 teachers use to engage students in in-depth conversations around socially responsible computing? How can teachers strengthen students' ability to "do the steering" through the ethical quagmires that arise during technological innovation? What sort of preparation do teachers need in order to support these conversations in their classrooms and strengthen students' sense of agency and voice, especially if students are not supported in doing so on a regular basis?

The findings detailed in this paper seek to explore these ideas, specifically from the perspectives of a high school math and CS public school teacher and her students. In particular, attention will be paid to the ways SRC teaching can develop pedagogies and classroom learning environments that strengthen students' critical thinking, voice, and sense of agency with computing in the larger world.

3 METHODOLOGY AND RESEARCH APPROACH

3.1 Research Questions

In an effort to understand what socially responsible computing (SRC) education could potentially be in K-12 contexts, as well as its potential value for CS students, this paper seeks to answer the following research questions:

1. What does student engagement look like when learning about SRC?
2. What SRC pedagogical moves most effectively support student engagement, critical thinking, and agency in SRC learning?
3. What must K-12 teachers take into consideration when preparing to teach about SRC?

This research took place within the context of a larger research-practice partnership in which the co-authors came together to understand what factors have the most impact on minoritized students' sense of engagement, agency, and identity in high school computer science courses. The goals of the larger research-practice partnership included amplifying minoritized high school

students' perspectives and experiences (as young women, students of color, and low-income students in a large, urban, west coast school district) when first being introduced to computer science in high school courses.

3.2 Research Context

In this paper we focus on one school in the larger study in which the teacher (Ms. Morris, the second author) regularly engaged students in SRC. This high school—Felicitas & Gonzalo Mendez High School, named after the parents of civil rights activist Sylvia Mendez, who played a key role in the 1946 *Mendez v. Westminster* school desegregation case—is located on the edge of downtown Los Angeles, where approximately half the residents were born outside of the U.S. Over 97% of students attending this local school are Latino/a/x, and 92.9% qualify for free/reduced-price lunches [37].

In 2016, the teacher/second-author collaborated with her principal to launch a CS education pathway for students in which all 9th graders are required to take an introductory CS course (Exploring Computer Science), after which they have the option to take Advanced Placement Computer Science Principles, Game Design, and Advanced Placement Computer Science A during their 10th-12th grade years. During the first three years of the pathway, AP CSP enrollment doubled every year (from 9 to 20 to 40 students each consecutive year). Ninety percent of students were female the first year, with male-to-female enrollment being near equal during the years that followed. Here we focus specifically on one of the teacher/second-author's 2018-19 Advanced Placement Computer Science Principles classrooms that enrolled a total of 18 students who all identified as Latino/a/x, with approximately 40% identifying as female. Four students had never taken a CS course before this class, and the rest had enrolled in Exploring Computer Science the year before. The teacher is a Latina with roots in Colombia and has been teaching math, CS, and fashion for over twenty years (9 years Multiple Subjects with an emphasis in Math for elementary students, 11 years high school math, 9 years CS, 8 years fashion).

In her classroom, the teacher sought to create an inviting and comfortable learning environment that felt part library, part interactive museum: students could find the latest magazines and books related to CS and fashion, while also touching and using older computing artifacts such as Apple II, Altair, Apple Power Book, or fashion design tools. These resources were organized neatly around the entire classroom, along with warm lighting that replaced the uncomfortable buzz and harshness of institutional fluorescent lights. The teacher arranged the students' desks in groups so that students could support each other's learning when questions arose, or during collaborative assignments. At the center of the room was a beautiful wooden table on a colorful rug, surrounded by comfortable chairs upholstered by the fashion club that made the space feel more like a living room where ideas could be exchanged rather than a typical classroom where students should be quiet. The walls were covered with student projects, celebrating their learning and growth over time.

3.3 Research Methods: Research-Practice Partnership

A **research-practice partnership (RPP)** between university researchers and public high school teachers formed this project's foundation. Building off of over ten years of collaboration that the third author developed in years prior—some of which is described in the book *Stuck in the Shallow End* [13] regarding the ways that inequality gets reproduced through CS education—the first and second authors began working closely together during the 2018-19 school year to document and understand what makes a positive difference in student engagement, identity, and agency in CS classrooms, especially for minoritized students from communities underrepresented in the field.

RPPs have been defined as long-term, mutually beneficial collaborations across practitioners and researchers that seek to produce findings that can have real positive impacts on educational

outcomes due to the improved relevance and value of the work to practitioners [38, 39]. At the same time, RPPs have the potential to produce more accurate and relatable findings because both researchers and practitioners jointly negotiate all aspects of the work together, from the development of research questions to the creation of data collection protocols, to data analysis [38]. In our own RPP, there was mutual agreement that more needed to be heard and understood from the perspective of youth about what works and doesn't work in making them feel engaged, welcome, and empowered by their computing education experiences.

3.4 Data Collection and Sources

In the RPP, the first and second authors collaborated closely, with the researcher (first author) conducting ethnographic observations during, at minimum, two class periods and one lunch period every week. The researcher would then write up observations into field notes (using an observation protocol co-developed with educators). She shared this directly with the teacher within twenty-four hours of every observation, and it served as a living document in which the teacher could offer additions, edits, clarifications, and raise questions for further observation and analysis. This paper focuses specifically on the AP Computer Science Principles classroom that the researcher (first author) observed during the 2018-19 school year.

Before beginning data collection, the RPP team developed a shared understanding of sociocultural learning theory [40] that shaped the researcher's approach to classroom observations. Building on this shared understanding, the researcher attended closely to the interactions that occurred between students and students as well as students and teachers, to explore how learning happened through joint activity. Observation field notes attempted to capture, over time, the words, gestures, facial expressions, tone of voice, and contextual factors of teacher and students engaged with one another, while describing what students were learning, as well as the CS concepts/practices that students engaged with most. During observations, photos and videos of student work were also captured. Artifacts of student work were recorded as well, to try to best understand what students were learning and how they were engaging with the CS materials. A total of 36 fieldnotes were analyzed in the data corpus for this paper, covering a total of approximately 36 hours of classroom observations of the AP Computer Science Principles classroom specifically.

Interview data were collected throughout the school year as well. The first author conducted beginning-of-the-year interviews with students to get to know students' interests, background experiences with computing, schooling history, cultural practices and values, and other details related to their personal identity and what they cared about. Throughout the year, interviews were also conducted with students about major projects they created in their CS classes, and what they learned in the process of creating these projects. Attention was paid to details of learning related to students' identities and personal agency with computing. End-of-year interviews were also conducted with students to understand if/how their engagement with computing may have shifted over the year, and what had the greatest impact on their interests with computing. Additionally, interviews were conducted with at least half of the students in this class during the two years following observations. Interviews were transcribed by an external transcription service, and transcripts were shared back with students for verification/editing to ensure greatest accuracy and also to stay true to what students wanted to share most. These interviews with all 18 students from the focal classroom were analyzed for this research exploration of SRC.

Interviews were also conducted with the teacher (second author) throughout the school year regarding her teaching philosophy, pedagogical approach to computing, history with CS teaching, definitions of "equity" and "broadening participation in computing," history with the CS for All movement, etc. An additional interview regarding the teacher's focus on SRC in her computer science classroom was also conducted (along with multiple informal conversations) to understand

her explicit pedagogical moves, motivations, and expectations. Issues related to what it takes for educators to engage in this kind of teaching were discussed. Two teacher interviews were analyzed for this study.

3.5 Data Analysis

As noted above, field notes written following every observation were sent to the teacher within 24 hours of every visit. The RPP team then scheduled regular meetings, at least once a month, where they would review observation fieldnotes and discuss what they had been noticing in terms of student engagement, learning, agency, schooling context, etc. Fieldnotes would be regularly clarified based on these conversations and the teacher's direct feedback on the documents. This collaborative sense-making process rooted in the RPP approach critically informed subsequent observations and field notes, the research coding scheme, as well as shaped the team's early analyses of key themes emerging from the data corpus.

At the end of the school year, the RPP team built off of their monthly reviews of fieldnote data and considered common threads that had arisen through student interviews, such as students' interests in issues of social justice and community impact. These conversations informed the coding scheme used to make sense of observation fieldnotes and interviews, which the researchers then analyzed closely for themes related to student engagement, identity, and agency (which was the focus of the larger RPP). From this broader research analysis—that involved coding data sources using Dedoose online software—the particular theme which is the focus of this paper emerged: Pedagogies focused on "real-world social/political issues." This code fell under the parent code "pedagogical actions" in the larger project. This paper looks more closely at the excerpts which were marked with these codes during the analysis process across both classroom observations and interviews. In particular, excerpts that were coded with both "real-world social/political issues" as well as "student agency" were deeply analyzed. Two of those excerpts are included as vignettes in the findings section below.

All fieldnote and interview excerpts were analyzed to deepen our understanding of student engagement with SRC, as well as pedagogical moves that supported such student engagement, voice, and agency while learning about ethics in computing. The RPP team met regularly to review the ideas that emerged from these analyses regarding ways that the teacher engaged students in thinking about the social and ethical implications of computing, as well as how students demonstrated their interest and learning of CS concepts and practices related to this topic.

4 FINDINGS

In what follows, two examples of what socially responsible computing education can look like in the classroom are followed by more in-depth perspectives of a student from that classroom. This is followed by pedagogical reflections on what educators may consider when teaching SRC in high school CS classes, including supporting students' sense of agency, critical thinking, and voice when learning about the complexities of these issues.

4.1 Examples from the Classroom – Debating the Pros and Cons of a Cashless Society

In the AP CSP classroom, conversations about the ethical and social implications of computing on our daily lives took place regularly throughout the year. Whether students were learning about binary numbers, how the Internet works, or how to program apps, the teacher regularly wove in journal reflections, whole-group discussions, videos, debates, student-led presentations, and readings for students that contextualized CS learning in the larger socio-political context in which her students live. The vignettes below describe two instances from typical class days, during which the teacher/co-author facilitated what we believe reflect an SRC approach to CS education.

4.1.1 Vignette #1: Debating the Pros and Cons of a Cashless Society. The following vignette describes a teacher-organized debate among the AP CSP students about the positives and negatives of digitizing all money in the world. During this class, all students—many of whom were often shy about speaking aloud—engaged deeply in the content of conversation when they saw how the topic related to real issues in their lives. As students discussed the topic, the teacher enacted instructional pedagogy that increased student agency and engagement with SRC specifically. We have broken up the example into separate sections that offer close detail of interactions as a way to illuminate what SRC pedagogy and learning can look like in detail. More specifically, these sections describe pedagogical moves that reflect our SRC definition in the ways the teacher: 1) **acknowledged the power tech creators hold** in society by **asking questions about who CS creates for and for what purpose**; 2) **refused the notion that CS is neutral and apolitical** by helping students **connect the discussion to their own personal realities/contexts in the socio-political world**; 3) re-voiced and elevated key student ideas while asking questions that expanded their **understanding of the interconnected issues**; 4) encouraged youth to consider the **ethical and social implications of computing-based decisions**; and 5) prepared youth to **think critically** about the issue while **holding students' accountable to their ideas** in ways that supported their ability to listen, argue, and **take a public stand** about the computing topic of discussion.

4.1.1.1 Contextualizing SRC Discussion in Students' Socio-political Contexts While Providing Space for Students to Practice Critical Thinking & Taking a Public Stand. Students were sitting in a circle and had been given the opportunity to choose whether they wanted to debate in favor of or against a cashless society. Five students (Yael, Lexi, Laura, Nardo, and Tristan—all students' names have been replaced with pseudonyms) grouped together against a cashless society, and eight students (Amelia, Camila, Elenor, Nathan, Tomas, Michelle, Ellie, and Oscar) facing them across the circle supported a cashless society. Ms. Morris asked who wanted to share their position first, and Yael raised his hand, stating that a cashless society was a bad idea because "it's easier to hack" and brought up issues of "privacy" if the government could see all your transactions. Ms. Morris nodded her head and replied, "I heard two reasons. It's hackable: let's respond to that first." Camila from the "pro" side of the room stood up to speak and agreed that it would be "a little bit hackable" but that the "Internet is always improving" and so we could protect ourselves against hacking. Furthermore, digital money would be more "convenient, fast, and easy." Ms. Morris summarized Camila's comment saying that one would be "offsetting risk with convenience." Camila confirmed Ms. Morris's interpretation, saying "you can access [your money] from any device."

Then, building off of students' ideas shared while grounding them in an example that students might be familiar with, Ms. Morris noted: "so that's a good thing that you don't have to be physically present to send money to your tía ['aunt' in Spanish]. But the problem is that it can be hacked by anyone, anywhere in the world. A con and a pro." Reflecting on this idea of one's tía, Nardo then asked, "are we talking about the whole world? Or just the US?" Nardo said this made a difference because if you go to Mexico, "not lots of places have those little machines to swipe cards. So what if it's the raspado man (street vendor)?" Yael jumped on Nardo's idea and noted that digitizing money would result in jobs getting taken away from people like the raspado man who won't get as much business if he cannot facilitate digital transactions. Nardo then added that a lot of kids buy things but not every kid has a credit card. Another student added that younger children didn't necessarily have phones either, which would be required for cash-free transactions.

Lexi then combined these points to note that a cashless society "would widen the poverty gap" because not all people have access to the same tools—such as phones, banks, or credit cards—so transitioning to a cashless society would "increase classism and racism." He also raised the point

that people who are left with so few options that they end up making money illegally (e.g., prostitutes, drug dealers, etc.) won't be able to make money if everything went digital, which would deny many poor people of the money they depended on for survival. Ms. Morris reiterated Lexi's position, stating that, "the lower-income sector will lose out in a cashless society, and this will widen the gap between classes if we go cashless because if you don't have a bank account and only have cash, you'll lose out." Lexi nodded his head. She then asked students what their readings for today described about illegal cash transactions. Several students turned to their articles and Amelia noted one that argued that society would benefit overall because illegal cash transactions would diminish, and Michelle added that this article argued that there would be less money laundering. Ms. Morris joked about cleaning money in a washing machine, after which Amelia explained that "dirty money is made illegally." Ms. Morris agreed and added that "money laundering is when you put dirty money through a business to make it look legitimate, you make it look cleanly earned."

Nardo then asked what people would do to help out homeless people begging from money on the street or when they're at church and the basket goes around for donations: "are you going to put your debit card in the basket?" Tomas replied that he doesn't go to church, while Michelle said quickly, "the church will come up with a system." Nardo replied, "what about the homeless person?"

The excerpt above describes how Ms. Morris created space for students to share their ideas about the ethical and social impacts of computing in ways that required critical thinking skills and practicing the act of taking a stand/position on a political issue. Importantly, Ms. Morris restated students' ideas in ways that contextualized their points within the realities of their current world: for example, she mentioned the ease with which people could send money to family (stated in Spanish), which many in this majority immigrant Latino/a/x community did on a regular basis. This way of connecting students' arguments to the local context encouraged more students to share. For example, Nardo highlighted the example of the "*raspado* man" who sells shaved-ice treats on the streets of the school's local community and in Mexico. Nardo builds on Ms. Morris's connections to everyday life by thinking about how a cashless society would affect the livelihood of these individuals specifically. This moment of thinking about one's *tía* and the *raspado* man became an important turning point for the larger discussion, opening space to consider the ethical implications of a cashless society on those with less wealth. Yael reflected on how many people would lose their sources of income, Nardo thought about the homeless and their neighborhood churches, and Lexi considered the impacts on low-income communities of color. Importantly, the students raise questions that may not typically be the center of conversation at CS industry design tables, sharing unique perspectives from their local context. Ms. Morris creates a space within which to practice sharing these ideas by welcoming the students' rich funds of knowledge in ways that connected issues of ethics with computing.

Further, throughout the discussion, Ms. Morris focused on creating a learning community in a non-hierarchical context where students and teacher all sat facing each other in a large circle. Those who were for or against a cashless society were on opposite sides of the circle, but with no space demarcating one vs. the other, creating room to have an open conversation: debate without conflict. Rather than forcing any particular student to share, Ms. Morris began the debate by welcoming anyone to begin with her/his/their ideas, whether pro or con. Then, as students shared, Ms. Morris made specific moves to re-voice what students stated, showing them that she was listening to what they said, but also creating opportunities for students to hear the idea again in different words while taking time for the ideas to be digested as they came up with support or rebuttals to those ideas. These specific pedagogical moves further supported a sense of safety in practicing one's critique of the issues at hand, and taking a stand in relation to one's own perspective.

Ms. Morris also explicitly helped students link these different ideas to one another, while then connecting back to assigned readings about illegal cash transactions and money laundering. And, very importantly, the teacher was always comfortable discussing issues of race and class that the students brought up, creating opportunities to go deeper with the ideas. Additionally, the teacher did not push her own ideas into the conversation, but simply echoed students' thoughts so that the debate could be about students' voices, and not her own.

In the next section, we see how students build momentum around the conversation as students and teacher continued re-voicing their ideas, while the teacher also began asking critically-placed questions that deepened the students' thinking around the social impacts of digitizing money.

4.1.1.2 Asking Key Questions to Deepen Critical Understanding of SRC in Current Socio-political Issues While Further Modeling & Supporting Agency. As the discussion continued, students began to think about the safety of a cash-free society. A pro-cashless society student mentioned that one would never have to fear losing their wallet, but Nardo and Laura noted you could still lose your card or your device. Ms. Morris interjected and asked the class what one does when losing a wallet or card. Students explained that you would call your bank, lock the phone or card, or cancel the card. Nardo then asked his peers what they would do when losing their phones? Would they find a quarter to call on a payphone? Ms. Morris asked jokingly, "a quarter? What's that?" and some students laughed, after which Ellie replied that there are always apps for tracking phones. But Yael countered that this was only helpful if you set this up ahead of time and Ellie conceded this was true. Camila pointed out that there could be other kinds of security measures set up to prevent hacking, such as the 2-factor authentication she used for her own iCloud and apps; this could be set up on digital cards and phones as well. Nardo then replied, "but the app needs Wi-Fi – what if there's no Wi-Fi?" Ms. Morris then reviewed the ideas shared: "So if I lose my wallet, I can call the bank to cancel the card. If I have cash and I lose it, I can't get back the cash. The bank can track digital money but not cash."

Lexi then noted that manufacturing cash was a waste of money and bad for the environment. Nathan picked up on Lexi's comment and mentioned the expenses of minting coin. Ms. Morris agreed and, holding up a $20 bill, she asked "this is legal tender, some would call a note. It's illegal to print this on your own at home. So is this hackable?" One of the girls mentioned that there was a way to see if the bills were fake, after which Ms. Morris demonstrated how there should be a specific sound, texture, and hologram on a real bill. Then Ms. Morris asked, "What makes the bill worth anything?" Students noted that if a bunch of fake bills were printed, the value of them would go down. Ms. Morris asked if students knew what the "gold standard" was. Students did not so Ms. Morris explained, "there was a time when you could go to the bank and get $20 worth of gold. We had to do away with that because the government didn't have enough gold to represent the money, and then they said this $20 bill represented what $20 could buy you. Why bills?" students said they were lighter than gold and Ms. Morris joked, "could you imagine if I was carrying gold to Starbucks?" and they laughed with her.

Ms. Morris then returned to Lexi's statement, asking if students thought it would be better to stop printing cash and driving cash around in trucks to save the environment. Some students agreed, nodding their heads. Then Ms. Morris acted out having a shop and noted how every time she swipes a card, the vendor pays a certain amount per swipe while the bank receives a percentage, and the buyer pays for both those things that are built into the price of the goods or services. She then said, if there is no more cash, "what if I don't trust banks?" Then Ms. Morris noted that banks make money every time we swipe our cards, and asked, "but are we hurting people who don't have bank access? Are they getting marginalized even more?" Michelle joked, "you're making me feel bad!" because she was on the pro-cashless society side. Ms. Morris picked up on this

and said "we're never choosing bad! The convenience is compelling!" At this point, near the end of class and after students shared their perspectives, Ms. Morris shared how one of her favorite restaurants stopped accepting cash about a year ago, and so she hasn't been back since. She said "I want the choice. That's *my* position."

Following all these discussions—about how a national disaster might impact a cashless society, whether or not people could manipulate a cashless system, how terrorism might impact peoples' access to funds, how a cashless society can support Internet artists and online businesses, impacts on the tax system, and how the elderly might be impacted by cashless systems—Ms. Morris ended class by asking, "anyone want to move?" [referring to the pro- or anti-cashless sides of the room]. Laura said she wanted to move, but that she was always on the fence between the two. Michelle stated, "I'm too proud to move" even though she was feeling swayed. Following this debate, the classroom community discussed how a cashless society is an example of two big ideas: the impact of computing on society and culture, and also abstraction. More specifically, they considered abstraction in terms of how consumers swipe/tap cards or phones that connect to underlying details of these transactions recorded through computing tools (regarding vendor/bank fees, payment, cost of goods, data being tracked, etc.).

In the excerpt above, we can see how Ms. Morris played a central role in pushing students' thinking around the debate by **asking critical questions at key moments**. Pedagogically, the teacher moved from welcoming students' ideas at the start of the debate (to create space for various voices and opinions without pressure) to now asking questions that **made students consider their positions from new angles** that deepened their consideration of ethical implications in the current socio-political context. For example, when students mentioned that a cashless society meant that people would not fear losing their wallets, Ms. Morris asked students to explain what happens when they lose credit/bank cards. This opened the conversation to more ideas around the complexities of banking systems and hacking such systems. Similarly, when students considered the cost (both financially and environmentally) to printing money, Ms. Morris asked questions that supported students critical thinking about what money actually signifies and how its value is calculated. At other points in the debate, she asked students about what happens to those who do not trust banks and who gets negatively impacted and who financially benefits by a system that requires the use of cards. Each time Ms. Morris asked a question, her students built upon those questions that complexified their understanding of how monetary systems work and why the digitization of money could be beneficial or harmful to society, and specifically to communities like their own that lack economic power.

Interestingly, the teacher waited until students had all shared their opinions and debated the issue before sharing her own preference to have a choice between using cash or not. Conscientious of how students see teachers as authority figures, Ms. Morris shared her views in a way that did not take over the conversation, but rather gave students more ideas to work with in their own debate while showing that educators are humans with opinions too. In this way, she also **modeled how to take a stand** for what she believed in around this issue.

And a powerful pedagogical move visible in this excerpt occurred near the end of the class period and debate: the teacher paused and asked if students wanted to switch sides. Rather than forcing students to stick with one opinion only, she **gave them space to shift, change, grow**. Furthermore, by allowing students to change sides in the debate, she **held the youth accountable to their arguments** and gave them the **room to be agentive** and choose based on their own beliefs and the shared conversation.

4.1.2 Vignette #2: Fireside Chat. This second vignette describes Ms. Morris's "fireside chats"—deeper text-based analyses that the teacher led around key assigned readings about SRC in her

classroom—which occurred on a regular basis throughout the school year. In this particular instance, students had been asked to read from the book *Blown to Bits* [41] and, during this class meeting they re-read and discussed book excerpts together. Students and teacher were seated in a circle so that all could see one another. At the front of the room, Ms. Morris projected a video of a fire burning in a fireplace, and audio speakers projected the crackling sounds of the wood burning. Ms. Morris explained that the class would participate in a shared "fireside chat" during which they could collaboratively think about the ideas they were reading in their book. Key aspects of SRC that came to life through this example include: 1) thinking about computing concepts (e.g., bits) and CS design decisions in relation to **current socio-political issues** that, in turn, 2) reflect how **computing is a form of power** that **cannot be considered neutral or apolitical** in its impacts on society and daily life.

4.1.2.1 Contextualizing Both Computing Content & SRC Issues in Current Socio-political Realities. Ms. Morris began the fireside chat by asking Tomas to read a couple of paragraphs in "Blown to Bits" about the countless amounts of data that everyone in the world was creating on a daily basis. He read, "So much disk storage is being produced every year that it could be used to record a page of information, every minute or two, about you and every other human being on earth. A remark made long ago can come back to haunt a political candidate…" [41, p. 3]. At this point, Ms. Morris paused and asked, "Is this true today?" Students agreed that political candidates' comments continue to be recorded and used against them. She asked students when the book was published, and they noted 2008 when most students were only five years old. Ms. Morris emphasized the continued applicability of this text to the present moment despite being over a decade old.

This initial reading led into the next section, regarding how bits are "exclusive and rivalrous." Ms. Morris asked students to share what they understood the terms "exclusive" and "rivalrous" to mean. She went over the idea that "non-exclusive" means that "all people have access" and that "non-rivalrous" means "I don't have any less because I gave something to you." She then reviewed how these two ideas reflect bits because, on the Internet, there are no restrictions to access to bits, and sharing bits with one another does not decrease the number of bits owned or used by the originator of those bits. The book cited a Thomas Jefferson quote: "If nature has made any one thing less susceptible than all others of exclusive property, it is the action of the thinking power called an idea, which an individual may exclusively possess as long as he keeps it to himself; but the moment it is divulged, it forces itself into the possession of every one, and the receiver cannot dispossess himself of it. Its peculiar character, too, is that no one possesses the less, because every other possesses the whole of it" [41 , p. 6].

Ms. Morris said "if you send me a copy of your file, you still have the original, and I have a copy. So why are we having a big fight with China about them infringing on intellectual property? In the US, we think we can control rights to ideas like with the copyright in this book – but China says 'they can come up with ideas and we can make copies of it.' Like designer clothing. They can make the same thing but with different fabric and they can make it faster. Is there anything wrong with copying an idea?" Camila said "maybe" and Yael replied, "yes…and no…"

Following this conversation about intellectual property, Ms. Morris then reviewed a section of the book entitled, "Naked in the Sunlight" that was all about the lack of privacy people have when they post personal information on the Internet, as well as public organizations that are currently involved in trying to defend peoples' privacy. Students laughed with Ms. Morris as she riffed on the section's title, joking that "we put our bits out there…" but then pondered carefully what the implications of this were as she added how people "post about their breakfast, lunch, and dinner. Some of you are perfectly okay with that. But thinking about privacy, take note of the organizations in the grey box. You may be able to use those references in your other classes." Ms. Morris

then welcomed student discussion about the free webcam sites listed in the book. Camila shared that she checked out the webcam in New York City Times Square and thought, "it was so weird. Did they know there was a 16-year-old watching?" Ms. Morris nodded her head and then added how there were CCTV in a lot of places, including the local chain coffee shop and the Metro. Students looked surprised and Michelle asked, "are those cameras in LA?!" Amelia replied from across the room, "yes! People are watching you!" Ms. Morris asked, "is this technology bad or good?" Tristan said that the problem was "the people, not the technology. José called out, "Murphy's Law!" and some students laughed. Ms. Morris replied with a scenario in which a robbery is caught on video with the CCTV cameras and how this could be useful for finding the robber, "but if someone hacks in…then what? How can we use technology to help create a healthy society?"

In this vignette, Ms. Morris grounds SRC reflections in a book discussion about how bits function as part of the Internet, as well as the lack of privacy people have in today's tech-infused world. This exploration of the text is rooted in considerations of **how computing is a form of power** and that those who design technology make decisions that ultimately result in *huge* impacts on peoples' everyday lives (e.g., through CCTV and webcams, etc.). While the book did not explore international power struggles over intellectual property on the Internet, Ms. Morris made **direct connections to the current socio-political issues students were familiar with** in regards to recent tensions between the US and China around intellectual property. In this way, she not only helped students understand computing content regarding how bits can be non-exclusive and non-rivalrous, while also exploring **ethical implications of freedom and ownership of ideas**. She made connections to **personal perspectives and identity** in the ways that youth engage with technology and relinquish privacy through uses of social media. Ms. Morris **directly asked students' opinions about whether such technology was "good or bad," opening space for consideration of social responsibility with computing.** Additionally, students were then welcomed to share about their exploration of the free webcams online and how they interpreted these creations in society at large. Students were all highly engaged in this text-based analysis while exploring these SRC issues with Ms. Morris.

4.2 Camila's Story: A Student's Engagement with SRC & Implications for SRC Teaching Practice

In addition to the classroom observations, student interviews also revealed how the discussions about SRC positively impacted their engagement with CS. Below we describe the school work and interview testimony of one specific student who participated in the cashless society debate described above. Camila was in the 11th grade at the time of initial data collection. Camila was a petite Latina with a quiet confidence that made her seem taller than her height. While the majority of students wore the traditional uniform enforced by the school, Camila wore her uniform in ways that signified her unique personality that she jokingly called "business casual" accented by glittering golden hi-tops. Unafraid of how others might judge her particular interests as "geeky," she proudly embraced her identity as an artist and her career plans to work in animation, sharing about her love of animation and gaming. In fact, during the summer after data collection, Camila was accepted into an internship where she learned new skills in computer animation and design. Some might describe Camila as an "old soul" in the ways she spoke her mind comfortably, regardless of whether she was with peers or adults, while willingly engaging in conversations about history, politics, art, or any current events. Everywhere she went, she carried drawing materials and kept a "bullet journal" in which she detailed—with beautifully illustrated words and drawings—the events of every day.

Camila initially enrolled in AP CSP because she was interested in learning how to create her own website as a way to feature and sell her art. Despite having negative experiences in a previous computing class—that spent an entire year just focusing on how to buy a computer based on its components—Camila decided that this AP CSP class might be different and prepare her with the skills needed to advance her art career. While she realized later that the focus was not web design, but instead on other topics such as the Internet, designing and building an app, etc., she shared, following her AP CSP experience, that she believed CS should be a mandatory course for all high school students because of its relevance and importance to our daily lives.

During this school year (2018-19), another SRC discussion in her AP CSP class was on net neutrality. Camila learned about what it was and about its repeal by the Republican presidential administration of that time. As she became aware of the social implications of ending net neutrality, especially on low-income communities including her own family, she became very passionate about the topic. This was especially true after her teacher introduced her to Internet co-creator Vint Cerf's 9 challenges described in the *Request For Comment 3271 The Internet is for Everyone* [42]. Following this, Camila prepared a two-minute flash talk for a class assignment regarding the Internet and its impact on people and society. The flash talk had to be accessible to family or friends with little to no CS knowledge. Camila decided to make a video about net neutrality.

In preparing her talk, Camila practiced reciting her speech about the repeal of net neutrality in front of her entire class. Below is what she shared:

> *Hello, my name is ____, and today we live in a great age of access and wealth in terms of information, and there is great economic opportunity here as well. And it can be quite prosperous. But now there is a new wave of the Internet and that is Net Neutrality. Net Neutrality itself is a regulation enforced by the FCC, or the Federal Communications Committee, which restricts the access of bits and packets, which are information that you send through the Internet as emails, videos, and photos, from being throttled when going through a bandwidth, or as it is referred to, a broadband, which is the capacity for how many bits and packages can be sent through to you or to someone else. Recently this just got repealed. And this means that these regulations are no longer in effect and this could cause very bad effects for the consumers and even the companies. As Vox stated—a news report channel and newspaper source—this could lead to higher prices for both the companies and consumers that could lead into a two-sided market for ISPs—Internet Service Providers—which gives you access to the Internet. Some people said that this could actually lead to more options for the consumers, resulting in data plans that could be more flexible and affordable. But these can also be very restrictive. Some say that this could actually further the divide between the lower class who aren't privileged to have the Internet because it would result in it being more expensive. And Wikipedia even predicts that this could lead to less competition and new innovations for services and platforms in the future.*

Seeking to make the topic accessible to people with little prior knowledge of computing, Camila broke down acronyms (such as the FCC), defined terms (including net neutrality and bits), and offered examples of these ideas for people to more easily understand (such as explaining that bits sent through the Internet could include the emails, videos, or photos that people share with each other on a regular basis). The ways Camila explained net neutrality showed that she understood the concept well.

Additionally, Camila demonstrated an understanding of net neutrality situated within the larger social and political contexts in which we live. Camila devoted half of her speech to breaking down how repealing net neutrality was not necessarily a good thing. She discussed how the price of the

Internet could increase. She then shared that if data plans decreased in cost, this might be at the expense of greater restrictions on what those packages offer. As a result, those who already have limited access to Wi-Fi and the Internet may be even further limited in their access to the world wide web, increasing the division between the rich and poor. She also described how the repeal of net neutrality may also result in decreasing competition between companies that, in turn, may decrease the development of new innovations for Internet service and platforms. While sharing all these details, Camila also made efforts to cite the sources she learned from when learning about net neutrality and the impact of its repeal.

While one might expect students to be able to engage with such computational concepts and practices in an AP CSP class—such as understanding CS concepts, communicating ideas and making clear arguments about computational artifacts, citing sources, etc.—Camila was not simply completing assignment requirements to fulfill schooling expectations. In fact, outside of class, Camila took time to turn these ideas into an animation piece that she posted on her personal YouTube channel. Building on her penchant for anime and the drawing skills she had learned outside of school, Camila created an animated video that friends, family, and anyone on the Internet could watch to learn about net neutrality and the impacts of its demise.

Over a year later, we interviewed Camila to learn about projects she worked on in her AP CSP class that she was proud of. Camila immediately referred to her net neutrality project without any prompting about socially responsible computing. Camila explained why this project was important to her:

> For my net neutrality video, at the time, I believe that the repeal of net neutrality was very recent. I was really passionate about that and I felt like it was political, but also really strongly related to computer science, and I really wanted to get across that now we don't have net neutrality, and how important that was. And I thought that the setting and my assignment for the class would perfectly fit in, especially since I was presenting to a bunch of my peers.

She drew a connection between CS and the larger political world, as well as the significance of informing her peers about this particular issue. She did not want this topic to go unnoticed, and really wanted her peers to understand how their rights might be affected by these Internet decisions. Also, it was significant that she used her unique voice, passions in animation, and artistic sense to share her perspectives about this issue.

Of particular note is the fact that, over a year later, Camila was able to clearly articulate the meaning of net neutrality and the social impacts of its repeal. In an interview, Camila explained:

> Net neutrality allows for bits to be sent at the same speed so that there's no discrimination against, like, Netflix. If Netflix's bits were slower and AT&T was telling them, "oh, if you pay us a bit more money we can get your bits sent at a faster speed." So it's creating this unfair system for people who don't have AT&T or people who don't have Internet at all. It's creating this unbalance and their websites are going to be slower and you won't be able to access some, and because the Internet is being increasingly involved in our lives, the fact that that's being taken away is really impactful. . . .[Net neutrality] creates an equal ground for you to access different websites and with it repealed it basically revokes that.

The clarity and passion with which Camila discussed this topic during the interview revealed how Camila was not learning about this topic simply for the sake of a grade on an assignment, but fully engaged with this computing concept because of its impact on our larger social world. As

such, she explained how it was important to share this with her friends and family outside of the classroom:

> My friends outside of the classroom are in different areas and interested in different things. And I was telling them how I was doing this project and they found out how I was doing this animation bit so I got to show [it to] them…and [to] a few of my family members as well…They were impressed with the animation but they were also, like, some of them are really into politics and so they were really interested in what I had uncovered with net neutrality and its repeal. And then my family got introduced to net neutrality so there was a lot explaining there, but it was good, it was fun.

When reflecting on all that she had learned in her computer science class and the benefits of that learning, Camila noted how her understanding shifted from thinking that "technology was just things I can use, like a tool, like a phone or computer" to now "realiz[ing] how much behind the scenes it is collecting data or how algorithms are working or how it can cause your feed to be like an echo chamber: like you're constantly putting out a specific thing and it keeps on spitting [that] back and not anything else." She continues saying "I think it is bad to live in an echo chamber, I think diversifying media and also opinions matter a lot in the grand scheme of things." In the long-run, Camila's engagement with computing deepened as she learned about issues in socially responsible computing and became compelled to share her voice and perspectives on these issues. As she explained, "I really liked the idea of how computer science impacts other fields and how it has this political-ness to it as well." Thus, integrating ethics and socially responsible computing into computer science class was something Camila found particularly valuable and engaging. Of course, not all of the students engaged with these discussions because of the "political-ness" of computing in today's world, but learning how computing has broader social and ethical implications in ways that made students accountable for their ideas, had a positive impact on almost all of the students' engagement in this CS classroom.

We share Camila's story to emphasize what learning engagement looks like with specific SRC teaching practices that she calls out in her story. More specifically, SRC teaching that: 1) contextualize CS concepts in the broader socio-political context, 2) illuminates the power dynamics associated with technology, 3) recognizes the role of personal identity and agency in one's computing creations/designs as well as everyday uses of technology, and 4) encourages youth to share their unique perspectives and understanding of computing with an SRC lens with others in the world around them in ways that support student agency and taking a stand.

4.3 The Teacher's Reflections on Key Considerations for Teaching Socially Responsible Computing

In an interview, Ms. Morris considered what pedagogical considerations were needed to effectively engage youth in socially responsible computing. Many of these ideas are highlighted in the classroom examples above and relate back to our definition of SRC (e.g., contextualizing computing education in the socio-political context, recognizing how computing is a form of power and the role computer scientists play in shaping our society, offering space for youth to practice taking a stand and personal agency, etc.). However, other practices that build the classroom community and culture necessary to engage in these conversations around ethics and social responsibility are not visible in a single class period, and take place over time. In what follows, we share the teacher's reflections on key considerations educators may want to consider in regards to pedagogy that can better support effective SRC learning in computing classrooms. These ideas connect closely to key features of SRC teaching, but are not exclusive to SRC. More specifically, Ms. Morris outlined

below the importance of: 1) knowing one's students and understanding students' interests to better contextualize SRC in socio-political issues that they care about; 2) developing a sense of shared authority and responsibility to one another so that it feels safer to share opinions and take a stand; 3) allowing youth to give voice to their ideas in ways that support practicing personal agency in computing; and 4) re-examining and/or reflecting of one's philosophy of teaching.

4.3.1 Understanding Students' Interests to Better Contextualize SRC in the Socio-Political Issues They Care About. Central to engaging students in SRC is understanding what students care about and want to know. Without this, it becomes nearly impossible to develop lessons and discussions that students feel compelled to engage in. Toward such ends, Ms. Morris does not start teaching content until she knows every student's name and until students learn each other's names. She seeks to understand the whole person rather than just what will get a student interested in programming. This requires learning about students' favorite subjects in school, activities outside of school, cultural interests (in music, films, literature, etc.), families and community cultural practices, and perspectives of the world. Such knowledge can then help guide teacher decisions about SRC subject matter, activities, and connections to students themselves.

As visible in the class debate, fireside chat, and Camila's learning example above, we observed how student engagement in CS frequently deepens when the content addresses issues of social responsibility and relates directly to the real social, cultural, and political worlds of our youth. This observation concurs with the body of research on the importance of culturally relevant pedagogy for student engagement and learning [43]. Engaging in socially responsible computing that introduces CS in relation to what is going on in the world not only motivates why students need to learn computing content (by showing its relevance) but also creates a context where students can share how they see the connections between learning and their lives. For the students in Ms. Morris's class this requires spanning across a wide range of issues from immigration, poverty, family relationships, policing in the community, to issues of social media and privacy. In all cases, Ms. Morris supported students' understanding by exploring the issues from all sides, as in the cashless society debate. The key for Ms. Morris was connecting computer science content to shared experiences, ideas, and knowledge that all students were familiar with (be it familiarity with the *raspado* man or CCTV cameras). Building one's knowledge of students' personal interests beyond the classroom strengthens the foundation for engaging youth with SRC.

4.3.2 Cultivating Shared Authority and Responsibility to Support Youth Agency in the Classroom. Because SRC contextualizes computing within an increasingly contentious socio-political world, it requires a strong classroom community—one that is both safe and brave. The classroom community and shared culture developed in a CS learning space is foundational to the depth with which teachers and students alike can delve into ideas of SRC and ethics. Ms. Morris describes this as a foundation of trust where community members "share both authority and responsibility to one another." Developing such a foundation is necessary for students to want to listen to each other's ideas and values, share their own, and feel the need to care about the impacts of their words, ideas, and actions. After all, it is often not easy to have discussions where issues of equity and justice are being addressed. In order to build this foundation, Ms. Morris upholds the idea that "your word is your bond." In such a space, students and teacher hold themselves accountable to being thoughtful about what is said and also respectfully listening to what is spoken because of the value and weight placed on words that mediate relationships, connection, and bonds. This, in turn, supports students feeling like they can trust that their voices are being heard and respected.

Ms. Morris, in interviews, also described how creating a humanizing space where students want to deeply engage with socially responsible computing also requires that teachers be "visibly human," i.e., share their own voices and humanity. This does not mean overstepping professional

boundaries of respectful teacher-student relationships. But rather, building on the foundation of shared authority and responsibility, teachers must model what it looks like to share one's voice and perspectives about issues that are important to them while closely listening to differing and/or opposing views. When educators talk about issues they care about, that passion can become contagious and motivate interest and engagement in learners. At the same time, this is most effective when done in ways that invite students to make connections to what *they* care about, to challenge them to see the significance of their positions both for individuals and for the larger society. Such moves embrace the whole person of both students and teacher through a willingness and bravery to show what one believes in and cares about.

Being "visibly human" also means owning up to one's mistakes, apologizing with grace, and showing that one can learn alongside students. This creates a safer and braver space in which students can discuss potentially difficult topics related to ethics and the political world in ways where it is okay to disagree with one another, and where differing opinions can be accepted. As Ms. Morris explained in interview: "Whatever it is that drives you as a human being, don't hide that. Don't hide it from your students. Show it. Let them see that you're human first, that you're a learner first and that everything else is second to that." At the same time, Ms. Morris recognized this was not as simple as educators simply sharing what they think or believe. Because of the power teachers wield in the classroom, students may feel compelled to agree or take on teachers' beliefs rather than developing their own. Thus, Ms. Morris believed it was important to always elicit students' ideas first with the goal of strengthening students' unique critical thinking, voice, and sense of agency before all else.

4.3.3 Giving Voice to Ideas in Support of Student Agency. Supporting student agency involves a process of creating space for students to share their ideas and perspectives in ways that teach them that they deserve their voices to be heard and to have a choice. As Ms. Morris explained in interview: "Everyone wants to have a choice in how they engage with the world or how they show a teacher what they know or think." Part of this involves welcoming students to create projects that connect to their interests and broader concerns in the community and world. Another aspect of this is reminding students that more choices become available to them when they learn and engage with the material at hand: the more they know, the more they can see the options that may be possible for themselves.

Of course, "choice" in society is complicated by the fact that, depending on our unique sociocultural and historical contexts as well as positionalities and identities, we may not always have equal access to opportunities and "choice." This is why open conversations about SRC are even more critical in the CS classroom so that students can understand how the choices they have are impacted by external factors, while also find ways to develop personal agency and the resources with which to challenge factors limiting their choices. All while recognizing that students do not have to fight alone, but can develop such agency with the support of community, peers, family, and teachers.

Hand-in-hand with a focus on choice is giving students opportunities to give voice to ideas, even when they are only half-formed. Ms. Morris emphasizes to students that she wants to "know what you *think* even if you don't *know*" which conveys respect for students' ideas-in-process that are often ignored in traditional school settings. She tries to encourage students to feel that they do not have to have a perfect answer, and that it is okay to feel uncomfortable and just put ideas out there—voicing ideas—without fearing judgment. This welcomes student opinions and perspectives on which new learning and content—such as that related to socially responsible computing—can build upon. And as students become comfortable sharing what they think with the teacher and their learning community, they practice personal agency in and with computing.

The ultimate goal of SRC pedagogy is to help students understand how power and technology interact in ways that differentially impact the world's diverse populations—in ways that commonly fall along race and class lines—while developing students' sense of agency with computing. This depends on teachers who can help students critically analyze and stand up to systems of power and privilege (that impact people differently by race, class, gender etc.)—including in the world of computer science. Yet, student agency depends on a firm foundation of classroom community/culture and the pedagogical practices such as those that Ms. Morris described and modelled. Similarly, the foundation of classroom community would eventually deteriorate and crumble without the values and sense of purpose of education that the teacher brings to her/his/their role to develop students' sense of agency.

4.3.4 Why Teach Socially Responsible Computing? Linking all of these pedagogical moves together was Ms. Morris's answer when we asked her why she felt it was important to teach socially responsible computing in her CS classes. She shared two main reasons. First, SRC is related to what she believes is the larger purpose of public education: to prepare youth to be critical thinkers, producers, and consumers. Students should be "able to not only read and add and subtract, but think critically and be able to tell the difference between fact and fiction and advertising and the news." She explained that "education in general is part of what we consider to be freedom and democracy. That's why we know how to read and we know how to write and express our thoughts and we know how to think critically to be an informed consumer, an informed citizen." And, more specifically, she saw it as her responsibility to prepare youth to have more agency by pushing them to engage critically with the world toward opening more pathways for learning while ensuring that past computing decisions that negatively impacted various individuals and communities are not repeated in the design of new innovations. With these emerging technologies, "it feels pressing…[CS] feels like a really good fit for something like, 'We're trying to figure out how we're going to digitize our world. This is an opportunity to not repeat the mistakes of the past.'"

Yet, even more than simply avoiding past mistakes, Ms. Morris pointed out that, with computing, we have an opportunity to think beyond only making money for a product towards creating something we can be "proud of." She believed that this greater value and meaning in computing creations would come from students "actively thinking about, 'How do we take into account different voices, marginalized groups, inequities that we've had?'" She noted that this, in particular, was important because "there is always new technology emerging and it has become so universal. As a result, technology is influencing new power and control structures that are digitizing inequities. Then these inequities become harder to see because they get encapsulated in the technology." Regardless of whether or not students pursue careers in CS, Ms. Morris believed all should be able to understand technology and computing's inner workings because otherwise we have situations like Mark Zuckerberg's 2018 Senate Hearing where the senators didn't seem to know what questions to ask of Zuckerberg nor have the vision with which to understand the unintended consequences of technological innovations. This is why law/regulations tend to be many steps behind advancements in computer science, but if students learn about these issues they may be able to shrink that distance.

Second, Ms. Morris described SRC as part of the "design problem" to also get students interested in CS. She noticed that more students engaged with CS when the content was connected to the larger social implications of the subject and work itself. Thus, she made connections to "the student's world" in ways that sought out *their* perspectives, experiences, and beliefs about technologies they were familiar with, from changes in Snapchat user policies to personal data collection with tools such as Alexa. Ms. Morris understood that "The problem with just doing, just teaching the content outside of a social context is that you leave out the people that are not in the

club. So they are already not seeing themselves in the club and you're teaching it in a way that isn't engaging for them in the first place." Thus, connecting SRC to one's personal philosophy of teaching can importantly facilitate implementing this work in the computing classroom.

5 DISCUSSION

Two years ago, a call in *ACM Communications* discussed the need for computer professionals to examine the impact and consequences of their work [22]. The examples cited were the possible deleterious effects of automation leading to loss of working-class jobs, the "friction-less sharing" on social media helping to promote fake news, and the possible connection of the smart phone to the rise in teen suicide and depression. Every year that has gone by, the stakes rise higher and higher. We believe it is critical to pay close attention to the work of prominent Black women researchers who have been pioneering critical examinations of algorithmic bias and machine learning (e.g., Buolamwini, Gebru, etc.), as well as what the designers and engineers at the Center for Humane Technology (www.humanetech.com) have warned us. More specifically, they point to how the tech industry's culture, techniques, and businesses have overwhelmed human nature through their addictive designs, but have also increased our collective abilities to address broader threats in society that will destroy our children's futures and democracy itself [44].

In this paper, we sought to describe how one teacher built student capacity with SRC so that, one day, they might be able to "do the steering" for the future, enact "civic courage" [45], and "take lead" in creating an inclusive world for social good not harm [34, p. 19]. In the examples above, we saw how students engaged deeply with CS as they considered the power that tech creators hold, explored whose experiences and perspectives were being denied and whose were being prioritized, challenged notions of CS neutrality, gave voice to their ideas about computing creations that were rooted in personal experience, and practiced taking a stand based on these beliefs. Importantly, SRC in their CS classroom created space to bring forward the experiences and perspectives that are currently missing from tech design tables (e.g., that of the *raspado* man), and gave youth an opportunity to consider how and why their voices matter in a world where computing is a form of power.

Indeed, SRC teaching and learning are critical components of using computing content and practices to analyze, critique, and innovate with a diverse set of life experiences, concerns, and priorities in mind, while supporting student agency to challenge the larger inequities that result from computing innovation and that exist in our schools and society. This means that considering issues of SRC leads to a rethinking of the purpose of schooling. Our research shows the depth of social responsibility and engagement that youth feel when given the opportunity to consider computing within its socio-political context [46, 47]. And, when we describe how CS teacher, Ms. Morris, says in multiple ways to her students "I want to know **what you think**" she is conveying respect for students' ideas and their minds. And, by doing so, she and other educators like her are showing how SRC teaching can counter education that is focused on the status quo such as "teaching to the test" and de-facto silencing—that which youth have been socialized to believe is "schooling."

This is why we believe SRC can support justice-centered computing efforts. SRC, as we saw come to life in Ms. Morris's AP CSP classroom, continues the work of "liberatory" and "abolitionist" education. SRC furthers liberatory education by supporting youth to consider how computing shapes opportunities (or the lack thereof) in their communities, while giving them the tools to address inequality [35]. SRC facilitates student agency, encouraging youth to learn about the world around them so that they do not internalize systemic inequalities and racism toward self-doubt or self-blame [48, p. 73–74]. An SRC classroom that focuses on student agency also supports an abolitionist educational philosophy delineating the difference between what educator and author

Dr. Bettina Love describes as either surviving or thriving [49, p. 11]. Abolitionist education challenges the current "educational survival complex" where "teaching to the test" prepares youth only to survive. Instead, abolitionist education provides youth with "homeplaces" where they can thrive. Love describes these homeplaces as "protect[ing] my humanity, my dignity, and not only told me I was powerful but taught me how to be powerful. These abolitionist spaces loved Blackness and understood that, to be dark, you must give this world hell to survive" [49, p. 68]. SRC upholds this same goal of providing students with real strategies to resist dehumanization in computing education, both within and outside of schools, so that they can thrive wherever they go in our technology-shaped world.

We believe that these examples of SRC teaching, learning, and pedagogical reflections help continue the dialogue begun by literature cited earlier in this paper [e.g., 12, 13, 18, 25, 26, 28, etc.], as well as curricular and professional development efforts both in and out of school. From #ethicalCS resources for in-school teachers, to out-of-school programs like CompuGirls, Diva Girls, Hack the Hood, Digital Nest, etc., important commitments are being made to strengthen the connection between students' experiences in our complex socio-political/cultural contexts and computing.

6 CONCLUSION

We conclude writing this article during a time when democracy is teetering on an edge. Racism is on the rise, schooling continues to reveal and perpetuate growing inequality, and we have all been called upon to examine and change our teams', organizations', institutions', and communities' systems, norms, and behaviors toward racial and social justice. At a time when we witnessed students straining to learn and stay connected through remote education, when students of color are battling all forms of inequality, when our democratic right to decide who will lead our country is under attack, we must consider how we can best prepare youth to steer us toward a more inclusive and just world. We believe that this should, now more than ever, require deep engagement with socially responsible computing in every CS classroom, with liberatory and abolitionist pedagogies serving as a compass for computing education.

There is no easy path toward these goals, however. We need more professional development supports that, like Exploring Computer Science, help teachers "interrogate their own understanding of the system in which they work; a system that continues to create barriers for students of color" toward "embrac[ing] their active role in creating social change" [50, p. 7]. We also need more administrators supporting educators in this difficult work, and policymakers supporting a serious look at the social impacts of computing in CS classrooms. Applying SRC to current CS classrooms can be challenging because many educational systems pressure teachers to maintain positions of "neutrality" around political issues [e.g., 50], and educators are teaching in an increasingly hostile climate for addressing issues of race and inequality. Furthermore, many computing educators themselves received more traditional CS education and professional development that failed to consider issues related to SRC. In order for these justice-centered SRC efforts to succeed on a broad scale, we not only need curricula that attend to issues of ethics and social responsibility, power and privilege, but also: 1) professional development that helps educators understand and integrate CS knowledge with subject material that they have long considered to be outside their scope, from the social sciences or humanities; 2) professional development that supports educators contextualizing CS content/skills in the real issues of community, power, and resistance that students care about; and 3) support for educators and their school leaders to engage in deeper reflection on their own perceptions of culture, social justice, student voice, and location in the larger socio-political context [51]. Those who shape CS education need to see why we need more youth and technologists who are aware of and care about the experiences of the *raspado* man and

other groups of people who are not now being considered during the tech design process in our country's computing hubs.

In his parting letter written before his death, civil rights leader and statesman John Lewis made an appeal for people in this country to understand that "Democracy is not a state, but an act and each generation must do its part" [52]. We believe that socially responsible computing, as described in this article, is a way that CS educators can do their part to challenge the systemic racism and inequality we have been called upon to dismantle both in our schools and the larger field of computing. And we believe this shift toward a more just and better world is possible in computing education when we prepare our students with the sense of agency and skills to also do their part.

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