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Learning, Identity, and Power: Tensions and Possibilities in Equity-Oriented Computer
Science Education

By

Sepehr Vakil

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in the

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University of California, Berkeley

Committee in charge:

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Professor Tapan Parikh

Summer 2016

Learning, Identity, and Power: Tensions and Possibilities in Equity-Oriented Computer
Science Education

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By Sepehr Vakil

Doctor of Philosophy in Education
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Abstract:

Computer science is rapidly emerging as a distinct feature of K-12 public education in the United States. Calls to expand computer science education are often linked to equity and diversity concerns around expanding access to girls and historically underrepresented students of color. In this dissertation, I argue that in addition to expanding access to the field, equity-oriented researchers and educators must also attend to how dominant discourses and ideologies are shaping the character of computer science education. Through a mixed-methods study combining ethnographic and social design experiment approaches, I examine (a) the current state of computer science education at a large, racially diverse high school in the San Francisco Bay Area, and (b) possibilities and tensions for computer science learning rooted in critical pedagogy and social justice traditions. The dissertation is organized as three distinct articles. Chapter 2 reviews extant literature in the field and advances a framework for computer science education rooted in sociopolitical theorizations of equity. In this chapter I also provide a case study and introduction to the Computer Science and Technology (CST) Academy, where studies presented in the next two articles are also based. Chapters 3 and 4 report on a social design experiment that provided students an opportunity to create socially relevant technology that addressed educational equity issues in their school. In Chapter 3, I draw on student surveys, artifacts (final project portfolios, student sketches, memos, presentations, and posters), artifact-based interviews, and field notes, to analyze the complex interplay between students' social identities and disciplinary identities in computer science. I argue that the kinds of learning opportunities provided in computer science classrooms have significant implications for how students come to view their own social identities and futures within the discipline. In Chapter 4, drawing upon video data of a particular episode from the class, I argue that a conflict between a white male student and a Black female student was rooted in a lack of trust and solidarity between the students. The conflict and other moments of tension between students limited opportunities for collective learning and action, and more critically, led to the Black student and other students of color experiencing discomfort and feeling violated. Ultimately, I argue that in addition to expanding curriculum to include culturally relevant or social justice topics, equity-oriented approaches must also attend to the quality of student relationships, particularly in racially diverse contexts. Taken together, the articles in this dissertation contribute to a vision of computer science education rooted in educational equity and social justice traditions. This research has implications for the design of computer science learning contexts that aim to prepare young people to address the increasingly complex local, global, environmental, human rights and sociopolitical issues of the 21st century.

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Chapter 1: Introduction

There is a growing movement in the field of education to broaden participation in computing, computer science, and technology-related disciplines. What some have called the “Learn to Code Movement” may be exemplified by any number of recent developments: the CS10K initiative funded by the National Science Foundation (NSF) to train and place 10,000 computer science (CS) teachers in 10,000 schools, the work of non-profits like Code.org, whose mission is to expand CS learning opportunities for women and underrepresented minorities, and the calls of numerous political leaders such as President Obama and former New York City Mayor Michael Bloomberg, to prioritize computer science learning opportunities in schools. The movement around “coding” has also attracted the support of civil rights leaders like Jesse Jackson, as well as sports celebrities such as NBA player Chris Bosh. It has even been glamorized through popular media such as the HBO series *Silicon Valley*, which humorously depicts the life of young computer programmers living in the San Francisco Bay Area. However, despite this surge of interest, computer science as a distinct discipline is still a relatively new phenomenon in education research, practice, and policy. As a casual example, consider that while often (and correctly) viewed as integral to engineering and technology-related disciplines, there is no “C” in “STEM” (science, technology, engineering, and mathematics) education. This newcomer status raises important questions as well as opportunities, especially from an educational equity and social justice standpoint. What are the broader goals and purposes of introducing computer science into the public school curriculum? What kinds of shifts and changes in curriculum may result from adding computer science? And importantly, whose interests are ultimately being served? At its core, this dissertation explores these questions at Bay Prep, a large, urban high school in the San Francisco Bay Area. Through a mixed-methods approach, I examined the current state of CS education at Bay Prep. I also collaborated with a CS high school teacher to explore new possibilities for CS pedagogy and curriculum rooted in equity and social justice principles.

A Brief Biographical Note

In addition to theoretical and scholarly perspectives learned over the past several years through coursework as a graduate student, participation in research groups, and my teaching and organizing work in the community, this dissertation draws inspiration from my own specific set of personal and life experiences. I share a brief autobiographical note below with the purpose of locating this dissertation within the broader set of experiences and concerns that motivate my interest in questions of equity and social justice in STEM education.

A few years before I started graduate school, I came across a short book on my parents’ bookshelf by Iranian social critic and teacher Samad Behrangi entitled “The Little Black Fish.” (Behrangi, 1987) This is a wondrous story about the interrelatedness of self-discovery, awareness, and complex sociopolitical relations in Iran. As an intellectual, Samad Behrangi worked tirelessly to portray the inhumanity in the conditions shaping the lives of poor, urban children in Azerbaijan-Iran, where both of my parents are originally from. As a teacher, he advanced a philosophy that espoused

engaging children, even young children, in learning about the world in ways that embrace both the beauty and the struggle, both the wonder and the tragedy of life; and ultimately to plant seeds of awakening and dissent amongst the most oppressed of Iranian society. During my graduate studies, I came across the works of critical pedagogues such as bell hooks and Paulo Freire; within which I found both a powerful language as well as a theory of learning and teaching that was first and foremost anchored in a liberatory vision. My research and professional interests began here, guided by a way to feel and think about the world that I have learned from my teachers, Behrangi, hooks, and Freire, among others.

My parents also introduced me to the sciences. In the years following the Islamic Revolution and before immigrating to the United States, my father was a high school math teacher in a small village outside of Tehran. His decision to teach was inspired both by his love of mathematics, but more importantly by his desire to empower marginalized members of his country. He saw these activities as emblematic of his love for his nation and his ongoing commitment to the freedom of the most oppressed in Iranian society. My mother, drawing on her interest in the sciences, volunteered in a hospital where she would care for hundreds of wounded soldiers during the Iran-Iraq war. Many of the soldiers my mother cared for were injured by chemical weapons supplied to Saddam Hussein by the United States (McNaugher, 1990), and delivered with the aid of advanced satellite technologies (Segal, 1988).

Both of my parents went on to earn advanced degrees in their fields. My father is now a professor of mathematics at St. Cloud State University, and my mother is a physician and a medical researcher in Phoenix, Arizona. Following in their footsteps, I studied electrical engineering at UCLA from 2001 to 2007. The September 11 attacks occurred the summer before I entered UCLA as a freshman, and during the spring of my second year, the United States invaded Iraq. During my years as a student, I developed an interest in educational issues through volunteering with various STEM (science, technology, engineering, and mathematics) outreach programs such as *Engineers Without Borders*. In addition to these activities and my coursework, I was also developing an interest in political activism, and began participating in the Iraq-war protests on campus. Perhaps because of the example my parents had provided, I held an intuitive understanding that what was happening around me in the world was deeply connected to what I was learning and doing in the engineering classroom. However, at the time, the connections — analytical, intellectual, and political — were mostly vague. This was true despite the centrality of technology in the war effort, and the forceful influence of the military-industrial complex on the cultural and economic life of Los Angeles, and upon the intellectual life of students and researchers at UCLA.

In many ways, my graduate studies at Berkeley culminating in this dissertation have offered me the opportunity to revisit and reflect deeply on the relationships between STEM, education, and questions of equity and social justice. I have also had the opportunity to think more carefully about my identity as a scholar of Iranian descent doing educational research within urban communities of color. And about the formidable and evasive, yet urgently necessary questions regarding the relationships between liberation and knowledge, freedom and learning, social justice and schooling. This dissertation reflects the culmination, a very temporary culmination, of my thinking on these issues.

Theoretical Perspectives

This dissertation is written as three distinct articles. While each article draws upon distinct theoretical perspectives, there is also a core set of interlocking ideas that underlies the entire dissertation. Each of these areas will be addressed separately below.

The (Racialized) Politics of Technology

A fundamental assumption underlying the articles in this dissertation is that scientific and technological knowledge, as well as the technological artifacts made possible and designed using this knowledge, are inherently cultural *and* political in nature. In other words, technological artifacts represent distinct sets of human values, and these values have implications for power relations in the world. This perspective is informed by several intellectual traditions, including (a) the philosophy of science and technology often organized around Science and Technology Studies (STS) on university campuses, (b) interdisciplinary work in Digital media studies and the Digital humanities, (c) sociocultural and sociopolitical perspectives in the learning sciences, as well as (d) the work of activists and cultural critics of technology.

Of course, a full review of these perspectives and traditions (and their internal conflicts and debates) would be beyond the scope of this introduction. However, given the current condition of the world which is constantly embroiled in technologically enabled warfare and destruction, I do want to pay tribute to the history of mathematicians, physicists and other scientists who have taken stances against the use of their disciplines for war-related technological production. Perhaps most notable in this history is the Russell-Einstein manifesto written in 1955, which was a passionate statement in the post war era urging the scientific community to refrain from participating in the development and manufacturing of technologies of mass destruction (Einstein, 1955). This manifesto and similar documents are critical for calling to attention the potentially harmful ways scientific knowledge can be used towards various ends.

Fast-forwarding a few decades, and moving across the Atlantic to the United States, we encounter African-American poet, playwright, and activist Amiri Baraka's influential essay "Technology and Ethos," which called for a critical examination and exploration of technology from a Black perspective (Baraka, 1965). In this short essay, he contrasts what he deems the immoral technological developments of the West, to alternative and emancipatory possibilities for technological development rooted in traditions of Black cultural expression. Underlying Baraka's call for resisting Western technology while also exploring alternative possibilities lies a conceptualization of technology and technical artifacts in which culture, and in particular race, play a central role in shaping not only the applications of, but also the development of, technological tools and artifacts.

Baraka's commentary on ethics and technology, particularly as it connects to issues of race and racialization, brings to mind other theorists of technology such as Langdon Winner, Hans Klein, Evelyn Hammonds, and Rayvon Fouche, among others. In articulating his theory of "black vernacular technological creativity" and how technology is "raced" or racialized, Fouche examines Winner's well-known article "Do Artifacts Have Politics?," and specifically Winner's description of how city planner

Robert Moses designed overpasses in Long Island in ways explicitly intended to exclude certain “undesirable” segments of the population (Fouché, 2006; Winner, 1986). The overpasses were constructed at a height designed to keep buses (primarily utilized by the poor and African-American population of the city) off the road, thereby exemplifying how “one man was able to embed his racial ideology within these technological artifacts, thereby racializing them during their construction and use.” (Fouché, 2006, p. 650)

Critical Theory and Critical Pedagogy

Keeping these perspectives in mind, I now consider another set of ideas that are central to this dissertation and that are specific to the field of education. Broadly speaking, the tradition of critical theory and critical pedagogy in educational research and practice is the “home base” from which my research and teaching departs, and ultimately returns.

Within educational research in the United States, there has been a substantive and ongoing dialogue with critical social theory frameworks and values. This history is often traced back to early 20th century philosopher and pragmatist John Dewey, who drew upon critical philosophy and social theory to outline a vision for progressive education premised on the notion that social change should be the goal of scientific inquiry (Popkewitz & Fendler, 1999; Leonardo, 2004). Scholars rooted in the Marxist tradition, particularly those within the Frankfurt School, were known for their critiques of capitalism, domination, and for their overarching commitment to social justice (Anyon, 2008; Calhoun, 1995). Beginning in the 1970s, educational scholars in the United States began to substantively draw upon Marxist frameworks, with notable contributions including *Schooling in Capitalist America* (Bowles & Gintis, 1976) and *Ideology and Curriculum* (Apple, 1979). These works mark the beginning of critical social theory applications to educational theory, and have made significant contributions to our understandings around the ways schools function to socialize students to know their place in a capitalist society, thereby working to reproduce and maintain social and economic inequalities (Gottesman, 2010).

However, perhaps most popular are the educational theories of Brazilian philosopher and social activist Paulo Freire, whose seminal book *Pedagogy of the Oppressed* (2000) laid the groundwork for what Aronowitz and Giroux (2003) later called “critical pedagogy.” It is important to note that Freire’s engagement with critical theory, though also rooted in Marxist thought, marks a departure from how critical theory had been used by other educational theorists. While critical theory had been primarily incorporated into educational thought through structural analyses of schools and the ways in which they reproduce the social order, Freire drew from Marx’s earlier writings that emphasized humanism, agency, and emancipation, concepts that are at the heart of contemporary educational programs predicated on liberatory and radical education (Gottesman, 2010). Indeed, it is with critical pedagogy that critical social theory began its most immediate contact with educational research, especially research that dealt directly with issues of practice. Educational and race scholar Leonardo (2004) argues that it is ultimately Freire’s work that “promotes ideology critique, an analysis of culture, attention to discourse, and a recasting of the teacher as an intellectual or cultural worker” (Leonardo, 2004, p. 11). Since Freire, there has been an active and lively conversation

amongst both educational theorists and practitioners around how to combine critical social theory values with pedagogical and curricular approaches, specifically through an emphasis on student agency in the face of oppressive social and economic conditions (e.g., Giroux, 1983; McLaren, 1994; Duncan-Andrade & Morrell, 2008; Stanley, 1992). Critical pedagogy's emphasis on agency in the face of oppression provides teachers and educational researchers committed to social justice with conceptual tools that link the everyday work of teaching and learning in classrooms to a collective struggle against what feminist scholar bell hooks has described as a "racist, sexist, capitalist state." (hooks, 2000, p. 4)

Therefore, though not without its own contradictions and internal debates (e.g., Ellsworth, 1989), there has been a sustained and robust tradition amongst educators and educational theorists to engage with the ideas, values, and political commitments of critical social theorists. However, while there is no shortage of educational studies that draw from critical theory and critical pedagogy traditions, less common are studies that engage critical traditions while simultaneously attending to issues of student learning, cognition, and identity.

Learning Sciences & Critical Pedagogies: Tensions and Possibilities

Transformative learning and the associated identity development processes are central to the studies described in this dissertation, and raise another relevant theoretical influence crucial to this dissertation – sociocultural perspectives in the learning sciences. Drawing on diverse fields ranging from cognitive science to cultural anthropology to computer science, learning sciences researchers work towards deepening our understanding of learning, conceptualized as an integral part of the broader effort to improve educational theory and *practice*. This dissertation draws in particular upon sociocultural perspectives in the learning sciences that focus on the relationship between culture and cognition (Cole, 1996; Cole & Engeström, 2007; Rogoff, 2003; Rogoff & Lave, 1984; Saxe, 1999; Scribner & Cole, 1981; Vygotsky, 1978), how contexts shape learning (Gutierrez, 1993), and the role of identity and agency in the learning process (Barton, 1998; Nasir, 2002). Sociocultural perspectives on learning have also taken into account issues of equity, race, and power, and have tended to prioritize the experiences of non-dominant groups (Nasir & Hand, 2006).

Nevertheless, the focus on improving practice *despite* inequality, oppression and racism in society creates an analytical tension between much of the critical scholarship discussed above and the goals and purposes of the learning sciences community. While critical scholarship has made extremely valuable contributions to our collective understanding of oppression as it relates to education, learning scientists who are committed to improving educational *practice* have traditionally looked elsewhere for theoretical and methodological insights with which to inform the design and study of learning environments. A common complaint of learning scientists has been the tendency of critical scholarship to dwell on "the problem" without sufficiently considering, imagining or working towards new possibilities for educational practice. However, the reverse is also true. Learning sciences research, while having contributed immensely to our understanding of cognition, learning, and identity, too rarely considers how these

processes are linked to ideology, power, and domination (Lipman & Hursh, 2007; Anyon, 2008; Apple, 2013).

However, there is an increasing overlap between learning sciences and critical research in education (Booker, Vossoughi, & Hooper, 2014). For example, a forthcoming volume titled *Power and Privilege in the Learning Sciences: Critical and Socio-cultural Theories of Learning* brings critical theory scholars together with learning scientists to more deeply examine tensions and possibilities across their respective traditions (Esmonde & Booker, in press). For example, a chapter in the book by Vossoughi and Gutierrez argues that critical pedagogy can benefit from a deeper engagement with Vygotsky's theories of socially mediated learning and development, and conversely, that sociocultural learning theory can benefit from a more rigorous treatment of the political nature of teaching and learning (Vossoughi & Gutierrez, in press).

From this perspective, the chapters in this dissertation draw both from learning sciences and critical perspectives in educational research. Critical pedagogical and sociocultural perspectives on teaching and learning together informed the design and implementation of the design aspect of this dissertation. My analysis similarly reflects theoretical commitments from both traditions. For example, the sociopolitical framework for CS education articulated in Chapter 2 rigorously engages the broader purposes and ideologies of dominant forms of CS education, a hallmark of critical educational scholarship. Within that, I also consider concerns specific to teaching and learning, student identity, and student relationships, which are staples of sociocultural learning theory.

Road Map of the Dissertation

The chapters that follow this introduction are written as three separate articles. In the first article (Chapter 2), I investigate two questions: (1) What are the similarities and differences between mainstream and sociopolitical approaches to equity in CS education? and (2) In what ways does a sociopolitical framework for CS education illuminate tensions in equity-oriented CS learning environments? To answer the first research question, I review extant CS education research and present a framework for research, practice, and policy rooted in sociopolitical theorizations of equity. The goal of this framework is to contrast what currently characterizes mainstream CS research and practice with an alternative vision for CS education rooted in social justice principles. In articulating a vision for what I call a sociopolitical approach to CS education, I draw upon multiple sources: (a) equity-oriented approaches in mathematics and science education (e.g., Bang & Medin, 2010; Brown, Reveles, & Kelly, 2005; Secada, 1989; Tate, 2001; Varles, Martin, & Kane, 2012) (b) the perspectives of computer scientists who highlight the moral and political dimensions of their discipline (e.g., Rogaway, 2015); as well as (c) my own experiences of teaching and researching CS over the past several years (Vakil, 2014; Van Wart, Vakil, & Parikh, 2014). To answer the second question, I introduce the Computer Science and Technology (CST) academy at Bay Prep, and its director and primary teacher, Mr. Mayson, whom I have been collaborating with in multiple capacities over the past several years. I utilize a sociopolitical framework to analyze the CST academy from an equity perspective. In this way, the article aims to locate the dissertation theoretically. Doing so also introduces and provides context for the CST academy, in which the studies presented in the next two articles are also based.

Chapters 3 and 4 report on a social design experiment (Gutierrez & Vossoughi, 2010) I conducted in the CST academy in collaboration with Mr. Mayson. Chapter 3 describes the DEP (Designing for Equity at Prep) curriculum that lies at the heart of the social design experiment, which we implemented in two of Mr. Mayson's 10th grade Introduction to Computer Science classes. The curriculum frames computer science concepts and practices as being relevant to educational equity issues impacting Bay Prep. While working in groups and provided with the freedom to choose issues they felt were important to them, students tackled a wide-ranging set of issues. These issues included (but were not limited to) the following: (a) the underrepresentation of students of color in advanced courses and academies at Prep, (b) the quality of school lunches, (c) gender inequities, and (d) school climate.

After providing an overview of student experiences resulting from the DEP curriculum, Chapter 3 provides in-depth case studies of two students and their projects, focusing specifically on how students' sociopolitical identities influenced and were influenced by the process of creating socially relevant technology. The purpose of the case studies is to dig deeper into the role of identity processes in CS learning environments. Specifically, my research questions are: What *kinds* of CS identity become possible in an equity-oriented learning environment? How do these identities exist in relation to other identities a student may have, such as their sociopolitical or racialized identities? The article ultimately makes the argument that the goals of equity-oriented CS education research and practice must move beyond simply expanding CS learning opportunities to girls and historically underrepresented students of color, and should include educational approaches (such as DEP) which honor and recognize students' multiple identities and interests. From this perspective, an equity agenda in CS education entails expanding who has access to the domain as well as the kinds of learning and practices that are viewed as legitimate within CS courses and pathways.

Chapter 4, also based on the social design experiment described in Chapter 3, addresses challenges in implementing this kind of equity-oriented pedagogy, particularly in racially diverse learning environments like the CST. The specific research question motivating the study emerged from my observations and experiences that highlighted racial tensions in the classroom. In an attempt to better understand these tensions and their implications for student experiences in the classroom, my study investigates the following research question: How do inter-racial student relationships mediate classroom interactions and student experiences in the context of an equity-oriented CS learning environment? Drawing upon video data of a particular episode from the class, I argue that a conflict between a white male student and a Black female student was rooted in a lack of trust and solidarity between the students. The conflict resulted in missed opportunities for collective learning and action, and more critically, led to the Black student and other students of color in the class experiencing discomfort and feeling violated. In this sense, a pedagogy aiming to empower and inspire fell short of its intended aims. Ultimately, this is a critique of the DEP unit as well as of my own pedagogical methods, as well as of other equity-oriented pedagogical approaches that may address potentially sensitive topics without attending sufficiently to the nature of student identities and relationships in the classroom. Drawing upon a recently developed construct we call *politicized trust* (Vakil, McKinney de Royston, Nasir, & Kirshner, 2016), this article challenges STEM

education generally and equity-oriented CS education in particular, to prioritize student relationships in the design and actualization of all learning environments.

In the final chapter of the dissertation (Chapter 5), I provide a brief conclusion to the dissertation. I step back to reflect on the three articles as a cohesive set. I begin with a short summary that captures the story told by the articles when taken together. I reflect on implications for theory and practice – sweeping a broad range of educational issues including curriculum, pedagogy, the dynamic role of student identity and student relationships in educational settings, and philosophical and political questions of social justice in CS education in particular, and STEM education more generally. I also include a discussion of the limitations for the dissertation as a whole, as well as for each of the three articles individually. I discuss limitations specific to the design of the DEP unit, my own pedagogical practices, as well as to analytical blind spots in my analysis and findings. Finally, I end the conclusion by providing an update of my role and involvement in the CST academy moving forward, and suggestions for future research in areas related to equity and social justice in computer science education.

Chapter 2: Towards a Sociopolitical Approach to Computer Science Education

[Bay Prep] will be a resource for Silicon Valley...We will stop the killing! We will stop the violence! We can! We will! We must!!....The goal is Intel! The goal is Google! The goal is Facebook!!

These are the words of civil rights activist Jesse Jackson, during a recent speech he delivered to students at Bay Prep High School¹ (known locally as “Prep”), a large, racially diverse urban school. His visit to the school followed a recent announcement that Intel would donate \$5 million to Prep and another school in the district, a deal that he had worked behind the scenes to help broker, and one that reflects a broader pattern of Silicon Valley’s involvement with public schools in the Bay Area. The speech, delivered in an auditorium filled with captive high school students attending a mandatory school assembly, reflects two common narratives regarding computer science (CS) education and urban students. First, it is indicative of a growing movement to engage youth in coding, and broaden participation in CS to include students of color, who have historically been underrepresented in STEM (science, technology, engineering, and mathematics) fields (Bang & Medin, 2010). Second, the speech draws upon several commonly-used rationalizations that frame the importance of learning CS in terms of (a) its utility in helping students gain employment at high profile Silicon Valley companies (“The goal is Intel! The goal is Google! ...”), and (b) an imagined future relationship with Silicon Valley that would presumably benefit an urban school/community (“[Prep] will be a resource for Silicon Valley”). Whereas the dominant ideological position on diversity, technology, and urban youth may view these narratives as complementary and part of an overall liberal march towards equality, an educational equity and social justice lens sees critical contradictions in narratives that purport to be simultaneously beneficial for marginalized communities/students as well as to large multi-national corporations and their interests. In this paper, drawing on related approaches in mathematics and science education (Bang, Warren, Rosebery, & Medin, 2013; Barton, 1998; Barton, Tan, & Rivet, 2008; Esmonde, 2009; Gutstein, 2006; Martin, 2000), I argue these tensions have not

¹ The name of the city, the school, academies and all interviewee names are pseudonyms.

been sufficiently scrutinized in existing CS education research and practice. I advance a theoretical framework rooted in sociopolitical conceptualizations of equity that I argue is necessary in order for CS education research, policy, and practice to realize educational and social justice aims. To illustrate one potential application of this framework, I elaborate the distinct components of the framework by interweaving a critical case study of the Computer Science and Technology (CST) academy at Prep, which is the (supposed) beneficiary of the deal with Intel, and the site of my dissertation research. Ultimately, I argue that a sociopolitical lens on equity in CS education enables us to examine tensions and possibilities in equity-oriented CS education research and practice. As I will demonstrate through the case study of the CST academy, the framework pushes us to consider the contradictions and limitations of CS learning environments, and importantly, to imagine new possibilities for transformative computer science curriculum and pedagogy. In the case of the CST academy, these tensions emerge where important equity goals of expanding robust learning opportunities in computer science to all students coincide with ideological and political goals that are not necessarily aligned with the best interests of students and communities of color.

Prior Research²

The framing of diversity in CS presented at the beginning of this paper is neither idiosyncratic nor uncommon, but rather reflects dominant educational discourses around technology, diversity, and race in the United States. Despite the ways the discourses connect to broader social issues, scholars have largely ignored questions around the purposes, ideologies, and underlying values of CS education. Equity-oriented research in CS education has tended to focus on illuminating structural issues preventing greater participation by girls and students of color (Barron, 2004; Margolis, Estrella, Goode, Jellison-Holme, & Nao, 2008; Margolis & Fisher, 2002; Ericson, Guzdial, & Biggers, 2007), developing new tools, platforms or learning environments that can scaffold the learning of complex computational concepts (Kelleher & Pausch, 2005; Maloney, Peppler, Kafai, Resnick, & Rusk, 2008), and more recently, sociocultural studies that explore the role of identity and stereotypes in mediating interest, participation, and engagement with CS and other technology-related fields (Cheryan, Master, & Meltzoff, 2015; Cheryan, Plaut, Handron, & Hudson, 2013; Fields & Enyedy, 2013; Kafai, Fields, & Burke, 2010). While building upon this body of work, I argue these studies take the broader sociopolitical context of CS education for granted, and in doing so, leave unexamined economic and ideological forces motivating calls for CS education that are not - and do not avow to be - rooted in commitments to marginalized communities or their interests.

In other STEM fields, one way scholars have examined tensions in equity-oriented interventions is through an interest convergence lens (Bell, 1979). For example, race and mathematics education scholar Danny Martin (2009) has written:

These statements also help demonstrate that workforce needs and the threat of demographic changes, not moral compunction, are often what drive increased

² Segments of the text in this section are adapted from a recent chapter I co-wrote with Professor Shirin Vossoughi (Vossoughi & Vakil, in press).

attention to underrepresentation issues in mathematics and science. As such, calls for increased participation by African American, Latino, and Native American students can be partly explained by critical race scholar Derrick Bell's (1992) concept of interest convergence. As explained by Delgado (2002), interest convergence suggests that "gains for blacks [and other minority groups] coincide with white self-interest and materialize at times when elite groups need a breakthrough for African Americans [and other minority groups], usually for the sake of world appearances or the imperatives of international competition" (p. 371). (p. 310)

The convergence of interests between equity narratives and the discourse of STEM education as tied to U.S. economic and military power—is partly a result of the growing national emphasis on STEM education, as well as shifts in funding that both incentivize STEM-oriented research and encourage particular approaches to equity (i.e. "broadening participation") as tied to workforce development and global economic competitiveness.

From this perspective, the increasingly ubiquitous equity narrative in STEM education exemplifies what Walter Seceda (1989) refers to as an "enlightened self-interest," and fails to prioritize the interests of underrepresented students and communities themselves. In this view, STEM careers may be more representative of a diverse population, but the fundamental grounding of those careers in capitalist and militarist social relations remain unchanged. For example, expanding the pool of qualified domestic labor so that U.S. technological innovation can lead markets does not disrupt the exploitation of workers that often accompanies the mass production of technological innovations, nor does it address the ways these technologies may be used to carry out new forms of surveillance and control (Giroux, 2005).

In this paper, I build upon these perspectives to advance a framework that outlines an approach to CS education rooted in sociopolitical theorizations of equity. The framework may be useful for researchers and educators designing and studying CS learning environments, as well as for policy makers who may want to understand the equity consequences of new CS education reforms in particular communities. While elaborating the components of the framework, I illustrate how it may be applied by offering a case study of the CST academy mentioned previously. I will demonstrate how a sociopolitical lens on CS education allows us to grapple with ways in which learning environments such as the CST academy are genuinely aligned with social justice principles, and the ways in which they are not. To summarize, I investigate the following research questions in this paper:

- 1) What are similarities and differences between mainstream and sociopolitical approaches to equity in CS education?
- 2) In what ways does a sociopolitical framework for CS education illuminate tensions in equity-oriented CS learning environments?

Methodological Approach

I describe the methodology for this study in two parts. First, I will describe the analytical process and series of related teaching and research experiences that contributed to the development of the theoretical framework that serves as the foundation for the empirical case study I present in this paper. Next, I describe the data and related analytical methods I utilized in constructing a case study of the CST academy.

First, the inspiration for developing a sociopolitical framework for computer science education is rooted in concerns around the current diversity and equity discourse in STEM education mentioned above. As part of a community of educators and researchers in STEM education genuinely concerned with issues of equity, we argue for the urgency of developing a new, critical language that clearly anchors STEM in social justice perspectives. If we fail to accomplish this, we risk inadvertently taking on the diversity ideology and discourses of sociopolitical forces that make no pretense about their hegemonic or economic commitments, such as the U.S. military and the corporate technology sector, both of which are increasingly vocal in recent STEM education diversity initiatives (Vossoughi & Vakil, in press). The theoretical framework advanced in this study aims to take this work up by clearly articulating what a sociopolitical approach in CS education is, and what it is not. It is a framework intended to sharpen our analyses of existing CS educational projects, as well as to help us imagine anew, and guide the development and design of novel approaches to CS education. In developing the framework, I drew on extant equity-oriented computer science, mathematics and science education research, perspectives in science and technology studies, as well as my own experience teaching and researching high school computer science.

To help ground the framework in current realities of CS education, I do two things. First, in constructing characterizations of mainstream approaches to CS, where relevant, I examine important curricular documents, including the *K-12 CS Standards* (Seehorn et al., 2011), and *Running on Empty: The Failure to Teach K-12 CS in the Digital Age* (Wilson, Sudol, Stephenson, & Stehlik, 2010). Both of these documents have been produced by the leading voices in CS education today - the Computer Science Teachers Association (CSTA), and the Association for Computing Machinery (ACM). Second, I interweave a case study of the CST academy as I elaborate the distinct attributes of a sociopolitical approach to CS education. The case study provides a close examination of equity issues by situating the academy within a sociopolitical context. This allows for a critical examination of how pedagogical practices and learning opportunities, identity trajectories, and curriculum, are shaped by the broader set of politics and discourses through which the CST academy operates. Data for the case study were drawn from a larger, multi-school study of race, equity, and learning in the district led by Professor Na'ilah Nasir at the University of California, Berkeley. My role in the first study focused on Bay Prep, and in particular the experiences of Black and Latina/o students enrolled in the CST academy. Using ethnographic approaches, I engaged in participant-observation of two 10th grade CS classes, collected detailed field notes from school and district events related to the CST Academy, and conducted semi-structured interviews with students, teachers, and administrators. I begin by providing some context for Bay Prep.

Bay Prep

Bay Prep is organized around several academies and learning pathways. In addition to the CST academy, the school offers the Engineering, Health, Biotech, and Arts/Fashion academy. Each academy has its own admissions requirements and course sequences. For example, entrance into the Engineering academy requires a rigorous mathematics assessment, and graduation from the academy requires completion of a series of advanced courses in mathematics and science. Students who choose and get accepted into an academy, and not all do, become part of the pathway cohort beginning in their sophomore year. Beyond academy-specific courses (CS courses in the case of the CST academy), cohort students take most other classes together as well. Based on my interviews with several of the CST academy teachers, I have learned that there is a conscious effort (not always realized) to draw conceptual connections across disciplinary areas in hopes of creating an overall coherent learning experience across subjects, but centered around the discipline to which the academy is most centrally related. The CST academy is an official California state sponsored academy, which means funding for the academy is derived at least in part from state funds. As mentioned in the beginning of this paper, most recently, it is also being partially sponsored by Intel Corporation as part of the company's diversity efforts and recent forays into public education.

Theoretical Framework: A Sociopolitical Approach to CS Education

In the framework I articulate below, I outline three distinct components of a sociopolitical approach to CS education that cut across issues related to practice, research, and policy: (a) questions of epistemology and ethics in curriculum, (b) conceptualizations of teaching and learning in K-12 CS, and (c) ways that CS educational projects are framed (e.g., how relationships are imagined and constructed between CS learning communities and the technology industry, the U.S. government, and/or with urban communities of color). Of course, CS education takes place everywhere, not just within or for communities of color. However, this particular framework emerges from my own praxis teaching and researching within urban communities of color, and is therefore specific to the “urban” experience and prioritizes the needs, desires, and experiences of students and communities of color,³ who in recent years have often been the targets of CS education reform efforts (Goode & Margolis, 2011). To better illuminate each of the three components, I contrast a sociopolitical approach to CS education with mainstream approaches to CS, which I view as being inclusive of some equity-oriented segments within the CS education research community. As I elaborate each of the components, I will draw on curricular documents as well as data collected from my research in the CST academy to demonstrate how the framework can illuminate tensions in equity-oriented CS learning environments.

³ Within the context of the CST academy, I use “students of color” for students who identify as African-American or Black, Latina/o, Arab, and Asian-American.

Table 1. Mainstream vs. Sociopolitical Approach to Computer Science Education

	Questions of Ethics in Curriculum	Conceptualizations of CS Teaching and Learning	Framing of CS Education
Mainstream approach to CS Ed	<p>Technology and computing as having social implications.</p> <p>Focus on individual and student choices. (e.g., piracy, cyber-bullying, obeying copyright laws, responsible social media use).</p> <p>Learning how to be responsible digital citizens.</p>	<p>Helping learners develop knowledge and skills through tools.</p> <p>Focus on cognition and mental processes.</p> <p>Deficit lens on girls and students of color.</p>	<p>Important for global economic competitiveness and national security.</p> <p>Helps non-dominant students gain employment in technology companies.</p>
Sociopolitical Approach to CS Ed	<p>Technology and computing as having social and political implications.</p> <p>Focus on individual rights and freedoms, and corporate and government responsibilities.</p> <p>Critique of unethical abuses of technological power (e.g., U.S. surveillance state and privacy vs. security debates)</p> <p>Understanding of role technology can play towards social justice goals.</p>	<p>Helping learners develop knowledge, skills, and positive CS identities.</p> <p>Views girls and students of color (and their communities) through asset lens.</p> <p>Pedagogical approach rooted in culturally relevant, critical approaches.</p>	<p>Important for the social and economic welfare of historically non-dominant students and their communities (including but not limited to students and communities of the United States).</p>

Questions of Epistemology and Ethics in Curriculum

I begin this section by providing an overview of how the mainstream CS education community conceptualizes the social dimensions of computing, and how this materializes in treatments of ethics in CS curriculum and practice. Within the mainstream CS education community, computing, and technology more broadly, is commonly understood to be influenced by and to influence the broader social context. For example, in the standards document produced by the Computer Science Teachers Association (Seehorn et al., 2011), it states, “Computers and networks are a multicultural

phenomenon that effect society at all levels.” (p. 12) The document also raises questions of equity:

Computing, like all technologies, has a profound impact on any culture into which it is placed. The distribution of computing resources in a global economy raises issues of equity, access, and power. Social and economic values influence the design and development of computing innovations. (p. 12)

Scanning the standards document, at first glance, one might observe that questions of ethics figure prominently as well (Seehorn et al., 2011). Because this is particularly true in the case of the standards specific to Grades 9-12, I will limit my discussion to this portion of the document. For the high school context, the standards span three discrete courses: (a) *Computer Science in the Modern World* (Grades 9 or 10), (b) *Computer Science Concepts and Practices* (Grades 10 or 11), and (c) *Topics in Computer Science* (Grades 11 or 12). The standards identify five strands that run through each of the three courses:

- Computational thinking
- Collaboration
- Computing practice
- Computers and communication devices
- Community, global, and ethical impacts

In a moment, I will more closely examine the “community, global, and ethical impacts” strand that presumably runs through each of the three courses. However, before unpacking this strand, I draw attention to the fact that only in the introductory course for 9th and 10th graders (*Computer Science in the Modern World*) does the word “ethics” or related concepts show up in the course description. Designed as a broad introduction to the field of CS, the description for this course references ethics in its last sentence:

Finally, they should understand the social and ethical impact of their various choices when using computing technology in their work and personal lives and the choices that have already been made for them by those who develop the technologies they use. (p. 9)

No such reference to ethics or ethical issues is made in the other two course descriptions, which were designed with advanced CS students in mind. The descriptions for these courses emphasize an “in-depth study of computer science,” and “algorithmic problem solving” in the context of “real-world problems” (in the case of *Computer Science Concepts and Practices* course), and “depth of study in one particular area of computing” (in the case of the *Topics in Computer Science* course).

Later in the document, each of the five strands is more fully articulated. Despite being absent from the descriptions of the more advanced courses in the three-course high school sequence, the “Community, Global, and Ethical Impacts” strand is explained as a “fundamental aspect of CS at all levels.” The central concept of this strand is couched in terms of individual choices and the notion of being “responsible citizens in the ever-

changing digital world” (p. 12):

As soon as students begin using the Internet, they should learn the norms for its ethical use. Principles of personal privacy, network security, software licenses, and copyrights must be taught at an appropriate level in order to prepare students to become responsible citizens in the modern world. Students should be able to make informed and ethical choices among various types of software such as proprietary and open source and understand the importance of adhering to the licensing or use agreements. Students should also be able to evaluate the reliability and accuracy of information they receive from the Internet. (pp. 11-12)

Before turning to explore how a sociopolitical approach conceptualizes and enacts issues of ethics in CS education in a different manner, I note here that the discussion above provides a rather generous characterization of treatments of ethics in mainstream approaches to CS education. The discussion so far has been limited to how issues of ethics are portrayed in the K-12 standards document produced by CSTA. In K-12 CS education research, ideas related to ethics and epistemology are scarcely the focus of inquiry or analysis. Rather, the focus in CS education research historically has been upon questions of learning particular CS concepts, the design of tools that demystify programming languages, instructional practices, and more recently, questions of diversity and broadening participation to include girls and historically underrepresented students of color. To provide just one example of this, in prominent CS education researcher Mark Guzdial’s recent book (Guzdial, 2015) that provides a thorough review of computing and CS education research, a key word search for “ethics” or “ethical” produces zero results. Similarly, surveying the final program for this year’s major CS education conference, SIGCSE, while multiple sessions (including keynote) sessions include “broadening participation” in their title or descriptions, only two sessions explicitly reference “ethics” (one of them a pre-symposium event).

A Sociopolitical Approach to Ethics in CS curriculum: Curricular Possibilities

In this section, I outline the ideological contours of what I argue can serve as the beginnings of a sociopolitical treatment of ethics in computer science education. I will illustrate that while ethical issues are prominent in some sectors of the computer science research community, they have yet to make headway amongst CS education researchers, or within official curriculum documents. However, the seeds of possibility for future curriculum design and development are bountiful.

A sociopolitical approach to CS education begins with the premise that issues of ethics are fundamental to all aspects of teaching and learning CS. In the extant approaches common in mainstream CS education discussed thus far, issues of ethics are framed primarily around decisions a student does or does not make, drawing heavily on discourses of personal responsibility and student choice. A sociopolitical framing of ethics in CS would argue that while discussions of personal responsibility and choice are important, they must be situated in larger conversations about the role of CS as a discipline in the advancement or obstruction of human welfare, and of democratic societies. From this perspective, personal rights, along with corporate and government

responsibilities, would be the analytical and political priority in discussions of ethics. Further, a structural and political analysis of CS as a discipline would drive questions of ethics at all levels of learning CS (and how to engage in the practices of CS). While mainstream approaches discussed above seem to devalue questions of ethics by relegating them primarily to introductory courses, by contrast, a sociopolitical approach would recognize that issues of ethics in CS are *always* relevant. Such issues are perhaps most significantly so at the *highest* levels, in which the learning of advanced CS concepts and practices makes the realization of consequential computational and technological devices more likely. To ground these arguments in a current example that powerfully exemplifies the tensions between the sociopolitical and mainstream approaches to ethics in CS, I turn my attention to the global debate around privacy and security on the Internet.

The case of NSA whistle-blower Edward Snowden, known around the world for his infamous leaks of unclassified National Security Administration (NSA) information in 2013, is an obvious place to begin this conversation. Snowden's leaks, reported upon in *The Guardian* and in other outlets by anti-establishment journalists like Glenn Greenwald (e.g., Greenwald, 2013), have exposed the unprecedented scope of mass surveillance carried out by the U.S. government (and its corporate partners), and has led to many other leaks revealing unlawful practices of the U.S. intelligence community, a phenomenon so frequent that it is commonly called "The Snowden Effect." To many, Snowden is a noble dissident, a hero who should be celebrated for standing up to the abuses of the U.S. government, while to many others, he is a traitor and should be imprisoned. The difference resides in disparate conceptualizations of ethics in CS.

For more insight into how questions of ethics factor into computer science, I turn to UC Davis Professor Philip Rogaway. In a recent address to professional computer scientists in New Zealand, Rogaway forcefully critiqued his colleagues for their collective role in helping build the technological capacity for what has become the U.S. surveillance state. In a related essay (Rogaway, 2015) based upon this address, he writes:

As computer scientists and cryptographers, we are twice culpable when it comes to mass surveillance: computer science created the technologies that underlie our communications infrastructure, and that are now turning it into an apparatus for surveillance and control; while cryptography contains within it the underused potential to redirect this tragic turn. (pp. 43-44)

From this perspective, the field's preoccupation with questions of security, rather than privacy, constitutes an ethical stance that reflects the political values and interests of the United States government, rather than its citizens. Importantly, Rogaway conceptualizes ethical, moral and political issues in CS from a position that privileges the rights of citizens, and holds CS as a discipline accountable for its role in facilitating assaults on democracy carried out by powerful actors such as the U.S. government, the intelligence community, and their corporate allies. This view of ethics and CS would cast Snowden as a hero, who, by taking on great personal risk, exposed the scope and size of the U.S. surveillance state. By contrast, the personal choice and responsibility rhetoric dominant in mainstream conceptions of ethics in CS education discussed earlier would cast Snowden not as a hero but as a traitor - an unethical actor. A sociopolitical approach to

CS education builds from the critiques inherent in Rogaway's address, but also from the seeds of possibility, which he articulates as the "underused potential to redirect this tragic turn." (p. 44)

From a curriculum standpoint, the idea of "underused potential" in a discipline as theoretically rich and complex as computer science opens up new possibilities for learning core CS concepts and practices in new ways and towards novel ends, what can be viewed as building blocks for what MIT digital media scholar and computer scientist Fox Harrell calls critical computational artifacts⁴ (Harrell, 2013). In other words, a sociopolitical approach to ethics in CS curriculum includes but is not limited to discussions of how computing technologies may be part and parcel of oppressive systems such as the surveillance apparatus of the U.S. government. From this perspective, a more thorough treatment of ethics in CS curriculum would involve computer scientists and CS educators working together to rethink fundamental concepts and practices throughout all CS courses, including advanced courses, in ways that center ethical issues and concerns as an integral part of CS education.

Treatments of Ethics in the CST Curriculum at Prep

To gain a sense of how the CST academy is addressing issues of ethics, I draw upon the ECS curriculum, which is a major (but not the only) source of curriculum in the CST academy. The ECS curriculum, developed by teachers and researchers at UCLA as part of an NSF-funded project to broaden participation in computing, begins with the premise that computing is a social phenomenon and also that computing education should be socially and culturally relevant (Goode & Chapman, 2011):

Exploring Computer Science teaches the creative, collaborative, interdisciplinary, and problem-solving nature of computing with instructional materials which feature an inquiry-based approach to learning and teaching. As part of this curriculum, students will delve into real-world computing problems that are culturally-relevant and address social and ethical issues while delivering foundational CS knowledge to students. Students will engage in several in-depth projects to demonstrate the real-world applications of computing. (p. 6)

In this way, technology is theorized in ways that resemble other mainstream approaches to CS: the social implications are recognized in a general sense, but not in ways that explicitly articulate ways in which technologies can facilitate or resist hierarchical or oppressive systems. Similarly, in the course overview, questions of ethics are mentioned in a general way without providing specifics: "Students will also be introduced to topics such as interface design, limits of computers and societal and ethical issues." (p. 5). Although ethical issues appear throughout the document, they do not figure prominently until the section on "Societal Impacts of Computing," one of seven content areas the course is organized around. The other six are:

⁴ Critical computational artifacts are computing systems and other forms of digital media designed intentionally to raise awareness around social and cultural injustices in society. Harrell's work at the MIT Media lab focuses on combining culture, cognition, and imagination towards the design of such devices. (Harrell, 2013)

- Computers and the internet
- Models of intelligent behavior
- Algorithms and abstraction
- Connections between mathematics and CS
- Creating computational artifacts
- Data and information

I note that while discussions of ethics are lacking in the above areas and are mostly confined to the section titled “Societal Impacts of Computing,” it is stated in the document several times that this section “should be woven throughout the course.” (e.g., p. 26). Yet, even within this section, a closer examination of the topic description and related activities reveals that the framing of ethics is depoliticized, avoiding student-learning outcomes that deal explicitly with substantive critiques of the ethical abuses of corporations, governments, or other powerful structures and systems. Rather, ethics shows up primarily as a question of individual behavior and choice:

Computing is situated within economic, social and cultural contexts and, therefore, influences and is influenced by each of these. The proliferation of computers and networks raises a number of ethical issues. Technology has had both positive and negative impacts on human culture. Students will be able to identify ethical behavior and articulate both sides of ethical topics. Students study the responsibilities of software users and software developers with respect to intellectual property rights, software failures, and the piracy of software and other digital media. They are introduced to the concept of open-source software development and explore its implications. Students identify and describe careers in computing and careers that employ computing. (p. 26)

Perhaps what best illustrates the individualistic and depoliticized framing of ethical topics in the ECS curriculum is found in the final project description. The final project provides students with four options including “an ethical dilemma website.” Within this selection, students are given four dilemmas from which they must choose one. These four dilemmas are reproduced verbatim here:

Ethical Dilemmas

- 1. People illegally download music over the internet. Although it's free, it is still illegal. What do you choose to do? Why?*
- 2. Your parent loses his/her job. You could help out by selling illegal dvds on the streets. What should you do?*
- 3. You have the ability to hack into the school computer system. You can change people's grades. Would you change your own? Why or why not? What if you could change the grade for a basketball player who has a scholarship to play for a big university?*

4. *Someone you know works at a store that sells iPods. He steals some and asks if you want to buy one for half the price the store sells it for? Should you buy it? Why or why not?*

From a sociopolitical stance, the framing of these “ethical dilemmas” too heavily centers upon student choice and decision making, and sends the message that questions of ethics in the field of CS are confined to what individual actors do or do not do. Questions such as how power, race, and culture influence the theoretical inquiries of computer scientists, for example, are left unexamined. Ethical issues regarding ways that technological systems work to reproduce social inequities, or suppress political dissent through mass surveillance with the aid of computing devices and algorithms are likewise completely ignored. Moreover, the ECS curriculum does not provide students opportunities to think about questions of ethics in CS in ways that are specific to their own communities, lived experiences, or possible futures. In these ways, through the ECS curriculum, the ways in which the question of ethics shows up in the CST academy is aligned mostly with mainstream approaches to CS education.

Conceptualization of CS Teaching and Learning

I begin this section by providing a broad characterization of how mainstream approaches to CS education research have historically treated and currently treat issues of teaching and learning, and, by extension, how such approaches treat CS teachers and learners. Following this, drawing on recent research in CS education, as well as equity-oriented research in the related fields of mathematics and science education, I outline substantive differences in how teaching and learning (and teachers and learners) can be conceptualized within a sociopolitical approach to CS education. Then, returning to the case study, I will demonstrate how teaching and learning practices within the CST academy align in some ways with mainstream approaches, while in other ways, the CST academy embraces aspects of a sociopolitical approach to CS education.

Educational research on the teaching and learning of CS traces back to the pioneering work of Seymour Papert at MIT in the 1980s, whose program of research was focused on helping children develop procedural thinking through LOGO programming (Papert, 1980; Papert & Harel, 1991). The following decades of CS education research similarly focused on understanding the mental and cognitive processes deemed critical in computer programming (e.g., abstraction, decomposition, recursive and iterative thinking), as well as the development of tools and programs that aided in the development of these processes. However, there was - and continues to be - heterogeneity and important tensions within the CS education research community. For instance, an unresolved conceptual battle amongst CS education researchers is whether coding should be viewed as an educational end-goal, or rather, if the real value of coding lies in its potential to help students deepen learning in disciplines including but not limited to computer science (Resnick & Siegel, 2015). In many ways, this debate culminated in Jeannette Wing’s short but influential 2006 article in the *Communications of the ACM*, in which she introduced the term “computational thinking” as a way to build upon but also move past an understanding of CS as being limited to computer programming (Wing,

2006). Even so, though computational thinking represented a significantly expanded view of the work of computer scientists, and despite its undisputed influence on the field, scholarship in the CS education research community has privileged cognitive and mental processes and has tended to downplay social and cultural, let alone political, factors. This point is made succinctly in a recent article by Shuchi Grover and Roy Pea (Grover & Pea, 2013) reviewing how computational thinking has been studied in K-12 research:

Barring some recent studies, such as Fadjo, Lu, and Black (2009) and Berland and Lee (2011), few others have taken into account contemporary research in the learning sciences in socio-cultural and situated learning, distributed and embodied cognition, as well as activity, interaction, and discourse analyses. (p. 42)

In recent years, in addition to studies on learning, there has been increased attention devoted to issues of inclusion and diversity in the mainstream CS education research community, focused primarily on finding ways to increase the number of girls and students of color in K-12 CS courses and pathways. Within these studies, despite the good intentions of researchers and educators, historically underrepresented students in CS are often viewed through a deficit lens. Let us return to CS education researcher Mark Guzdial's recent review of CS education research (Guzdial, 2015). In describing what the field knows about how students learn CS, and commenting on the overrepresentation of studies conducted at the college level, Guzdial correctly observes that CS education is "mostly available to students in the middle- and upper-income brackets. What we know about teaching computing education is mostly from teaching privileged students." (p. 15) At first glance, this may seem to be the beginning of a deeper discussion about equity issues in the field, but rather remarkably, Guzdial goes on to conceptually conflate students lacking privilege with students lacking intelligence:

Elementary and high school students are mostly filled with students who will not go on to college, at least in the U.S. We have little research about teaching students who are below average in intelligence or who have special needs... When we make assumptions about teaching computer science to everyone based on our experiences in teaching computing education, we might be making biased decisions... In computing education research focused on undergraduates, we may believe that we are studying average students, but in reality, we only see the students who truly are "above average." (p. 15)

I do not intend to single out Guzdial here. Along with his collaborators, he has contributed valuable scholarship to the CS education research community (e.g., Guzdial, 2015; Forte & Guzdial, 2005; Ranum, Miller, Zelle, & Guzdial, 2006), as well as to the general public through his blog called "Computing Education Blog" of which I am a regular visitor (<https://computinged.wordpress.com/>). On a regular basis, he advocates for more inclusivity and greater access to the discipline of CS for all students. These are important calls in a highly segregated field, and consistent with the sociopolitical goals of equity which we will discuss shortly. However, at the same time, Guzdial's views reflect mainstream conceptualizations of equity that fail to substantively challenge the culture, ideology, and practices of CS and CS education. The idea that highly-advanced

instructional methods geared towards “above average” children are a primary culprit in the diversity battle in computer science carries negative assumptions about the intellectual capacity of children who are not currently in CS pathways (girls and historically underrepresented students of color). While the sociopolitical approach shares concerns about diversity, it departs in important ways in its foundational assumptions about students, and in its pedagogical approach to addressing the “diversity problem.”

A sociopolitical approach to teaching and learning CS

A sociopolitical perspective begins with a different set of premises about the nature and goals of teaching and learning CS, and about CS learners. Drawing on sociocultural perspectives in the learning sciences (Gutiérrez & Rogoff, 2003; Lee, 2003; Nasir & Hand, 2006; Nasir, Rosebery, Warren, & Lee, 2006), cultivating positive CS identities (alongside the focus on mastery of CS concepts and practices) becomes a central pedagogical goal. Moreover, CS identity is conceptualized as lived and dynamic, and part of a larger constellation of student identities, including racialized and political identities (Martin, 2007). A sociopolitical frame recognizes that cultural norms and values in many CS learning environments may be incongruent with the cultural norms and values of non-dominant students and communities. Therefore, a sociopolitical approach to teaching CS employs pedagogical and curricular methods that aim to cultivate students’ CS identities in ways that explicitly invite students to draw upon their multiple social identities, including those that may not typically be considered valuable in STEM learning environments. In the next chapter of this dissertation, I provide an example of such an approach.

For another example, consider *West Side Stories*, a recent web-based digital interactive produced by Oakland-based non-profit Youth Radio, an organization with a long history of offering low-income youth of color opportunities to learn digital and new media literacies (Bliss, 2015). In *West Side Stories*, seven young people worked with a team of designers and programmers to create a visually-compelling and information-rich interactive website that boldly explores the gentrification of West Oakland.⁵ Over the course of several months, youth interviewed long-time residents, debated with one another, and engaged in collaborative design and computer programming - culminating in a media-rich interactive website that beautifully and powerfully engages a complex social issue in their community.

A sociopolitical approach to teaching CS rejects deficit narratives of non-dominant students, and takes up pedagogical approaches that acknowledge, respect, and build upon student identities and interests. While mainstream approaches to CS education often assume communities of color, women, or working class communities lack technological sophistication, a sociopolitical approach to teaching CS is committed to knowing and building on the technological literacies that often go unrecognized in marginalized communities. Underlying this approach are theorizations of literacy (including new-media literacies), youth, and marginalized communities that recognize and value the interests, practices, and ingenuity inherent to all human communities

⁵ West Oakland is a historically African American neighborhood. In recent years, long-time residents and community members have been displaced due to rising property values triggered by the surrounding technology-boom of Oakland and the larger San Francisco Bay Area.

(McDermott & Raley, 2011). As one example, new media scholar Linda Herrera's edited volume *Wired Citizenship: Youth learning and activism in the Middle East* documents the complex and diverse ways youth throughout the Middle East have created, manipulated, and leveraged digital technologies in their quest for social justice and freedom within their respective countries (Herrera, 2014). In another example, education and literacy scholar Kris Gutierrez's research group *Connected Research Learning Network (CLRN)* (of which I am an active member), conducted a multi-sited ethnography of 12 Latina/o families to better understand the rich technological and new media literacies the families engage in through their daily activities. These and other similar studies begin with the premise that non-dominant communities and students engage in technologically rich and culturally mediated practices as part of their everyday lives. From this perspective, CS education research and practice is tasked with uncovering those practices and designing learning environments that creatively build upon the multiple identities and literacies of historically non-dominant youth.

In sum, a sociopolitical approach to teaching and learning CS theorizes identity as *central* to the learning process, recognizes the diverse strengths, identities, and literacies historically marginalized youth bring to learning environments, and employs pedagogical approaches that explicitly build upon these and empower youth to learn CS as part of a broader social justice agenda.

Teaching and Learning CS in the CST Academy

To contextualize the nature of teaching and learning in the CST academy, I begin with a brief historical note. I will demonstrate how the origins of the academy and its current status in the school positions CST academy students in relation to other students in less racially diverse academies and learning pathways, and examine implications this positioning has for how students in the academy are viewed as learners of CS. I will also describe some of the salient pedagogical practices I have observed during my time teaching and conducting research alongside Mr. Mayson, director of the CST academy.

CST Academy: A Racial Justice Intervention

The origins of the CST Academy are tightly linked to the lack of diversity in another academy in the school, the Engineering Academy. Mr Mayson, who was born and raised in Nigeria, came to Bay Prep with the intention of spreading his passion for computing to students of color, which he knew were underrepresented in the field. Given his background in STEM, he was asked to teach in the Engineering academy. Not aware of the structural and racialized inequities of the school (Nasir & Vakil, in press), he accepted the position. However, upon realizing that most of the students he wished to reach (students of color and girls) were not enrolled in the academy, he worked with the leadership of the school to create the CST academy, which would specifically target underrepresented students. The table below shows the racial and gender diversity of the CST academy, what should be noted as an outlier when compared to other computer science academies in diverse urban schools (Margolis, Estrella, Goode, Holme, & Nao, 2010; Ryoo, Margolis, Lee, Sandoval, & Goode, 2013).

Table 2. Racial Demographics of Academies at Bay Prep

Academy	% Male	% Female	% African American	% Asian	% Latina/o	% White
CST (avg GPA 2.48)	73	27	40	23	17	15
Engineering (avg GPA 3.77)	55	45	5	28	5	58
Art & Design (avg GPA 2.44)	45	55	68	3	12	10
Health (avg GPA 2.98)	26	74	34	23	22	16

When asked about why he decided to create the academy, Mr. Mayson describes it as “his passion.” He says:

I felt like, um, that would be difficult really for me to try to change these type of things, why don't I just stay with my passion it is you know computing and all that and start a computer thing so I you know started a [technology] academy that was based on interest.

He also talked about having the opportunity to work with Bob Moses (founder of the Algebra Project) in the late 1990s, and how Moses’s vision of mathematics literacy as a civil right deeply (Moses & Cobb, 2001) informed his own approach to creating a CS academy at Prep that offered opportunities to students of color at the school.

Importantly, this intentionality around creating a technology-focused space that had equity goals at its center was not lost on students. One CST academy student, an 11th grade African American boy named Gerald, described the purpose of the CST academy as follows:

...uhh most likely for Blacks and African Americans I would say it's because like since there are so many Caucasian white people in kinda in all these top industries and stuff like that I think most of what [Prep] is trying to do because of the [CST] academy their tryna like implement things like girls who code where they get girls into the computer science field or African Americans into the computer science field so that its more diverse in that field. But I'm not sure about any of the other academies cause I haven't been but that's what I know about the [CST] academy.

A genuinely complete assessment of student perceptions across the CST academy

is beyond the scope of this case study. In other work, I have explored more fully how students of color in the CST make sense of the racial dynamics of their academy in relation to other academies in the school, as well as the significance of Mr. Mayson himself acknowledging the intentionality of the CST academy as a space designed with racial justice goals (Nasir & Vakil, in press). During lunch and in between classes, students of color would often congregate to eat, relax, or share stories with each other and with Mr. Mayson, who was not only respected as a teacher, but also viewed as an ally and a friend. When several students of color from the academy decided to create a racial justice student organization⁶ to address equity issues in the school, Mr. Mayson supported by offering his class as a meeting place, and even providing financial help to provide food for student meetings. His own identity as a man of African descent, combined with his passion and commitment to diversifying the field, contributed to a learning environment that cultivated the multiple identities of students and provided the space for historically underrepresented groups of students to take on CS identities that were not contradictory with their cultural and racial identities. In these ways, the CST academy takes on attributes characteristic of a sociopolitical approach to CS education.

Even so, a closer examination of his pedagogical practices suggests a more dominant orientation to CS education. In my observations of the academy, students were often engaged in pair-programming, self-directed learning (Lieberman & Linn, 1991) and were being dynamically assessed (Shepard, 2000) through public demonstrations of their class projects to other students and visitors to the class — pedagogical practices supported by learning sciences and educational psychology research. While any one of these practices alone is not necessarily contradictory to a sociopolitical approach, taken together, and in the absence of other pedagogical practices designed explicitly to support students' multiple social identities (e.g., Brown, Reveles, & Kelly, 2005), they amount to an instantiation of a dominant method of teaching computer science. As one example of how this impacted learning in the classroom, I remind the reader that girls were heavily outnumbered in the CST academy (See Table 2) and frequently described the sexism and discrimination they experienced from other students in the class (Nasir & Vakil, in press). While Mr. Mayson's own daughter was a student in the CST academy, and he often expressed concerns about recruiting and retaining more girls, there was no evidence of pedagogical practices designed explicitly with issues of gender equality or gender justice in mind. A sociopolitical approach would demand this kind of culturally aware and interventionist pedagogy in all aspects of teaching and learning computer science: from recruitment and retention strategies, to curricular and pedagogical choices in the classroom. Yet, beyond instructional and pedagogical strategies that deal with questions local to the learning environment (for example, how micro dynamics of race, gender or other forms of social power influence participation in a particular classroom) a sociopolitical approach is also undergirded by an educational philosophy that is rooted in social justice and critical educational frameworks (Freire, 2000; Giroux, 1997). In the context of CS, these perspectives begin by asking “computer science for what?” and “computer science for whom?” (Vossoughi & Vakil, in press), questions that lead us to a

⁶ The organization is called SPOCN (Supporting People of Color Now!) and emerged initially as part of a university-community partnership between teachers and students at Bay Prep, and graduate students in Professor Na'ilah Nasir's SRATUS research group (of which I was a part). The organization is active, and the university-community partnership is ongoing.

discussion of how computer science education has been and is currently being framed to particular communities.

How CS Education is Framed

The third and final component of the sociopolitical framework for CS education entails perhaps its most consequential and defining attributes, and where its differences with mainstream approaches may appear most stark. This component brings to the fore the philosophical and political logic, and ambitions, of CS educational projects. In other words, it carries important implications for the answer to a basic question that the education community is beginning to collectively ask: Why do students, let alone *all* students, need to learn computer science? After outlining the stark political-ideological differences between mainstream and sociopolitical responses to this question, I return to examine the complex (explicit and implicit) ways this question is answered to students of the CST academy. I will show that the CST academy, like all learning environments, reflects diverse political, economic, and ideological commitments. How Mr. Mayson, along with students, parents, and school officials work through these various commitments in the years to come will ultimately define what kind of political-ideological project the CST will mature into.

Mainstream Framings of CS Education: Past and Present

I begin this section by returning once again to the origins of CS education mentioned earlier, highlighting ways that early advocates of CS framed the importance of CS in education in terms drastically different from those used in mainstream approaches of today. The work of early pioneers of computing and computer science education, including Seymour Papert, Alan Perlis, Alan Kay, and Andrea diSessa, to name but a few, was predicated on a genuine sense of wonder and excitement for what computing technologies could offer the world of education, and offer the world of the mind. Although heterogeneous in methodological and epistemological orientations to cognition and computing, the overarching focus of this wave of work on computing education, spanning the 1980s and early 1990s, was about how computers could potentially expand the range of imaginative and expressive functions of the mind, and the ways in which computers held untapped possibilities for the field of education. It is also important to note that in that era, there was not the labor demand that currently exists for computer programmers (Guzdial, 2015). Against this historical backdrop of computing as a means for empowerment and expression, Guzdial expresses concerns about the more recent goals of CS education:

Unfortunately, most of a computer science education today is about getting better at producing software developers. The goal is greater productivity of higher-quality software developers. The annual SIGCSE Technical Symposium is mostly a meeting of over 1000 undergraduate computer science teachers, where their shared goal is to provide great teaching to contribute workers to the software industry. I share that goal, but I believe that there is a broader picture of providing access to the advantages of computing as a tool to think with to everyone who

wants it. (Preface)

In this instance, we see in Guzdial's comments a sense of discomfort with educational goals that have become so narrowly organized around interests of economic forces such as the software industry. A sociopolitical perspective shares this concern, but with a more forceful critique that, in addition to questioning economic interests influencing the goals of CS education, takes to task ideologies and discourses of CS education that may be materially, as well as symbolically, harmful to historically marginalized communities. For instance, in the widely-cited report produced jointly by the Association for Computing Machinery and the Computer Science Teachers Association, entitled *Running on Empty: The Failure to Teach K-12 CS in the Digital Age* (Wilson, Sudol, Stephenson, & Stehlik, 2010), an argument for the importance of computer science draws partially upon national security discourses that presuppose allegiance to U.S. exceptionalism and militarism:

Computer Science underpins the technology sector, which has made tremendous contributions to the domestic economy, as well as numerous other economic sectors that depend on innovative, highly skilled computer science graduates. Computing touches everyone's daily lives. Securing our cyber-infrastructure, voting in elections, protecting national security, and making our energy infrastructure more efficient are among numerous issues dependent on computing and a strong computing-savvy workforce. (p. 30)

Linking a rationale for computer science education to "protecting national security" and related interests is highly problematic from a sociopolitical stance, but it is reflective of the growing involvement of the U.S. military in CS education and STEM education initiatives (Vossoughi & Vakil, in press). A sociopolitical approach to CS education actively resists discourses that rationalize the importance of learning CS in terms of U.S. national-security, recognizing that "national-security" and "defense" are often intentional misnomers concealing the militarist and imperialist ambitions of U.S. foreign policy and its corporate partners. Rather, for the sociopolitical approach, the goals for CS education are rooted in social justice values and concerns, including (but not limited to) conscientious opposition to the development of technologies through programming or other CS practices that advance the interests of the U.S. military at home and abroad.

Furthermore, in contrast to mainstream framings of CS education, a sociopolitical approach does not have an avowed allegiance to the software industry or the corporate sector. Rather, it views these industries and their agendas with skepticism, joining with a long tradition of critical educational scholarship and activism that challenges, questions, and resists the influence of corporate and economic interests on education (e.g., Apple, 2013; Giroux, 1989). While a mainstream approach to CS education draws on multicultural discourses of equity and inclusion and ultimately hopes to create "pipelines" into these industries to increase the number of underrepresented students of color and women in these fields (Martin, McAlear, & Scott, 2015), a sociopolitical approach challenges the corporate technology sector on moral, epistemological, and political grounds. How are these companies working to advance social justice locally and

abroad? At whose expense do these companies make profit? What ideological and political projects are these industries working in service of? These are the questions that animate a sociopolitical approach to CS education.

Instead of looking to national security or employment in the technology sector as the prime rationales to learn CS, the sociopolitical framing argues for the learning of CS for sociopolitical and moral aims and purposes. A sociopolitical approach encourages people to learn to program and design systems that critique power. It encourages programmers to develop encryption technologies that allow communities of color to live free of government surveillance. This approach seeks to join with community activists to design and deploy technologies that advance the interests of marginalized groups. It seeks to use digital and computational technologies to build empowering social networks and create digital forms of solidarity between oppressed populations. These are but a few examples of the kinds of ideological and political projects that frame the importance of CS education within a sociopolitical framework.

How is the CST Framed to Students at Bay Prep?

Let us return to Jesse Jackson's speech to Bay Prep students during the mandatory assembly that was cited at the beginning of this paper. While Jesse Jackson's bold directives to students, "[Bay Prep] will be a resource for Silicon Valley... The goal is Intel! The goal is Google! The goal is Facebook!," may be an instance of unusual candor regarding the political goals of an educational project within a public school, the underlying ideology and sentiment is consistent with the overall framing of the CST academy at Bay Prep.

While other academies, such as the Engineering Academy, also receive financial support from technology companies, the relationship with the CST academy and neighboring technology companies appears to be more direct. For instance, the prospect of summer internships and other kinds of future employment in technology-related industries are a major incentive for students choosing to enroll in the CST academy. As one student candidly stated, "I selected the computer academy because I wasn't really interested in any of the other academies... the main factors included job opportunities for the future. There are many job opportunities in the computer science field and this influenced my decision." Beyond providing future prospects for employment, technology companies also contribute material resources such as hardware and software, routers, scanners, and more recently with the recent Intel partnership, there are conversations about the potential for curricular and pedagogical interventions as well. In my interview with Mr. Mayson, he expressed mixed feelings and ambivalence regarding the CST academy's relationship with outside technology companies.

While there is a sense of appreciation for the financial support and resources gained as a result of these partnerships, he is also wary of the increasing influence they are exerting on the overall structure and daily processes of teaching and learning in the CST academy. As one example of this kind of intrusiveness, Mr. Mayson reported being pressured on several occasions by district officials who work with Pixar, another local technology corporation, to allow the company to insert an animation course into the already fixed course sequence of the academy, a move Mr. Mayson firmly opposes. While mainstream approaches to CS education celebrate efforts to diversify the

technology industry through corporate-school partnerships such as those described here, a sociopolitical approach pauses to consider whose interests are ultimately being served, and longer term social and economic implications for the communities that are the (supposed) beneficiaries of such partnerships.

I add to our discussion here that in my time conducting research in the CST academy, I have not seen any evidence of U.S. military or Department of Defense (DoD) meddling or influence. Of course, we know the DoD has been involved with a variety of STEM education initiatives across the country (Jolly, 2009), but to my knowledge there has been no such relationship with the CST or even the district more broadly to date. A fuller examination here could potentially examine DoD relationships with companies such as Intel that are now involved in providing resources and shaping curriculum, and potential moves in the future for more direct involvement by U.S. military and related outfits. I also note, however, that in my examination of the curriculum resources and teaching practices in the CST academy, there were no opportunities for students to grapple intellectually with the ways in which CS as a discipline is implicated in surveillance, weapons or other war-related technologies of the U.S. government. This is despite the fact that there were several students from Yemen in the CST academy, a country in the Middle East that is particularly impacted by drone warfare, a technology not possible without the aid of recent advances in computer science and computing technologies. In sum, the framing of the CST academy to students at Prep was a complex ideological stew comprised of both dominant and sociopolitical elements.

Discussion & Concluding Thoughts

In this paper, I have presented a framework that critically examines extant CS education research while outlining a vision for CS education rooted in sociopolitical theorizations of educational equity and social justice. Theoretical implications for this framework include the development of a critical stance towards the ideologies, discourses and practices that currently undergird and characterize mainstream approaches to computer science education. I have pointed to potential directions for this sort of critical project, but future research is necessary in this area to deepen our collective challenges — pedagogical, philosophical, and epistemological— to appropriations of CS education that are not motivated by a “deep moral concern” (Martin, 2009) for children of color, who are often the targets of CS education reforms. Importantly, this framework also points to new epistemological and learning possibilities rooted in philosophical and political commitments to learning computer science as part of a larger, anti-oppressive educational project.

For CS educators, the elements of the framework each have specific and practical implications for the design of computer science learning environments. For example, how technology is theorized, along with ethical and epistemological stances in computer science, will matter significantly for the kinds of curriculum included, or excluded. Similarly, questions of pedagogical design are a function of how we view learners of CS — as having rich repertoires of knowledge and cultural practices that can be utilized in the CS classroom, or as novices whose technological naiveté has little to offer to a CS classroom.

Questions of gender, race and power are always present when questions of intelligence, motivation, deservingness, knowledge, and skill are involved. While keeping in mind the broader political and ideological factors shaping the nature of teaching and learning within the CST academy, we also pay attention to the localized experiences of race and equity that play out in all learning environments. In this way, the CST academy's equity limitations and possibilities can be both rigorously and fairly assessed and analyzed. With an eye towards curriculum and pedagogy rooted in student experiences and sociocultural perspectives on learning, and a historical understanding of how the CST academy came about and for whom it was intended, we may more fully appreciate the equity successes of the academy. At the same time, we can challenge the equity limitations of the academy by asking critical questions regarding the political and ideological discourses that frame the importance of CS learning and teaching at Bay Prep, as well as engage in new kinds of social design experiments (Gutierrez & Vossoughi, 2010) that explore new possibilities for learning and teaching in computer science in ways more explicitly aligned with the interests of students of color and their communities.

Computer science education will soon be a prominent feature of U.S. public education. While still emerging in many states and school districts, its imminence is inevitable. The political goals of CS education, explicit and implicit, are as diverse as the stakeholders currently involved: teachers, parents, and students, non-profits, large corporations, the DoD, and others. The fact that CS education is forcefully emerging should be a call to action. Distinct from mathematics and science education, which are in some ways more established and therefore a more difficult task to reform, CS education is nascent and therefore malleable to a wide-ranging set of political interests and ideologies. There is no doubt that conservative elements of the public education landscape will vie for maximum influence over the future of CS education. It is therefore an urgent project of CS education researchers and teachers committed to social justice to develop theories and frameworks that challenge dominant trends in this nascent field, and articulate our own visions rooted in commitments towards freedom, human dignity, and democratic societies. It is my hope that this paper is a step in that direction.

Chapter 3: Designing Technology for Social Change: Identity Trajectories and Transformations in a Computer Science Classroom

I begin with a story that made national news in the fall of 2015. Leslie Miley, an African-American software engineer, left Twitter after frustrations with the company's inability and unwillingness to meaningfully address diversity issues. While tensions over diversity in Silicon Valley (and other arenas) are now very much part of the public discourse, what makes this story unique is the rationale Miley provided after he left Twitter. Reflecting on a discussion with senior management prior to his decision to leave, Miley (2015) wrote:

As we continued the discussion, he suggested I create a tool to analyze candidates last names to classify their ethnicity. His rationale was to track candidates through the pipeline to understand where they were falling out. He made the argument that the last name Nguyen, for example, has an extremely high likelihood of being Vietnamese. As an engineer, I understand this suggestion and why it may seem logical. However, classifying ethnicity's (sic) by name is problematic as evidenced by my name (Leslie Miley). What I also found disconcerting is this otherwise highly sophisticated thinker could posit that an issue this complex could be addressed by name analysis... While not intentional, his idea underscored the unconscious tendency to ignore the complex forces of history, colonization, slavery and identity. (Miley, 2015)

Miley's decision to leave Twitter and his subsequent commentary reflect two important concerns underlying the research described in this paper. First, the premise of his departure reflects the "glaring lack of diversity" in the technology field, an overarching concern motivating my research in computer science education in urban schools (Vakil, 2014; Van Wart, Vakil, & Parikh, 2014). Second, Miley's reference to the "unconscious tendency" within the technology sector to "ignore the complex forces of history, colonization, slavery and identity" is also applicable to dominant discourses in the field of STEM education in general (e.g., Bang & Medin, 2010; Gutstein, Lipman, Hernandez, & de los Reyes, 1997; Martin, 2000), and computer science (CS) education in particular. The neglect of these varied historical and sociopolitical forces impacts many dimensions of computer science education research. In this paper I focus specifically on the relationship between sociopolitical identities of students and CS disciplinary identities in the context of designing socially relevant technologies. The study reported upon in this paper draws from a social design experiment (Gutierrez & Vossoughi, 2010) conducted in a computer science class within a large urban high school, in which students were invited to design technologies that addressed social justice problems in their school context. My analysis examines how student identities shaped the ideas and artifacts they

produced, and how the practice of creating socially relevant technology shaped students' multiple social and disciplinary identities, ultimately creating new, more expansive STEM identity possibilities.

Prior Research and Theoretical Perspectives

Identity Undertheorized in CS/Computing Ed

In a review of computational thinking, Grover & Pea argue “barring some recent studies, few others have taken into account contemporary research in the learning sciences in socio-cultural and situated learning, distributed and embodied cognition, as well as activity, interaction and discourse analyses... That body of research should be brought to bear on 21st century cognition” (Grover & Pea, 2013, p. 42). In addition to studies focusing on computational thinking and cognition, sociocultural perspectives are critical for a deeper understanding of the role of identity in computational thinking and in computer science education generally. In the related fields of mathematics and science education, researchers focusing on issues of identity are also often attending to equity and social justice issues in their respective fields (e.g., Barton, 1998; Boaler, 2008; Gutstein, 2003, 2006; Secada, 1989). The link between student identities and issues of equity comes as no surprise, and in an increasingly diverse and unequal society, is reflective of larger scholarly as well as public discourses around diversity, race, gender, immigration status, religion, sexual orientation and other socially and politically constructed markers of hierarchy and marginalization.

However, in CS education, while there is a highly visible public and academic conversation about issues of equity (e.g., NSF calls to broaden participation in computing and the Twitter story that began this article), identity remains relatively under-researched and under-theorized in the literature. This may be due to the fact that, compared to other subfields such as mathematics or science education, CS education is a relative newcomer to educational research (and practice). The undertheorization of identity may also be linked to the general unwillingness of CS education scholars to address sociopolitical issues, where issues of identity are especially salient (e.g., questions around the purposes, ideologies and underlying values of computer science education; issues of race, power and epistemology; culturally relevant pedagogy and practice). I should add here that there is a growing group of scholars who are pushing the field towards equity considerations, and issues of identity are beginning to be addressed here. Work in this area traces its origins back to the large body of research in CS and computing education about the development of new tools, platforms and learning environments that can scaffold the learning of complex computational concepts (Ericson, Guzdial, & Biggers, 2007; Kelleher & Pausch, 2005; Maloney, Peppler, Kafai, Resnick, & Rusk, 2008), the related area of research illuminating structural barriers to greater participation in computing for girls and students of color (Kafai, Fields, & Burke, 2010; Margolis, 2008; Margolis & Fisher, 2002), as well as more recent research on issues of participation, engagement, and identity (Barron, 2004; Fields & Enyedy, 2013; Lee, Husman, Scott, & Eggum-Wilkens, 2015). There is also an even smaller but growing group of critical CS education scholars exploring culturally-relevant and critical pedagogy approaches to learning in CS and

related fields (Ryoo, Margolis, Lee, Sandoval, & Goode, 2013; Scott & White, 2013; Scott & Zhang, 2014; Vakil, 2014; Van Wart, Vakil, & Parikh, 2014).

I locate my work within these traditions, but offer a few additional notes on how identity is often conceptualized and operationalized in ways that I find limiting. Much of the work cited above on equity and identity within CS education has tended to conceptualize CS identity in relation to other constructs, such as participation and engagement, or interest and motivation. Within these perspectives, there is often a tacit view of CS identity as binary, or moving along a one-dimensional axis. Either students have it, do not have it, or are somewhere in the process of acquiring it. Within this conceptualization, the object of research becomes developing theories, methods and pedagogical strategies or tools to move students towards the direction of a “CS identity,” whatever that may be. In this study, I dig deeper into possible meanings and expressions of CS identity. What *kinds* of CS identity become possible in an equity-oriented learning environment? How do these identities exist in relation to other identities a student may have, such as their sociopolitical or racialized identities? I take up these questions within a context of a social design experiment where students are engaged in the practice of the design of critical computational artifacts, which I explain further in the next section. However, I will first elaborate how I am theorizing identity in my study.

Theorizing Identity

Sociocultural perspectives in the learning sciences have demonstrated the centrality of identity in the learning process, and the overall importance of positive academic and disciplinary identities for learning (Conchas, 2001; Fordham & Ogbu, 1986; Mehan, 1996; Nasir, 2006; Wortham, 2006). Even so, the construct of identity within the learning sciences is contested. Some authors conceptualize identity as a global category, static and stable over time, while others see identity being shaped both by global and local factors, an inherently dynamic phenomenon, produced and reproduced through a continuous process of social interaction and discourse (Holland, Lachiotte, Skinner, & Cain, 1998; Wenger, 1998).

I draw in particular on Nasir’s notion of practice-linked identities, which emphasizes the relationship between identity and activity in cultural practices (Nasir, 2002; Nasir & Hand, 2008). From this perspective, identity is conceptualized “as a fluid construct, one that both shapes and is shaped by social context” (Nasir, 2002, p. 219). Nasir & Hand (2006) more generally theorize the relationship between the nature of sociocultural activity and the resulting identity possibilities for individuals: “The identities and practices that an individual is exposed to and negotiates along a trajectory of activity support an array of imagined trajectories of becoming. A more constrained trajectory results in less variety in imagined identities” (Nasir & Hand, 2006, p. 468). In the context of CS education, drawing on these insights, we are able to ask challenging questions related to the kinds of real and imagined CS identities made available to students, particularly students from historically marginalized communities. The social design experiment reported on in this study presents a particular kind of learning environment that facilitates engagement with the practice of critical design, what I argue below constitutes a transformative sociocultural activity. My analysis examines how this

particular kind of activity opens up new identity possibilities for youth of color in a 10th grade computer science context.

To expand the possible meanings associated with a CS identity in a racialized urban schooling context, I draw from perspectives that recognize the inherent complexities and tensions for identity construction within challenging sociopolitical environments. Scholars from this tradition align with developmental perspectives that point to adolescence as a crucial period in which young people negotiate their cultural identities (Erikson, 1980; Fine, Burns, Payne & Torre, 2004; Helms, 1990; Solis, 2003; Sirin & Fine, 2007), but emphasize the specificity of ways youth of color in “tight circumstances” (McDermott, 2010) experience identity construction in ways that are racialized, classed, gendered, or otherwise mediated by sociopolitical structures and discourses (e.g., Sirin & Fine, 2007). How do these sociopolitical identities relate to or interact with identities specific to (and arguably necessary for success in) computer science?

To think about these connections, the work of mathematics education scholar Danny Martin comes to mind. Martin’s work speaks directly to complex relationships between racial and disciplinary identities. In a lecture he presented at the Social Policy and Research in Cognition and Mathematics Education (SPaRCME) conference at UC Berkeley on May 29, 2015, he presented his larger research agenda as being organized around two central questions: “What does it mean to be Black while doing math? And what does it mean to do math while being Black?” Martin’s questions reveal an attention to the specificity of identity possibilities, moving past simplified notions of having or not having a positive “math identity” in his case, to explore more complex, nuanced, and varied configurations of relations between one’s math and racial identities. In a related study with colleagues, Varles, Martin, & Kane (2012) argue that “as a sociocultural and sociopolitical experience, learning any subject matter is about developing competencies related to this discipline and ‘a way of being in the world’ [Wenger, 1998, p. 151] relative to the discipline.” (Varelas, Martin, & Kane, 2012, p. 324). They draw upon empirical studies to argue that to support Black children’s learning of mathematics, it is important to understand how these various identities “interact, overlap, diverge, and develop together” along with content learning (p. 325). Drawing from these perspectives along with Nasir’s notion of practice-linked identities, this study is focused on how students’ identities can be resources in *critical design* activities, and conversely, how the practice of designing these technologies opens up new identity possibilities in computer science. Before describing the context and methods of the study, I will describe critical design as a distinct form of sociocultural practice and activity.

Critical Design as a Sociocultural Practice

While a complete discussion about the lengthy history and multiplicity of associations and meanings of “critical design” is beyond the scope of this paper, in this study I am drawing generally on perspectives that view STEM and computer science in particular as inherently political and value-laden (Rogaway, 2015; Vossoughi & Vakil, in press; Winner, 1986), and more specifically on the work of Fox Harrell. Harrell’s recent book *Phantasmal Media: An Approach to Imagination, Computation, and Expression* (Harrell, 2013), focuses on the relationships between culture, cognition and computation

in the context of designing computational media for social empowerment. Embracing a social change philosophy, he argues that purposefully designed technologies can “contribute to both the empowerment of individuals and the understanding of disempowering social infrastructures, particularly regarding social networking and gaming.” (Harrell, 2010, p. 188). Drawing from these ideas, the pedagogical and curricular approach described later in this study were intended to guide students through a process of working collaboratively with their peers to identify, research, and analyze social issues in their school, particularly issues they felt personally connected to. Then, using a design thinking for social innovation approach (Brown & Wyatt, 2015), students used a variety of tools and platforms to design technologies (games, websites, and mobile apps) that addressed these social issues.

In more recent work, Harrell has explicitly addressed issues of self-representation and identity, calling upon the design community to more fully take advantage of identity research in diverse fields such as cognitive science and sociology to guide the design of what he calls *computational identity technologies* (Harrell, 2010, p. 205). I note here that the way he operationalizes identity is very different than the focus of the study described in this paper. While Harrell is concerned primarily with the identity experiences of the eventual end *users* of the technologies, I am more interested in the identity trajectories and transformations for the students who are *designing* the technologies.

More specifically, in this study I analyze how to sociopolitical identities of students mediated the kinds of technology they designed in the context of a 10-week critical design curriculum unit, and, in turn, how the nature of this particular kind of sociocultural of activity mediated students’ sociopolitical and computer science disciplinary identities.

Methods

Research Setting, Context, and Goals

This study reports on a social design experiment (Gutierrez & Jurow, 2016; Gutierrez & Vossoughi, 2010) conducted in partnership with a computer science teacher at Bay Prep⁷ (referred to as “Prep”), a racially diverse public school in the Greenwood Unified School District (GUSD). Social design experiments (SDEs) share features with design-based research approaches (DBR) but have a more deliberate focus on designing for equity and social transformation. Similar to more traditional forms of DBR (e.g., Brown & Palincsar, 1989; Brown & Campione, 1990; Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003; Penuel, Fishman, Cheng, & Sabelli, 2011), SDEs aim to create novel learning opportunities in specific educational contexts as well as contribute to theories of learning – particularly in ways that account for how learning and participation are intricately connected to the social ecologies in which they occur. However, beyond solely taking the social context into account while designing and studying learning in situ, SDEs aim to transform the systems and structures that work to disempower particular groups. In this vein, SDEs are often

⁷ The name of the school, district, and all student and teacher names are pseudonyms.

conducted alongside and in solidarity with students and communities of color (Vakil, Mckinney de Royston, Nasir, & Kirshner, 2016), and in addition to learning and theoretical goals related to learning, carry an explicit social change agenda (Gutierrez & Jurow, 2016). The study conducted at Bay Prep was rooted in these commitments.

Prep is the largest comprehensive public school in the district, serving over 1800 students. Although they were previously the majority population of the school, African-American students currently constitute less than 40% of the student population. The remaining population is almost evenly divided between Asian, Latina/o, and White students. Over half of the students at Prep are classified as socioeconomically disadvantaged. However, due to neighborhood gentrification, this number has been declining in recent years. Prep is known throughout the district for its academies and learning pathways, including the Computer Science and Technology (CST) Academy, where this study was conducted.

The design experiment was ethnographically informed and has its origins in a larger, multi-school project examining issues of race, equity and learning in an urban district. My role in this larger study focused on Prep, and in particular the experiences of Black and Latina/o students enrolled in the CST academy. Emergent findings from this data set informed the study reported on in this paper, a pedagogical and curricular intervention carried out by myself and another classroom teacher within two 10th grade computer science classrooms of the CST academy.

Rooted in my previous work exploring culturally relevant and critical pedagogical approaches to computer science (Vakil, 2014; van Wart, Vakil, & Parikh, 2014), I collaborated with the director of the academy, Mr. Mayson, to design and teach a 10-week unit that drew connections between design, computing and educational equity topics. The structure of the 10-week curriculum was based in large measure on a previous high school course I co-designed and co-taught with Professor Tapan Parikh and Sarah van Wart in the Information School of UC Berkeley. That collaboration was similarly rooted in an orientation towards technology as a potential tool for student agency and social justice. We designed and taught a course that aimed to “introduce students to the technology design process, in support of youth organizing for social change in their communities and neighborhoods.” (taken from course description in Parikh, van Wart, & Vakil, 2014) However, the content of the curriculum in this study was substantively different, informed directly from insights about the school and the CST Academy gained from the ethnographic phase of the study mentioned previously, and reported upon in a recent publication (Nasir & Vakil, in press). These include the following: (a) the CST Academy was established and operates as a racial justice intervention in the school. The academy was founded as a response to the lack of diversity in another STEM academy, the mostly White and Asian Engineering Academy; (b) students of color at Prep are well aware of the history and purpose of the academy; yet (c) discussions of equity, gender, race, and other politicized topics are largely absent within the 10th grade Introductory Computer Science classes. This absence persists despite the formal adoption of the culturally relevant Exploring Computer Science (ECS) curriculum developed by UCLA teachers and researchers (Goode & Margolis, 2011). Based on these insights, the 10-week project-based unit, Designing for Equity at Prep (DEP), consists of a series of activities intended to reframe students’ experiences with race and equity issues as highly relevant

to the teaching and learning of computer science. An overview of the unit is depicted in Figure 1, and key activities are described in Appendix A.

Table 3. DEP Curriculum Unit

DEP Curriculum Unit		
week	Topic	Activites
1	Introduction to Unit	Identity Memo
2	Identify Problem	Design Ideation Problem Activity.
3-4	Explore Problem	Construct theoretical framework (interviews, surveys, readings)
5	Technology as a Tool	Design Ideation Solution Activity.
6-7	The Politics of Technology	Politics of Tech Memo
8-10	Prototyping and Artifact Development	Balsamic wireframes Pair-programming

Data Collection

The DEP curriculum unit was implemented in two periods of Mr. Mayson’s 10th grade Computer Science class, with approximately 30 students in each class. From these two classes, my study focuses on 12 focal students, spanning 7 student groups, each group focusing on a specific equity issue within the school. Given my research focus on the possible relationships between students’ computer science and sociopolitical identities within the designed context, students were selected based on their level of engagement in the class, determined both by Mr. Mayson’s recommendations as well as ethnographic observations of CST students preceding the design (Nasir & Vakil, in press). Major data sources include student artifacts (N=12) (final project portfolios, student sketches, designs, memos, PowerPoint presentations, and posters), artifact-based group interviews (N=7), field notes as well as audio reflections of class sessions, and video recordings of cooperative group work and whole-class conversations. Two to three video recordings were made per week, amounting to over 60 hours of video data. Two video cameras were used, and each recording was either focused on a single group, pedagogical and instructional practices, or whole-class conversations. In addition to these data sources, survey data was used to help provide a broad sense of how students experienced the unit, and to guide my analysis in useful directions. Using what we were learning from the ethnographic phase of the study mentioned previously, both in terms of how computer science was being framed in the school, and also in terms of how salient the equity issues were at Prep, I created a survey that I administered prior to the design

experiment, and immediately after. Broadly, survey questions were designed to assess how students think about technology in relation to the social condition of their school and community. The survey is available in its entirety in Appendix B.

Analytic Approach

Given this range in data sources, my analytical methods were varied. I did a number of things with each component of the data set. Drawing on the notion of technobiographies (Pinkard, Barron, & Martin, 2008), I utilized student artifacts to create portraits of each of the focal students. The aim of these portraits was to identify the politics of students' technologies. I bolster my analysis with student work from the *Politics of Technology Memo* assignment (see Appendix A), as well as recordings of students discussing the politics of their technology during group, as well as in whole-class conversations. Next, I trace the development of the politics, trying to understand when they emerged in activity, how they developed and through what processes they ultimately entered into the design of the technology. Finally, with an understanding of the artifacts and the process through which the sociocultural/political ideas within them took shape, I focused my attention to understanding how students' multiple identities (racial, political, and disciplinary) shaped and were shaped by participating in the practice of critical design. Using video data and the artifacts themselves, I created a more detailed case study analysis for two focal students (Yin, 2003), Stacey and Lupe, focusing specifically on ways that students' identities shaped and were shaped by the design process. These students were selected for two reasons. First, based on survey and ethnographic data as well as Mr. Mayson's assessment, Stacey and Lupe had strong computer science identities in the traditional sense. Both students were deeply engaged in the class, prior to and during the design experiment, and were viewed by their classmates as leaders. Second, they expressed very different sociopolitical identities, particularly prior to the DEP unit. The fact that they displayed similarities in terms of their disciplinary identity yet had differences in their sociopolitical identities provided a window into exploring the multiplicity of possibilities for interaction between computer science and sociopolitical identity.

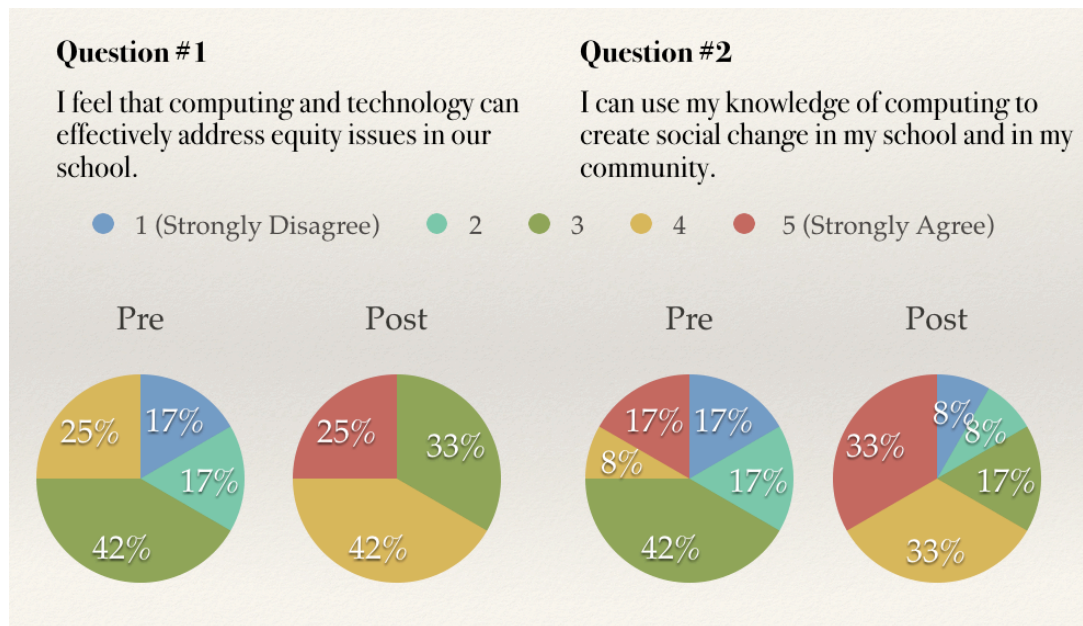
Findings

Overall, data from the design experiment shows that the practice of critical design created opportunities for students' sociopolitical identities as well as computer science identities to interact and inform one another. Moreover, I found that a designed context that creates space for these identities to interact with one another creates opportunities for students to design computational artifacts that reflect their sociocultural viewpoints, identities, and experiences. Before sharing data from the two focal case studies, I will share some results from the survey data that provides context for the case studies.

Broadly speaking, the survey results indicate that the 10-week DEP curriculum unit organized around critical design practices created new identity opportunities for students. I highlight here two survey questions that deal with how students think about technology in relation to the social condition of their school and community. The questions are similar, yet different in subtle but important ways: the first question was

designed to gauge how students feel in general about the extent to which technology can be a force for change, with the second question designed to assess students' own sense of their knowledge and agency to create change. Results from both of these questions, displayed in Figure 2, reveal that the designed environment created opportunities for students to think differently about the way they could use technology as a tool for social transformation.

Figure 1. Survey Results



Beginning with the first question, at the beginning of the design experiment, 34% (N=4) students reported that they either disagreed or strongly disagreed with the proposition that technology/computing could address equity issues at their school. Most students (42%) were neutral on the issue (N=5), while a smaller number (25%, N=3) of the students said that they agreed with the proposition. While it is significant to note that the post-survey indicates a greater number of students (67%) either agreeing or strongly agreeing with the claim that technology could address equity issues at the school (N=8), there are several possible interpretations of these results. One possible interpretation of the survey results would suggest that a designed learning context could positively impact students' perceptions of the power and possibility of technology to create social change in their school. However, it is important to note that this interpretation leaves unexamined how other factors may have mediated student responses, such as students' views on equity issues, and students' sociopolitical identities and stances. For example, it is possible that a particular student believes in the power of technology for social change, but also has a structural analysis of equity issues in their school that dampens their belief about the power of technology to effect meaningful change in their school. Alternatively, a student's general apathy or lack of interest in equity or social justice issues can also mediate their response to this question. Finally, there was the possibility that students' self-assessment, both in terms of sense of agency to act on equity issues generally, and

also in terms of sense of agency to create technological artifacts, could have impacted the way they answered this question. To more directly probe notions of agency and identity, the second survey question was an attempt to move beyond a general sense of how students viewed the role and power of technology by asking a question that centered students within the question. This was an attempt to gauge the extent to which students personally felt empowered to create technology for social change. Interestingly, the patterns were similar to the first question: the post-survey results reveal that a greater percentage of students (67%, N=8) agreed or strongly agreed with the proposition that they could use their knowledge of computing to create social change compared to the pre-survey results (25%, N=3). While these results do not provide an in- depth look into *how* the designed context opened up new possible interactions and relationships between student sociopolitical and CS disciplinary identities, they do generally reveal that the designed environment created opportunities for students to think differently about the way they could use technology as a tool for social transformation in their school. The case studies provided below explore how the designed context accomplished this, focusing particular attention on the mediating influence of students' identities.

Case Studies: Tensions and Possibilities between Computer Science and Sociopolitical Identities

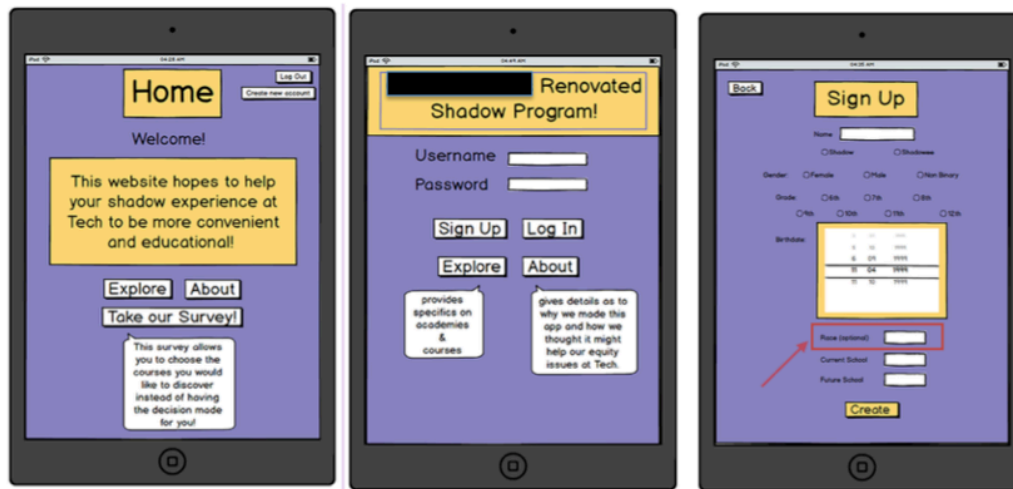
In this section, I closely examine the identity experiences of two students, Stacey and Lupe, throughout the ten-week social design experiment. My analysis focuses on how their sociopolitical and CS disciplinary identities interacted with one another and informed the final technological artifacts they designed. The two cases illustrate not only that students' identities informed their production of technological artifacts designed to stimulate social change in their school, but also that being engaged in the practice of critical design had important implications for students' identities, both their sociopolitical identities as well as their disciplinary CS identities. Though the identity trajectories and transformations of Stacey and Lupe were quite distinct, both students experienced a shift in the relationship *between* their sociopolitical and CS identity, and importantly, in ways that I argue ultimately represented a strengthening of their overall STEM identity. For Stacey, engaging in a collaborative process of critical design challenged her ideas about equity and social justice, and opened up new sociopolitical identity possibilities for her. Although she was a highly engaged and motivated CS student prior to the design study, she took on a new identity as an advocate for social justice that was tightly linked to her CS identity. Lupe was a similarly engaged and high-performing CS student prior to the 10-week unit. However, in contrast to Stacey, Lupe also had a strong sociopolitical identity that existed alongside but in tension with her CS identity. The experience of engaging in the practice of critical design strengthened her overall CS identity by attending directly to this tension, ultimately allowing Lupe to view her interest in CS as complementary - rather than contradictory - to her social justice commitments.

To tell the story of Stacey and Lupe and the artifacts they created, I have to also tell the story of the groups they worked within. I must simultaneously tell the story of how the broader pedagogical and learning environment of the designed context both contributed and constrained the kinds of politics ultimately represented in the group's

final artifacts and the related identity experiences students had. I begin each case by describing the technological artifact and the politics it represents, focusing particularly on how the artifact was framing equity issues in the school. I then narrow my attention to the unique experiences of Stacey and Lupe, focusing specifically on the identity trajectories and transformations they experienced throughout the design process. I begin with Stacey and the Woodland Fairies Group.

Case Study: Stacey and the Woodland Fairies Group

Figure 2. Shadow App



Stacey and her group mates, Lidiya, Angela, Candice, and Ben, call themselves the “Woodland Fairies group.” They worked together for several weeks to design an app that aimed to increase diversity in the most rigorous academic spaces in their school. Stacey, in her Politics of Technology Memo, describes the equity issue her group addresses as “...the inability of low income and of minorities to be exposed to the amount of crucial opportunities they could be provided.”

Their final app was an intervention upon the shadow system⁸ of the school and was appropriately titled “The Shadow App” (See Figure 2). The shadow app aims to alter the processes through which incoming students are matched with upper classmen in the school’s existing shadow system. The current shadow system of the school has been implemented to help incoming 9th graders gain a sense of the various programs and academies within the school by “shadowing” an upper classmen. The students call the one who is being shadowed the “shadowee.” Angela, a quiet but thoughtful member of the Woodland Fairies, elaborates further in her Politics of Tech Memo:

We are taking the basic Shadowing system here at [Prep] and building onto it... This will enable students, and anyone else who wants to see, to get a more in depth view of academies and programs and other things that are offered at school.

⁸ The shadow system allows incoming 9th graders to observe or “shadow” upperclassmen in academic as well as social spaces in the school.

The target audience is mainly incoming freshmen, but as we develop the idea, could be useful for students in general. We would like to provide a source of role models for minorities.

The students argued in the course of the design process that tailoring the shadow system to students' interests would allow a greater number of students of color, who are drastically underrepresented in many of the school's academies and programs (Nasir & Vakil, in press), to make a connection with and ultimately seek entry into one of the school's rigorous academies. Stacey, again in her Politics of Tech memo, addresses the issue of race/ethnicity (and gender) directly: "We also provide the opportunity to choose the gender and ethnicity of the individual if they feel more comfortable identifying with race than with the subject itself." Similarly, Angela frames the shortcomings of the current shadow system in general and the ways their artifact would improve upon it in terms of potential benefits to students of color in particular.

We want their stories to be up on our site for encouragement or information or just to let people know that people like them exist; people like them have checked out the opportunities at [Prep]. The Shadowing aspect will work with [Prep] to schedule more detailed shadowings. Students should be able to go in and get a first person view of the things they are interested in and are thinking about checking out at [Prep]. With our current system, students are either set up with a friend/relative or a random person, and these options do not necessarily give students a wide range of things to see. The website/app itself will have a menu page that clearly links to people's advice, descriptions of academies and what not, and a contact page. It should be easy to navigate, and easy to set up a Shadowing visit... This method addresses the equity problem because it allows for minorities, who are statistically less present in academies and such at [Prep], to see what they are interested in and get a role model's perspective. It empowers kids to know that they can beat racial biases and do what they want to do.

To these ends, the app offers three primary functions/services: (a) a repository of detailed information about each of the school's various academies, including course sequences and requirements for admission; (b) a survey intended to develop a profile of student interest (including race and gender information to allow students of color and girls to select a shadowee from a race/gender of their choosing); and (c) a matching algorithm that matches students to shadowees based on the profile and availability of shadowees.

Engaging in Critical Design: Stacey's Identity Processes and Transformations

Beyond the computational concepts and practices necessary to design a technological artifact, a central pedagogical goal of the unit was for students to collectively work out the politics of their developing artifacts, often explained to students as "how and where they are locating the problem." (Field Notes, March 20). I wanted students to gain an understanding that their technological artifact would itself stand as an argument for how the group was conceptualizing the underlying problem they were

hoping to address. Ultimately, for the Woodland Fairies group, by intervening on a school level structure (the existing shadowing system) and framing student interest as being deeply connected to structures of opportunity within the school, the politics of their artifact, summarized in Table 1, aligns with critical and sociocultural perspectives on student interest, and educational inequity in urban schools (e.g., Barron, 2004; Noguera & Wing, 2006).

Table 4. Politics of Shadow App

<i>Technology Feature/Function</i>	<i>Politics Represented</i>
Repository of information about academies	Lack of role models of particular race/genders in rigorous academic spaces contributes to discourse that marginalizes students of color in the school.
Survey to assess student interest	Race-conscious systems are needed to address racialized inequities in the school.
Matching Algorithm	Student interest as tied to opportunity structures.

However, it is important to note that the features and functions of their final artifact and the politics associated with it were constantly in negotiation throughout the course of the 10-week unit. The pedagogical design of the unit included collaborative design activities for students to work out their ideas in groups and present and receive feedback from the class, as well as individual assignments in which students wrote individual memos articulating the politics of their artifacts (see Appendix 1). Drawing on Stacey’s experience as an illustrative case, I argue below that being engaged in this process of negotiation is a socioculturally intensive experience that both shapes and is shaped by students’ multiple identities.

At the beginning of the unit, Stacey articulated a different set of politics linked to school equity that mirrored deficit narratives in educational discourse. During a discussion with members of her group about a commonly used phrase in the school, “Two [Preps],” which highlights the highly unequal and racialized experiences of students within the school, Stacey stated:

I have never heard this term before...I think what people mean by that term is that the people who are chosen are part of an elite that, that academy prefers. . . preferences either through grade, ethnicity. . . um, and I guess behavior maybe...but I disagree with it though because if you put your mind and effort everyone can have the same opportunities.

The following week, Stacey and her group had settled on diversity as their equity topic, but they were still working out how best to characterize the problem, how to talk about the problem, and, most importantly, how to situate their own identities in relation

to the problem. In my field notes written after another group discussion on March 26, I begin to notice a relationship between Stacey's racial identity and her conceptualization of the diversity problem at Prep:

Students worked today to identify root causes of the diversity problem in their school...lots of good discussion and some disagreement. Interesting that Stacey, the only other Black student in the group (besides Lidiya, who is of Eritrean descent), frames diversity mostly in terms of the culture of underrepresented groups, and even referred specifically to "group mentality" amongst African-American students to explain why they are not represented in some of the academies. I also observed that she talks about Black students in a way that suggests she may not see herself as Black. I wonder how this plays into her understanding of diversity issues.

A few classes later, in another discussion with her group, Stacey voluntarily brought up her own racial identity while discussing the experiences of Black students in the academies. "I'm not complete black, I'm mixed but..." Lidiya, who identifies both as Black and Eritrean, was seated on a table, interrupted Stacey, leaned down and patted her on the shoulder while saying with a warm smile, "...you are Black," as if to affirm her authority in talking about the experiences of other Black students in the school. Interestingly, the following week after another group in the class had presented their design ideas about addressing diversity specifically within an Honors English/History pathway of the school, Stacey raised her hand and offered up her own experience as testimony during a class debate about whether or not the equity focus of the presenting group was justified (with which Lidiya had taken issue⁹). Stacey, seated in the back of the room then addressed the entire class, "In my [Excelsior¹⁰] class, Brian and I are like the only Black people," stated in such a way as to affirm the worthiness of the equity topic of the presenting group. In my field notes from that class, I noted that her voice had lowered a little bit while she was saying this, but marked a significant moment where Stacey claims a Black racial identity in front of the entire class as a way to legitimize her viewpoint and bolster her argument in support of the presenting group. Her evolving racial identity paralleled her developing conceptualization of the diversity problem her group was addressing as a uniquely racialized issue in the school. In a written assignment midway through the unit, Stacey elaborated her growing understanding of the diversity problem her group was tackling. "I began to notice that the mixed girls I was seeing in the hall weren't in my advanced courses, and the girls with the poofy hair weren't in my [Excelsior] class, which caused me to reevaluate how diverse the school actually was on a smaller level, the classroom."

I now turn to examining how Stacey's developing understanding of diversity as a specifically racialized issue in her school, along with her evolving racial identity, was linked to her involvement in the practice of critical design (Nasir & Hand, 2006), and the resulting implications for her disciplinary CS identity. In the pre- and post- survey, students were asked to describe how and why they selected to enroll in the CST academy.

⁹ A detailed examination of this episode is the focus of Chapter 4 of this dissertation.

¹⁰ An advanced learning pathway focused on English and Social Studies.

Stacey answered the same question quite differently in the post survey. In the pre-survey, she wrote: “I joined the academy because I believed a basic knowledge in this field is good to enter when finding jobs in the 21st century. I also believed there would be many jobs in this field for women and I hoped it would prepare me for the future.” In the post-survey, she similarly framed her interest in the CST academy in terms of future employment opportunities. However, in addition to the gendered analysis, she also included a racialized narrative absent in the pre-survey: “I chose the Computer Science and Technology Academy because I have always had an interest in technology as well as the belief that one day every job will involve technology...When I visited [Preps] courses before officially enrolling in the school, Mr. [Mayson] converted me even more towards practicing computer science with the thought that, especially as a mixed girl, it would open so many more opportunities that I never believed I had.” That Stacey links learning computer science to the opening up of new opportunities “especially as a mixed girl” signals an emerging identity relationship between her racial identity on the one hand, and her CS identity on the other.

Stacey’s emergent Black racial identity and racialized understanding of diversity issues at Prep also had implications for how she engaged in the critical design process. In her Politics of Tech memo she provided an assessment of her group’s progress on their artifact. “Although most of our ideas and technology is thought out, there are still a few problems with our concept. The first being that there might not be a black sophomore in the engineering academy next year that a sophomore was hoping to visit, but we will try our best to fix those flaws through more brainstorming and effort.” Here, Stacey, concerned about a potential scenario where their artifact in its current iteration would fall short from its intended goals, not only demonstrates the attention to detail required in user-centered design projects (e.g., Abras, Maloney-Krichmar, & Preece, 2004; Ghosh, Parikh, & Chavan, 2003), but also a sensitivity and focused attention to the experiences of Black people in particular, signaling an emergent racially-conscious approach to design (Fouché, 2006). In this case, the critical design process had created the conditions under which Stacey’s racial identity and racialized understanding of her group’s topic were evolving, and in turn, shaping the thinking and design of her group’s technological artifact.

In summary, for Stacey, engaging collaboratively in critical design to create an artifact had important implications for her own racial identity development. This was because of her understanding of and commitment to diversity issues in her school, and her disciplinary identity as a computer scientist. She went on to lead a club focused on racial justice that is ongoing and the subject of a forthcoming article on student activism. I end this case study with Stacey’s overall reflections on the project:

Because of this project, I am not only creating and coding an app that hopes to aid the issue, which is something I never envisioned accomplishing, but it has also opened the door to so many opportunities and interests I never knew I had such as internships and maybe the chance to lead a club that aims will be to help [Prep’s] equity issues. This unity has taught me so much about my community and how it is structured, why it is the way it is and what we can do to make it better through technology. I have loved discussing my point of views with peers and

reevaluating thoughts I once thought were true, but now not so much. I hope that by pursuing and perfecting my app that I will learn more.

Case Study: Lupe and STEM Gal

I turn now to the case of Lupe, who, along with her best friend and design partner, Candice, created an impressive video game designed to empower girls of color in STEM spaces. In contrast to Stacey, Lupe and Candice's racial as well as political identities were central to how they defined themselves, and were evident from the very beginning of the DEP unit. Lupe, Latina, and Candice, African-American, repeatedly expressed the deep connections between race and gender issues. In her Identity Memo, Candice drew links between her out-of-school interests and her own racial and gender identity:

Feminism is important to me because I'm a BLACK GIRL [caps original] which is 2 minorities wrapped into one...I'm in a lot of clubs at school like film club which is where we watch movies and feminist club where we talk about feminism and QSA where we talk about queerphobia.

Similarly, Lupe said that social justice concerns were central to her identity:

I really want to make a change in this school but also in general. I am a feminist and I feel like that covers intersectionality and the problems that people of color and trans people and disabled people and all the types of oppression that comes together in this world. In my experience as a girl I have felt uncomfortable and definitely annoyed with male teachers and just overall not the same environment as a female teacher environment. [Excelsior] is something I especially want to fix because there are so little people of color and girls speak only when called on while boys speak when it's not even their turn.

While brainstorming about specific equity issues to address, the students narrowed their focus on gender inequality within the CST academy itself. However, their analysis and focus on gender was not disconnected from their broader experiences related to race. As Candice stated in her Politics of Technology memo:

And when I say gender inequality I'm not just talking about gender, race comes into play too. I'm one of I think 4 black girls in my year of technology academy. I think Lupe is 1 of 3 Latina girls in Technology Academy. It's important that with our technology we target girls, but getting girls of color involved in STEM is really important to us too.

Stem Gal: A Game by and for Girls of Color in STEM

Using the Scratch programming environment, Lupe and Candice designed *Stem Gal* (see Figure 3), a video game to help girls of color resist negative stereotyping in STEM environments. *Stem Gal* incorporates elements from a genre of video game design known as action role-playing games, or action RPGs, in which the player's success is a function of the speed, frequency, and timing of particular actions. In the case of *Stem Gal*, the primary objective for the main player, a customizable avatar set by default to a phenotypically Black female, is to effectively navigate a hostile STEM environment by avoiding condescending remarks and interactions from (white) males and to build solidarity with other girls of color in the environment and earn "confidence points" while doing so.

Figure 3. Stem Gal



The concept for this game not only reflects Lupe and Candice's social justice orientation in a general manner, but also emerges from and reflects specific experiences the students have experienced at Prep. In her Politics of Technology Memo, Lupe describes one such experience in the Computer Academy:

The tech world has so many guys but there really aren't a lot of girls and when there are, they're in a male dominated environment that makes them self conscious about their abilities, purpose, and a lot of other things. We know this because this is how we feel. One time we were doing a lab [in the Computer Academy] where we take apart a computer and this boy came and super patronizingly asked us if we needed help. He said we looked like we needed help because we were going a little slower than everyone else. That would be a huge reason for girls not wanting to be in STEM. And then I think for girls of color it's because there's no representation. You rarely see anyone that

looks like you that's painted in a good light in the media if you're a girl of color, so you probably really won't see one in STEM.

Table 5. Politics of Stem Gal

<i>Technology Feature/Function</i>	<i>Politics Represented</i>
Girl of Color Avatar as Protagonist and White Male Avatar as Antagonist	Girls of color experience marginalization in White and male-dominated STEM spaces. Social justice is achieved through empowering people of color.
Confidence points	Individual members of marginalized groups can develop confidence through acts of solidarity with one another.
Simulation of motion/navigation through STEM space	STEM learning environments are relational environments. Interactions with other students shape quality of learning experiences.
Simulation of Jumping Over White Male Antagonists	Racism/sexism should be actively confronted and resisted.

I now provide a closer examination of the nature of the politics advanced through *Stem Gal*, summarized in Table 2. Both Lupe and Candice were clear about *whom* their game was being designed for: girls of color in STEM spaces. Designing intentionally with specific target users in mind is generally regarded as an important design practice (Abrams, Maloney-Krichmar, & Preece, 2004), but in this case, it is also an enactment of Lupe and Candice’s racially conscious politics. They not only knew what the problem was, but from which angle they wanted their technology to address the problem. In her Politics of Technology Memo, Candice elaborated:

Games that are targeted at privileged people in the point of view of oppressed people are so problematic. They don’t ever accomplish anything because they tell the story that oppressed people have been trying to tell forever. It promotes the practice of disbelieving oppressed people until the privileged ones have experienced it. They pat privileged people on the back for a) creating the game if they did and bringing about ‘change’ by playing the game and showing basic decency and empathy which creates the idea within privileged people that they’ve done something of substance (I guarantee they’ll think “I’ve ended racism/sexism/etc!!”) It gives the impression that they’re changing something when in reality all they are doing is dominating the narrative of the oppressed and closing their ears further to oppressed peoples experiences.

In addition to creating a game that explicitly aims to empower girls of color, the incentive system of the game also made an argument for a specific kind of resistance to gender and race-based marginalization. Lupe’s explains in more detail:

You have interactions with all types of people you would normally encounter as a scientist who's a girl. There'd be a conversation with a male peer who's trying to incite you or subtly making fun of you and the choice bubble will tell you this and ask you what you'd like to do next. You can walk away or give him your two cents (more points for this one). and then you'll see yourself saying to him something you could actually say yourself irl [in real life].

I note here that while related to liberal ideas such as diversity and inclusion, *Stem Gal* actually is more aligned with social justice perspectives on educational equity. The game's incentive system encourages users -girls of color - to directly confront marginalization ("you can walk away or give him your two cents (more points for this one).") The main player is empowered by actively resisting (in the game this is jumping over) white men characters who have condescending or negative things to say, such as "good job sweetheart," as well as by building solidarity with other women in the space.

Engaging in Critical Design: Lupe's Identity Processes and Transformations

As mentioned earlier, Lupe entered into the process of critical design as an already politicized girl of color *and* also an engaged and successful computer science student. Unlike Stacey, the transformation she experienced was not one of becoming politicized or developing a stronger racial identity through the process of designing politically relevant technology. Nor did the DEP unit spark a previously dormant interest in computer science. After all, Lupe, like Stacey, had self-selected into the Computer Science and Technology Academy of their high school, and she was already one of the best students in the class. Rather, for Lupe, engaging in critical design was an opportunity for her to reconsider the relationship *between* her sociopolitical identity and her computer science identity, a relationship that was tenuous prior to the DEP unit. In her Identity Memo, despite expressing her interest in and knack for computers and technology, Lupe also gives voice to the tension she feels towards the discipline of computer science:

I'm at the age where the question "what do you want to be" is becoming more relevant. I've always been scared that someday I'm going to sell out and do something that I hate. I feel like I even think of computer science like that, like being a part of a huge unfeeling oppressive corporation that makes you money sure, but never does something good.

In the previous chapter of this dissertation, I discussed how computer science is being framed to students at Prep, which sheds light onto the very tension Lupe is expressing in the excerpt above. I now draw attention to the fact that she is experiencing a tension between her sociopolitical identity and her developing CS identity. With this in mind, the practices of critical design offered up a new and exciting possibility for

Lupe to *be* political while engaged in creating technology. In a written assignment reflecting on the DEP unit as a whole, she writes:

I think that's another thing that this project opened up for me. I never *actually* [italics original] thought of computer science doing something like this. Well I had but it was so vague like it was always "you can create anything. It could change the world," which makes absolutely no sense bc like how do you do that? How does it work? But now I totally know the process of how to locate a problem and narrow it down to something workable.

She revisits her earlier comments linking the practice of computer science and her fear of being part of a "huge unfeeling oppressive corporation":

But now my idea of this has changed (not about those corporations but in general) and that this could be something that I could pursue and be passionate about. Overall this was a super fun, inspiring, empowering project that I'm really grateful I had the chance to have.

The DEP unit provided an opportunity for Lupe to bring together multiple aspects of her identity, aspects of herself which, prior to this learning experience, existed in uneasy relation to one another. Thought not always intentional, learning environments that do not create clear opportunities for students like Lupe to draw upon their sociopolitical positionalities and identities inadvertently send messages that those identities are irrelevant or unwanted. In the process, students who may otherwise have excelled in particular domains, such as STEM and computer science, are ushered out of these pathways.

Discussion and Concluding Thoughts

Equity scholars in STEM fields, in particular in mathematics and science education, have long been attending to issues of identity. In the sub-field of computer science education, though identity has been less of an analytic focus, scholars and practitioners have recently been increasingly attending to issues of equity, participation, and engagement. In this paper, I have made the argument that in the quest for equity in computer science education, we must begin to go beyond narrow conceptualizations of identity that ignore or dismiss the full scope of students' identities, including their racialized and sociopolitical identities, which may be interacting with their CS and STEM identities in unanticipated and unproductive ways. The story of Leslie Miley, the Twitter engineer whose departure from the company due to disputes over diversity with senior management, bears great resemblance to the case studies presented in this study. Leslie, Stacey, and Lupe, all people of color, worked to negotiate their multiple identities, sociopolitical and STEM-related, in consequential ways. For Leslie Miley, there was ultimately an irreconcilable tension between the aspect of his identity that led him to

advocate on behalf of racial diversity issues and the demands of working at a major technology company. Perhaps his story most closely resonates with that of Lupe, who was also grappling with identity tensions related to the conflicts between her interest in activism and her interest in computer science. Fortunately, at least at the culmination of the DEP unit, Lupe seemed to be reconciling these two identities. Lupe seemed to be moving towards a new strengthened STEM and sociopolitical identity that brought together her activism and technology interests. For Stacey, engaging in computer science in a new way allowed her to expand her racial identity and develop a political identity which, while new, was beginning to intersect with her CS identity in important and exciting ways. Taken together, these case studies hold important implications for the future of equity-oriented CS education research and practice. Equity goals should be recalibrated to move beyond skills or even practices to include explicit goals around supporting students' multiple identities, broadening possible CS identities in ways that not only acknowledge but respect and invite students' racial and political identities to enter into the "space" of computer science learning. Like the DEP unit, learning environments that approach equity from this lens create new possibilities for the learning and doing of computer science in ways that not only broaden access to underrepresented groups, but redefine the field itself – thus leading to designs, practices and technologies that are socio-politically aware and rooted in concerns and values of populations that have been historically neglected in STEM disciplines.

Chapter 4: “You’re so far out, and you’re trying to look in”: Exploring Politicized Trust in a Racially Diverse Computer Science Classroom

In the United States, educational practitioners, scholars, and activists who take an explicitly political or social justice focus often work in disciplinary areas related to the humanities or social sciences, and less commonly in STEM education (science, technology, engineering, and mathematics). This is the case despite the myriad ways STEM-related knowledge and practice is deeply related to issues of power, race, immigration, gender, and justice. For just two very recent examples, I point to the Flint water crisis,¹¹ and the highly publicized debates between Apple and the FBI.¹² In the former case, questions of anti-Black racism (Dumas & ross, 2016), public health, and environmental justice intersected in grotesque ways as government officials deliberately ignored evidence of flagrant abuse and injustice (Bernstein & Dennis, 2016). In the latter case, legal and technical questions arose alongside Islamophobic discourses of terrorism and national security (Ahmed, 2015).

STEM issues live in the everyday, locally and globally and have profound social, educational, economic, and social justice implications, especially for people from nondominant communities. These are complex issues that require complex thinking and nuanced and multi-pronged solutions. Yet, in the United States, seldom (if ever) does learning in STEM disciplines prepare youth to think about or analyze, let alone act upon, the increasingly complex local, global, environmental, human rights, and sociopolitical issues of the 21st century. Fortunately, however, there are a growing number of scholars, educators and activists who are working collectively, albeit often in very different ways, to transform STEM education towards more intellectually robust and socio-politically relevant ends. It may come as no surprise that social justice and equity scholars in STEM education have tended to focus on issues of curriculum (the “what”) and pedagogy (the “how”), essential dimensions of any serious educational project and generally the first move in reframing STEM education. Even so, in this paper I argue that in addition to curriculum and pedagogy, equity and social justice approaches to STEM must also consider questions of human relationships and solidarity. This must include not only relationships between teachers and students, but also those between students themselves,

¹¹ In 2014, the city of Flint, Michigan changed its water source to the Flint River in an effort to save money. As a result, the city’s predominantly African-American and poor residents have been exposed to unsafe levels of lead in their drinking water – levels which were high enough to cause permanent brain damage in children (Lerner, 2016). Several independent reports indicate that race and poverty played a role in the government’s neglectful and delayed response to the crisis (Bosman, 2016).

¹² After the December 2015 terrorist attack in San Bernardino, California, Apple defied the FBI and several court orders by declining to create the software necessary to unlock the recovered phone of shooter Syed Rizwan Farook (Froomkin & McLaughlin, 2016). The Department of Justice later dropped this case after the FBI announced a third party had helped to unlock the phone.

particularly so in the context of racially diverse classrooms and schools. This paper reports on a study conducted within an equity-oriented 10th grade computer science classroom in a large urban high school in the San Francisco Bay Area. The framing question for the study is: What kinds of tensions surface while implementing equity-oriented computer science educational projects in racially diverse learning environments? Focusing on the topic of student relationships specifically, I ask: How do inter-racial student relationships mediate classroom interactions and student experiences in the context of an equity-oriented computer science learning environment? I present video data that illuminates the nature of student relationships in a particular episode of conflict that arose during student presentations about social justice topics in the school. I argue that a lack of trust and solidarity between students ultimately compromised the equity-oriented goals of the classroom. The findings presented in this paper argue that (a) we must attend to student relationships in equity-oriented STEM learning environments, and (b) we must do so in ways that explicitly take issues of race and power into account.

Literature Review

This work draws on and extends insights of an important body of work in STEM education that has advanced our understanding of collaborative learning, student interactions, and student conversations, issues central to reform-oriented STEM learning environments. In particular, I build from a smaller body of work that addresses student relationships more directly. After this, I then elaborate the concept of *politicized trust* as an analytical tool and lens that builds from these conversations by explicitly addressing issues of race and power within student relationships in diverse classrooms.

Recent curricular documents, such as the Common Core for Mathematics and English and Next Generation Standards in Science (NGSS), place greater emphasis on collaborative work, student voice, and student-directed learning (Porter, McMaken, Hwang, & Yang, 2011; Lee, Quinn, & Valdes, 2013). Similarly, in the educational research community, there has been considerable focus on designing and studying learning environments that promote group and collaborative learning, in which students are asked to work together on a common task, to brainstorm, discuss, debate and problem solve (Lemke, 2001). Within mathematics and science education in particular, researchers, especially those drawing on sociocultural perspectives of learning, have focused on topics such as student conversations (Sfard & Kieran, 2001), the conditions and pedagogical practices necessary to promote student dialogue (Boaler & Humphreys, 2005), and the resulting learning and conceptual gains associated with collaborative and group-based learning activities (Cohen & Lotan, 1997, 2004; Greeno, 1998). Within these approaches lies a recognition that successful collaborative learning is contingent upon the nature and quality of student interactions. For instance, in Brigid Barron's seminal study of 12 triads of 6th-grade students working together to solve math problems, she found it was the quality of interactions between group members that was the strongest predictor of group outcomes, and which was also correlated with individual learning gains (Barron, 2003). In another well-known study, researchers reported that pairs of math students working collaboratively to write explanations in geometry manage not only conceptual ideas related to the problem, but also interpersonal concerns favoring agreement (Engle & Greeno, 1994).

The increased focus on student interactions within collaborative STEM settings has also raised important equity concerns related to student positioning, status, and power. For instance, in their recent study of a lively, student-led debate within an elementary science classroom, Engle, Langer-Osuna, and McKinney de Royston (2014) examine how one student, despite having less normatively valid scientific ideas, exerted “unmerited influence” over other students. In the context of mathematics education, with similar issues in mind, researchers and practitioners at Stanford University have developed the Complex Instruction (CI) approach, explicitly designed to address status and equity issues within reform-oriented mathematics classrooms organized around student collaboration and group work (e.g., Cohen & Lotan, 2004; Esmonde, 2009, Esmonde & Langer-Osuna, 2013). Taken together, these studies reflect an important shift towards considering student relationships in the context of STEM learning. At the same time, it is important to note this shift is often justified as part of a larger goal of helping students gain conceptual understanding or improve learning in a disciplinary domain, which are undoubtedly important aims. However, even within this frame, student relationships become a means, not an end unto themselves. In contrast to other scholars in educational research who have treated relationships in schools, both teacher-student and student-student, as an ethical priority (e.g., Noddings, 2013; Valenzuela, 2010), cultivating relationships in practice and attending to them analytically in research, has been less common in the domain of STEM education.

Why Do We Need Politicized Trust in Equity Approaches to STEM Education?

In this paper, I build on an important counter example to this trend, mathematics education researcher Jo Boaler’s work on “relational equity,” which she defines as “equitable relations in classrooms; relations that include students treating each other with respect and considering different viewpoints fairly...” (p 168). Writing about the CI approach mentioned above, she argues for a conceptualization of equity within mathematics education that emphasizes the importance of “values such as respect and responsibility for others, including those from a different culture, sex and/or social class” (Boaler, 2008, p. 172). Drawing a clear distinction between relational equity and other conceptualizations of equity in mathematics education, she explains:

In classrooms that promote relational equity students would learn to respect each other’s differences, to listen to others who have a different opinion, perspective or experience and to act in equitable ways. This is different from the ‘social justice’ perspective put forward by Frankenstein, Gutstein and others, who consider the ways mathematics knowledge may be used to combat issues of injustice (Frankenstein, 1989, 1990; Gustein et al., 1997). (p. 173)

On one hand, I appreciate the conceptual clarity gained when Boaler distinguishes relational equity from other approaches (such as the “social justice perspective”), framing issues of respect and communication between students as important irrespective of *what* is being learned or collaboratively problem-solved. On the other hand, it strikes me that while relational equity may offer important organizing principles for any learning environment, issues of student respect, understanding, and communication become

particularly critical in STEM classrooms that *are* specifically focused on social justice topics. Furthermore, this point is heightened within racially and socioeconomically diverse classrooms and schools, in which the lived experiences and racialized identities of students in relation to issues of justice and oppression may create formidable challenges, but also opportunities, for developing the kinds of equitable relations Boaler describes. Despite Boaler's research taking place in diverse urban settings (Boaler & Staples, 2008), her focus on respect and relationships leaves fundamental issues of race and power underexamined and undertheorized, despite broad appeals to ideals of diversity and inclusivity:

I contend, as have others (Cogan & Derricott, 1988; Steiner-Khamsi et al., 2002), that one of the goals of schools should be to produce citizens who treat each other with respect, who value the contributions of others with whom they interact, irrespective of their race, class or gender, and who act with a sense of justice in considering the needs of others in society. (pp. 167-168)

I agree with Boaler that developing student relations based on respect should be a primary goal of education, but disagree with her assumption that this can be achieved "irrespective of their race, class or gender." The analysis presented in this study suggests that attempting to develop relations based on respect, and, I add trust and solidarity, without thoughtfully attending to the racialized and politicized dimensions of student relationships not only amounts to a reproduction of colorblind ideologies (e.g., Bonilla Silva, 2003; Omi & Winant, 2014; Richeson & Nussbaum, 2004), but also may create tensions between students from racialized groups that can limit the potential for collective learning and action. In other work, building on critical race theory perspectives, I have argued against colorblind approaches in education (Vakil, McKinney de Royston, Nasir, & Kirsher, 2016):

If the idea of racialization suggests that the recognition of an individual or group's race serves to locate them "within a socially and historically demarcated set of demographic and cultural boundaries, state activities, 'life-chances,' and tropes of identity/difference/(in)equality" (Omi & Winant, 2014, p. 125), then its conceptual opposite is *colorblindness*. . . Colorblindness also effectively erases individuals' and groups of people's social and political histories and contemporary identities, practices, and everyday experiences that are linked to their racialized realities. In so doing, colorblind policies and practices operate under an abstract liberalist ideal that seeks to move us "beyond" race but effectively (and perhaps unintentionally) perpetuates and encourages racially disparate outcomes. (Bonilla Silva, 2003; Omi & Winant, 2014)

For these reasons, a colorblind approach to understanding student relationships is both undesirable and impossible. Instead, I argue for the acknowledgement of the on-going presence and significance of race, and other dynamics of power, in all classroom interactions, and by extension, student relationships.

Below I offer the notion of *politicized trust* as a way to conceptualize these student relationships in the context of a social design experiment (Gutierrez &

Vossoughi, 2010) in a computer science (CS) classroom that was organized around the explicit aim of engaging students in addressing sociopolitical issues in their school through the design of critical computational artifacts (Harrell, 2010). While the focus of this paper is on student relationships, I note here that the idea of politicized trust originates in a recent project (in collaboration with Na'ilah Nasir, Maxine Mckinney de Royston, and Ben Kirshner) in which our focus was on relations between communities and researchers in the context of participatory design projects. In that paper, we argue that constructing respectful and mutually reciprocal relations with community partners is an often overlooked yet essential aspect of conducting participatory design research, particularly with marginalized communities, and involves taking seriously how race and power mediate relationships (Vakil, Mckinney de Royston, Nasir, & Kirshner, 2016). Below, I adapt the idea of politicized trust for the purposes of examining student relationships in the social design experiment referenced above. Because analyses of race and power are central to the notion of politicized trust, and to the classroom episode I describe later in this paper, I begin with a discussion of how I am conceptualizing these ideas in this study.

Conceptualizing Race, Racialization, and Power in Student Relationships¹³

We are in a historical moment marked by both extreme forms of racialized violence as well as a surge of race-specific forms of political resistance. The energetic and highly organized grassroots coalitions of #Blacklivesmatter and other racial justice organizations have renewed, recentered, and elevated discussions of race in public discourse in ways that are reminiscent of the Civil Rights era. However, our public discourse often frames race and racism as individualistic and disjointed from sociohistorical relations of power, subjugation, and oppression in the United States. I draw on a conceptualization of race that understands the U.S. as a racially organized society and suggest that race is simultaneously a social construct and an everyday tangible reality (Omi & Winant, 2014). In particular, my study builds on the idea that “race is a concept, a representation or signification of identity that refers to different types of human bodies, to the perceived corporal and phenotypic markers of difference and the meanings and social practices that are ascribed to these differences” (p. 112) that has a way of “making up” people (p. 105). Race therefore operates as a *master category* that constantly structures our society via our interpersonal and institutional interactions and practices even as the realizations and realities of race shift over time.

Omi and Winant (2014) utilize this idea of race as a master category to introduce the process of racialization or “the extension of racial meaning to a previously racially unclassified relationship, social practice, or group” (p. 112) and to explain how race organizes large and small-scale activities and interactions in explicit and implicit ways in American society. In the context of classrooms, the notion of racialization illuminates how interactions between students are always racialized, regardless of the object of the learning activity, the race of students, or the political goals of the classroom or the school.

¹³ The following section includes text adapted from excerpts taken from my recent co-authored article in the *Journal of Cognition and Instruction* (Vakil, Mckinney de Royston, Nasir, & Kirshner, 2016).

From this perspective, it becomes critical to assess not “if” but “how” classroom interactions, and student relationships, are racialized. Exploring how racialization occurs may entail attending to how affinity groups form (Gee, 2000), issues of positioning (Esmonde, 2009), power and status in collaborative learning activities, as well as sources of tension between students of different racialized groups.

Given the history of white supremacist policies in the United States, racial difference also overlaps considerably with differences in power. Because a complete treatment of power, ranging from its political to discursive expressions, is beyond the scope of this paper, I focus here on power as it manifests in language and interaction, such as who speaks, how they speak, who is heard, and who decides on a group’s courses of action (e.g., O’Connor, Hanny, & Lewis, 2011). Unequal expressions of power based on race, age, gender and sexuality, class, and language should be expected even in classroom learning environments intended to be democratic or horizontal. For example, communication researchers have shown how variations in cultural norms for meeting behavior can impede the productivity of groups (Sprain & Boromisza-Habashi, 2012). Likewise, O’Connor et al. (2011) showed how a community-wide effort in Rochester to empower “community resident” leadership was derailed by the inability of some members, despite being schooled in the discourse practices common to nonprofit and foundation-driven strategic planning, to successfully listen to or accommodate the perspectives of community members who had less formal schooling.

Conceptual Lens: Politicized Trust

In the classroom I examine in this paper, I focus on trust as a key dimension of student relationships. I argue that trust is fundamental to the development of a productive classroom community and learning environment, and moreover, is a key site of racialization. Underlying my conception of trust is a recognition that our available discourse about relationships—and related constructs such as care, mutuality, and respect—tend to be silent about the political dimensions of those relationships. Here, by political, I refer to the ways in which relationships are power-laden, “preconstructed by history,” and “weighted with social gravity” (Erickson, 2006, p. 237). Just as sociocultural theorists acknowledge the ways that human thinking is mediated by cultural and historical tools that precede the actors’ arrival on the scene, human relationships are shaped by histories of race and differential power that set the stage for partnership formation. However, I also assert that relationships are sites of contestation, constantly negotiated and managed through moment-to-moment interaction and activity. In this way, I not only draw attention to the political dimensions of relationships, but also to how they are politicized through purposeful collective activity. Drawing on related literatures, Table 1 below outlines three relational dimensions of politicized trust: (a) solidarity with one another, (b) respect for one another, and (c) understanding of each other. Taken together, these components set the stage for student relationships primed for the kind of collective thinking, learning and doing desired in social justice educational projects.

Table 6. Framework for Conceptualizing Politicized Trust in Student Relationships

<p>Solidarity (Erickson & Schultz, 1997; Fraser, 1998; Gillborn, 2005; Hancock, 2011; Vakil & Vossoughi, 2015)</p>	<ul style="list-style-type: none"> • Shared political, racial, gender, ethnicity, sexual, or religious-based experiences with discrimination or marginalization. • Shared commitments to social justice and equity. • Resisting “Oppression Olympics” while acknowledging differentials of privilege, power and hierarchy, and related issues of authority, legitimacy, and authenticity. • Recognition that a politics of recognition is distinct from “identity politics” and central to social justice efforts. • Drawing analytical and political connections, but not equating, disparate forms of oppression and marginalization. • Expressions (and recognition) of good intentions as necessary but not sufficient for solidarity. • A social accomplishment, dynamic, constructed through interaction and discourse, and mediated by dynamics of race and power.
<p>Political Understanding (Beaubeauf-Lafontant, 1999)</p>	<ul style="list-style-type: none"> • Every student is an individual <i>and</i> a member of communities with distinct histories of oppression, marginalization, privilege, power, etc. • Students’ academic trajectories result from a complex set of social forces, individual choices, and available opportunities. • Historical and place-based understanding of each other’s communities and challenges facing those communities. • Racialized history of U.S. schooling and historical tensions that exist between particular racial and cultural groups.
<p>Respect (Boaler, 2008; Calhoun, 1995)</p>	<ul style="list-style-type: none"> • Engaging in respectful, constructive dialogue with one another despite disagreements or differences in opinion. • Knowing when to “step up” and when to “step back.” • Allowing others to speak their truth. • Acknowledging ways of being and knowing derived from non-dominant communities.

Of course, in the natural flux and fluidity of human relationships, there are no clear boundaries between solidarity, understanding, and respect. Even so, distilling politicized trust into separate components opens up analytical possibilities for more specifically attending to particular features and characteristics of student relationships. In this paper, the data and analysis that I provide are focused on the component of solidarity between students, though I contend that true solidarity requires both respect and understanding. I add that in the way I am conceptualizing these components, the reverse is not necessarily true. In other words, it is possible to have respect for and even a deep understanding of other communities without necessarily being or “standing” in solidarity

with them. However, what is “solidarity” and why is solidarity necessary for politicized trust to thrive between students?

I begin with the premise that establishing politicized trust between students, especially in racially and culturally diverse communities that serve students from nondominant *and* dominant groups, requires not only positive student relationships in the traditional sense, but also a political or racial solidarity between students. This is particularly urgent given the historically racialized context of U.S. schooling, as well as the varied experiences with discrimination and related inter-group tensions that have long existed in racially diverse urban schools (Rosenbloom & Way, 2004). I argue that solidarity is not gained (nor should it be) by the mere assertion of good intentions, is not the property of individuals; is always a social accomplishment, but cannot be accomplished merely once and then set aside (Erickson & Schultz, 1997). Rather, solidarity is highly dynamic, always negotiated through discourse and interaction, and constantly subject to racialized tensions and power dynamics between students and their respective communities. Solidarity is therefore relationally specific. Depending on the actors involved, it looks and feels different, and carries different implications. For example, solidarity between a White man and his mostly Black and Brown high school students may be qualitatively and politically distinct from the kind of solidarity that might exist between two Latina youth volunteering together in a local neighborhood organization. In certain contexts, therefore, such as cross-racial relationships, it may begin on highly fragile ground and be susceptible to undoing throughout. In other contexts, where shared racial or gender identification may provide the basis for initial solidarity, it is also susceptible to undoing and calls for ongoing attention. It follows that solidarity work involves drawing analytical and political connections, while not equating, disparate experiences with marginalization and oppression (Vakil & Vossoughi, 2015). As an example of this analytical work derived from my own reflections on working in solidarity with Black and Brown students and communities in the United States as a scholar of Iranian descent, I share an extended excerpt from an essay I wrote with scholar Shirin Vossoughi, who is also of Iranian descent:

From our perspective, [solidarity] requires naming and contending with our own participation in racism. We might ask: where do our complicities and interests lie? Broadly, the act of migrating and living in the U.S. implicates us in the settler-colonial project, as does our participation in a political and economic system built on racial categories. More specifically, Iranians have struggled with and sometimes against the bargain of “honorary whiteness,” whereby active dis-identification with Black and Brown communities serves as a ticket to participate in the spoils and privileges of whiteness. 9/11 and the overt surveillance and criminalization of Muslim and Middle Eastern communities shook many out of the fantasy of what Linda Sarsour (Executive Director of the Arab American Association of New York) calls “artificial white privilege.” Yet our continued participation in narratives that position Iranians as a uniquely successful immigrant community both thwart possibilities for solidarity, and erase the economic, social and racial hierarchies within our own community. (Vakil & Vossoughi, 2015)

I share this excerpt to highlight that solidarity work is highly complex and is contingent upon how sociopolitical identities are understood, perceived, and enacted. From my perspective, solidarity work is also always shaped by dynamics of race and power, even if these dynamics may manifest differently and in varying degrees across various contexts. In the remainder of this paper, I draw upon the idea of politicized trust as a lens to reflect on how dynamics of race and power mediated student relationships in a social justice based CS curriculum unit within a diverse urban classroom.

Context and Data Sources

Data for this study is drawn from a co-teaching social design experiment (Gutierrez & Vossoughi, 2010) I conducted in two 10th grade CS classrooms at Bay Prep High School,¹⁴ the largest comprehensive high school in the Greenwood Unified School District (GUSD). Social design experiments (SDEs) are a particular kind of design-based research (DBR) that focuses on equity and social transformation. More traditional DBR research is similarly interventionist research that aims to create novel learning opportunities in specific educational contexts (e.g., Brown & Palincsar, 1989; Brown & Campione, 1990; Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003; Penuel, Fishman, Cheng, & Sabelli, 2011), but does not necessarily take up equity or social transformation goals critical to SDEs (Gutierrez & Vossoughi, 2010; Gutierrez & Jurow, 2016). The design experiment reported in this study consisted of designing and teaching a 10-week unit in Mr. Mayson's class, the director of the Computer Science and Technology (CST) Academy. My relationship with Mr. Mayson began long before this study. Most recently, Mr. Mayson was one of the teachers my research group had interviewed as part of a larger research project led by Na'ilah Nasir, investigating issues of race, learning and equity in the GUSD. As part of that project, I had been observing his classroom for several months as well as interviewing several of his students.

Designing for Equity at Prep, a Collaboration with Mr. Mayson

My relationship with Mr. Mayson began in 2009, when we worked together to create an afterschool STEM-focused program in collaboration with the Boys and Girls Club, which I have written about elsewhere (Vakil, 2014). A central aim of the program was to empower students in STEM, specifically in technology, through culturally relevant and critical pedagogy approaches. In the study described in this paper, my collaboration with Mr. Mayson was designed to build from both the research described earlier which examined equity issues at Bay Prep, as well as an approach to computer science education that is fundamentally rooted in social justice perspectives (Cammarota & Fine, 2008). Starting with a curriculum Mr. Mayson was already using, the Exploring Computer Science Curriculum developed by researchers and educators at UCLA (Goode & Margolis, 2011), we created a unit entitled "Designing for Equity at Prep" (DEP). In the first several weeks of the unit, students work in groups to identify and analyze equity issues in their school. The goal of the unit is for students to work collaboratively to design technological artifacts addressing important equity issues in their school, *and* to also demonstrate an awareness of the specific politics their artifacts represent.

¹⁴ The name of the district, school, and all student and teacher names are pseudonyms.

One of the classroom activities designed during weeks 6-7 of the unit, specifically to support this latter goal, is the context for the analysis presented in this paper. In preparation for the *Politics of My Technology Memo* (see Figure 4) assignment that was due at the end of week 7, Mr. Mayson and I asked students to work in their groups to discuss and represent the politics of their technology in a simple two-column fashion, with the technology idea on the left column and a corresponding discussion of the “politics” on the right hand column (see an example of a group’s poster in Figure 5).

Students were then asked to make presentations, sharing their problem with the class, its significance, a theoretical framework (to explain how they were conceptualizing the problem they were focusing on), and a discussion of the politics of their chosen technology solution. The topics chosen were diverse and exhibited a range of different experiences with the school, as well as surfacing quite different social and political perspectives that students held. While the most common equity issue that arose was the

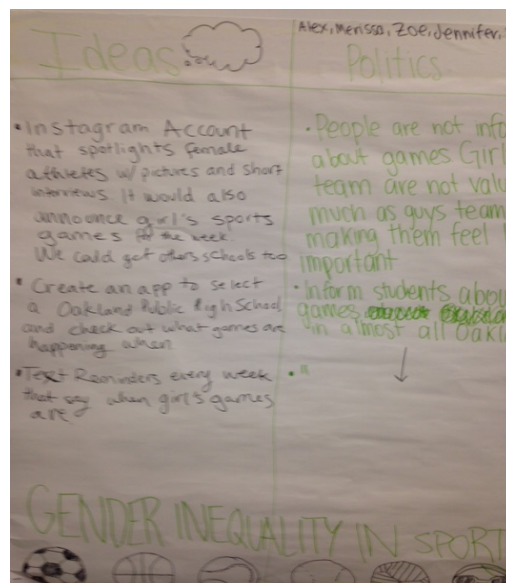
Figure 4. Politics of Technology Memo

Figure 5. Example of Student Politics Poster

Politics of My Technology: What, why, how, who, and where?

In 1-2 single-spaced pages, please describe the technology idea your group has decided to create, and why you believe this particular artifact can effectively address your equity issue. Make sure your memo addresses the following 5 questions.

- 1) *What* is the equity topic you have decided to address?
- 2) *Why* did you choose this idea?
- 3) *How*, specifically, does your technological artifact address your educational equity issue? What does it miss?
- 4) *Who* is your technology designed for?
- 5) *Where* does your technology “locate the problem?”



racial inequities across various classes and academies, students also tackled other topics including quality of school lunches, school trash, gender inequality in sports, gender inequality in the CST Academy, racism towards Asian American students, teacher quality, and overcrowded classrooms.

In the previous chapter of this dissertation, I described how the DEP unit created opportunities for novel interactions between the sociopolitical and disciplinary identities of students, ultimately expanding possible meanings of a STEM identity to encompass the diverse sociopolitical identities of students. In this study, I shift my attention to the tensions and challenges within my design and pedagogical approach. Main data sources for this study include a 45-minute video recording showing classroom discourse and

activity during and following a class presentation, an in-depth interview with one student immediately after the presentation, ethnographic field notes, as well as student artifacts (PowerPoint deck, Politics of Technology memos from N=3 students). Drawing on politicized trust as an analytic lens, I highlight both how the absence of sufficient politicized trust between students strained classroom interactions, as well as how trust and solidarity was negotiated through dynamics of race and power in the classroom. Prior to this episode, I had observed tensions between students, particularly race and gender-based tensions, throughout various activities of the unit. I had also had several conversations with students about their general frustration, usually referencing the apathy or ignorance of particular students about equity or social justice issues. However, I choose this particular segment for deeper analysis for two reasons: (a) the tensions surfaced in a highly visible way, providing a revelatory case (Yin, 2003) of how politicized trust (and the absence of it) manifests through classroom discourse and activity, and (b) the particularly intense tensions described in this episode were surprising given the relative political-ideological alignment on both “sides” of the conflict, which I will describe in more detail shortly.

Methods of Analysis¹⁵

Video recordings are the primary data for researchers studying human interaction as a semiotic ecology. Though there has been a growing presence of researchers using video in educational research (Derry, Pea, Barron, Engle, Erickson, Goldman, & Sherin, 2010), fewer studies have focused on non-verbal components of social interaction in classrooms. In this study I follow microethnographic approaches that attend to the full semiotic ecology of classrooms in the study of meaning making in learning environments. The segment chosen for analysis captures the tension between Scott, a White male student, and several students of color in the class during Scott and his group’s presentation to the class, which was met with several challenges from students of color in the class. I chose this particular segment because of the highly visible display of tension alongside rich and respectful student discourse. The episode, while unique in duration and intensity, is reflective of a more subtle, constant presence of tension I had observed between some of the White students and students of color in the class, particularly when issues of race and equity were discussed.

My intention was to gain an understanding of the source of the tension and how the tension manifested through student discourse and interaction. To this end, my approach for video analysis included a careful examination of Scott’s movement and body language during his presentation to the class, a focus on verbal as well as non-verbal forms of communication, particularly as employed to effectively navigate the challenges to his presentation from students of color in the class. Drawing from perspectives that view classroom activity as a complex semiotic ecology, I also paid careful attention to other students in the classroom. I wanted to see not only how students reacted to the conflict itself, but also how they collectively and individually responded to Scott’s various moves, gestures, and speech acts. With these perspectives in mind, I viewed the video segment multiple times; each viewing revealing various features of the

¹⁵ Segments of the text in this section of the paper are adapted from a recent article (Mckinney de Royston, Vakil, Nasir, ross, Givens, & Holman, in press).

classroom that later became important for my analysis. Using the InqScribe transcription software, I was able to view the video in slow and fast motion, as well as without audio, focusing my attention on particular movements and gestures of individuals in the space.

Adapting an approach to the study of power and language I had used in another study (McKinney de Royston, Vakil, Nasir, Ross, Givens, & Holman, in press), on a single sheet of paper, oriented lengthwise, I drew by hand an overall chart of the real time sequence of major activities and participation structures within the whole event that was videotaped. The time line of this chart ranged from left to right across the top. In the top row of the chart, I drew a rough sketch of the participation structure of the class, with attention to the physical layout of the classroom (location of tables, chairs, etc.), as well the spatial positioning of Mr. Mayson, myself, and students in the class. I also depicted whether or not students were standing or sitting, and their bodily directions (whether or not students were facing the teacher). The next four rows were dedicated lanes for four of the participants: Scott, Lidiya, Stacey, and Teresa. Each of these rows was divided into two separate smaller rows, one labeled “verbal” and the other labeled “non-verbal.” This allowed me to view direct quote transcriptions uttered by each of the four participants in parallel with their “actions” - what they were doing (or not doing) at a particular moment. I drew vertical lines down the sheet with two seconds of spacing between each line, prompting myself to analyze verbal and non-verbal activity for each of the four participants every two seconds for the duration of the clip. Finally, the last three rows, added towards the final stages of analysis, graphically depicted tension between Scott and other students in the class. The first row traced the tension between Scott and Lidiya, as well as the tension between Scott and Teresa. The next row tracked the tension between Scott and Stacey. The last row reflected the tension between the classroom and Scott. To aid my analysis of student relationships, I coded for two types of visible tension: “positive” (colored green) and “negative” (colored red). This was done to distinguish between moments of trouble in the classroom activity and engaged moments of productive classroom discussion and problem resolution. The graphical representation for tension was a simple line graph that ranged from “low” to “high,” showing how various forms of tension were either rising or dissipating during the episode.

To summarize, for every two-second interval in the selected segment, the following features of classroom activity were represented on the chart: the classroom participation structure, including student and teacher positioning, verbal and non-verbal activity for each of the four key participants, and qualitative assessments of tension through “positive” and “negative” forms of tension between participants and throughout the class.

Ultimately, the chart provided a visual representation of the simultaneous and sequential verbal and nonverbal actions of various parties in the classroom. Although an arduous process, the work of creating this visual representation was itself critical for the analytical process, as was the ability to view the chart as a whole after its completion. In the following section, I will detail specific aspects of the analysis that exemplify in practice how politicized trust shaped student relationships in the classroom.

Negotiating Politicized Trust between Lidiya and Scott

In the analysis below, I provide a detailed examination of a “conflict” between two students, Lidiya, who self-identifies as Black/Eritrean and female, and Scott, who self-identifies as White and male. The conflict arose during the Q&A session that followed Scott and his group’s presentation on their equity topic. Drawing on the substance of the presentation itself, the classroom discourse and interaction that followed, as well as an extended conversation with Lidiya to reflect on both, I argue that the source of the tension between Lidiya and Scott was rooted in a lack of politicized trust between the students. In other words, I argue that while Lidiya and Scott did have important ideological discrepancies in terms of how they were conceptualizing matters of race and equity within their school, the tension between the students was rooted more in the nature of their relationship, specifically one that was not rooted in a racial or political solidarity. Ultimately, this lack of politicized trust limited opportunities for collective learning and action in the context of a computer science unit organized around social justice values (Camarota & Fine, 2008; Duncan-Andrade & Morrell, 2008). Before describing the episode that is the main focus of my analysis, in order to aid my interpretation of the episode, I begin with descriptions of each student.

Lidiya

If 4th period *Introduction to Computer Science* was a party (and to the chagrin of parents I’ve talked to and some studious students, in some ways, it was), Lidiya was very much the life of it. She was always engaged, quick to flash a smile, and seemingly at the center of *all* activity. This is not to say she is the perfect student, whatever our conception of that may be. During my time observing and teaching in the CST academy, I came to know Lidiya as a highly intelligent and outspoken member of the classroom. However, she was also mischievous, and prone to side conversations with friends which often culminated in eruptions of uncontrollable laughter. While very social and definitely popular amongst her classmates, Lidiya is also a deeply introspective and observant young woman. In her Identity Memo assignment which talked about her desires, goals and sense of self, she poetically wrote:

I never wanted to be anything, I never had any superficial goals. Instead I enjoy the small intricacies of life. Interestingly enough I have found that those small intricacies are what allows for happiness. So you ask who I am and I am nothing, because nothing defines me.

She goes on to talk about “light” and “happiness” and insightfully connects these notions to getting an education and issues of opportunity in her school:

I know for anybody, including myself, to obtain and maintain this happiness is by getting an education. But this is not reflected at [Bay Prep]. The diversity of Oakland is not being exemplified in our classrooms. We are not compensating for the environments that students come from in which education is not given. Students are being excluded from opportunities that they will greatly benefit from

and capable of doing. They're unaware of these opportunities because of the lack access of support for these students.

Central to Lidiya was not only her racial identity as a Black female, which she referenced often, but also her racial and political consciousness and agency. She spoke often in front of the class about negative portrayals of African-Americans in the media and how this adversely impacted the ambitions of many of her African-American peers. For instance, when she used hip hop artist J Cole's¹⁶ song "No Role Modelz" to draw attention to the lack of positive role models for Black students in her school (Field Notes, May 2, 2015). During whole class conversations, specifically those focused on issues of race or diversity, Lidiya was often vocal, and demonstrated leadership and keen insight on pressing social and racial problems confronting the school. She is a founding member and student leader in a new club that focuses on racial justice issues at Prep, specifically addressing issues of diversity in the elite academies and pathways where African-American and Latina/o students are grossly underrepresented (Nasir & Vakil, in press). Her focus and work during the DEP unit was similarly focused on issues of race, diversity and opportunity in her school.

Scott

Similar to Lidiya, Scott was highly engaged during the time I taught in the CST academy. However, he was less popular, mainly socializing with a small group of friends, none of which were Black or Latina/o. In his smaller sphere of friends, however, he was a leader in many respects and took the work of the class seriously. While he exuded a sense of thoughtfulness and care about the issues being discussed in class, he lacked the same understanding and personal experience that Lidiya brought to bear. In his Identity Memo assignment, he wrote frankly:

You see, I live in the hills and everything I have seen here is the direct opposite of what I have seen in the rest of [the city]. My location is said to be where the wealthy reside while the rest live in the flatter areas of the city. Yet, it always puzzled me as up here nothing could be more different from what lays down there. My neighborhood is not diverse, it is predominantly white, in fact, I have only ever had two African American neighbors live next to me. I never understood this. I never understood how my neighborhood could exist in such a diverse city and yet be so isolated from it. Nowhere else in [the city] is the racial divide more clear than in the hills compared with downtown.

Central to Scott's identity is a sense of himself as different from other people who may look like him or live in his "hills" community. In his Identity Memo, he goes on to say, "I am not like everyone else up here or at least I hope I am not." Scott takes a certain pride having attended public schools all of his life:

¹⁶ J. Cole is a hip hop recording artist whose lyrics are known for their playfulness as well as social commentary. "No Role Modelz" is a song from his third album, 2014 Forest Hills Drive.

I was lucky; I had the chance at a very early age to learn about people from all walks of life as my classmates came from all over Oakland. This was not the same for most of my neighbors who, almost all, attended the private school right next to my public one. Everyone there was white and almost all of them had the same story, they weren't learning about the real world by being surrounded by exact copies of themselves.

However, his proclaimed appreciation and understanding of diversity, is complicated by his views on race, which in many ways mirror liberal, colorblind perspectives (Bonilla-Silva, 2003; Gallagher, 2003; ross, 2016).

Yet, even though, my elementary school was diverse, I had no idea what race was. I did not see any differences between my African American friend and myself other than the fact his skin was darker than mine. In fact, it would not be until 5th grade when I figured out what race was. Instantly, I noticed divisions popping up everywhere, in the news, in my community, and even in the school which I had almost gone through never knowing what races were. In the news, they would always talk about some African American male committing a crime, rarely did the news talk about whites or any other race. I did not understand. I did not understand why West Oakland was, according to my parents and others, a place where you do not want to be and why there appeared to be such a racial divide between West Oakland and the rest of the city.

Alongside his self-proclaimed innocence (I'm "different than everyone else up here"...) and his emergent, if naïve, views on race and diversity, Scott projects a measure of sincerity about wanting to "learn more." Explaining his decision to focus on racial inequity for his topic during the unit, he explains:

All of my life, I have wanted to learn more. I have wanted to learn more and this was no different. I needed to know why the two parts of my city differed so much. That is what inspired me to take up racial divisions as my educational equity problem, because I have always wondered why such divisions exist. I have seen it in my community and in my city and I cannot understand it as these divides do not segregate opposites but instead people with just different skin colors.

"What Does Diversity Mean to You?"

Scott and his group mates, John, Lin, and Bob, began their presentation entitled "Racial Divides in Oakland" by asking a series of questions. Taking turns to lead the class, they began with Scott asking a general question intended to stimulate dialogue in the class, "What does diversity mean to you?" Lidiya was one of the first students to raise her hand and offer a response, which led a few (but not many) other students to volunteer ideas. Scott then presented some statistical information about the Honors History/English track known as Excelsior, and asked the class, "Why are there more Caucasians enrolled in [Excelsior] than African Americans?" Students were less responsive to this particular question. Several moments of awkward silence ensued before Scott, with his arms

crossed shyly over one another, and while he uncertainly placed his hands in his pockets, implored the class, “does...anybody want to uh..give their thoughts on that..their opinions?” Lidiya again volunteered, this time responding with a question of her own, “What if they honestly don’t want to be in [Excelsior]?” Scott, clearly not expecting that response, and his group mates making no visible indication that they were going to jump in, said “Uh, yeah, that could be one of the reasons.” In response to this, Lidiya and Patti whispered back and forth and laughed. After this, they then fixed their gaze back on the presenters, awaiting a response. This, in turn, triggered a few of Scott’s group mates to fidget. They then let out an uncomfortable, stuttered laughter. Scott, attempting to interrupt the awkward moment, slurred his words, “...(inaudible)...I honestly don’t know how to respond.” He was then rescued from the uncomfortable interaction by another question from a student, Stacey, a female student who identifies alternately as mixed-race and Black. Similar to Lidiya, she did not provide the kind of answer the group was probably seeking to their original question (“Why aren’t there more Caucasians enrolled in [Excelsior] than African Americans?”), instead choosing to offer some meta-commentary on the question itself:

That’s a really (*slows down for emphasis and moves her head forward*) large question, there might be a lot of factors that play into why certain groups, or just like people in general, individuals, don’t want to be in rigorous courses, (*pause*), so I mean, (*makes “I don’t know what to tell you” gesture with hands*), it’s a really big question to ask us.

Once again on the defensive, Scott responded, “Yeah, we’ll try to address those later in the presentation, but for now we’re going to show you more statistics.” Scott then proceeded by presenting a series of diversity statistics within various academies in the school, culminating in a declaration of his understanding of root causes of the problem:

Causes of problem are.....unawareness of the situation...and also defacto segregation...minorities living in situations where they didn’t have access to a lot of things, and another cause is problems at home or within the community...they may not feel motivated to do so because of peer pressure.

Noticing his group mates had been silent for the last several minutes, Scott meekly asked his group mates to elaborate, but they declined. What happened next in the presentation involves an escalation of tension, specifically that between Scott and Lidiya. Before turning to a detailed examination of this episode, I pause to offer additional context along with analysis of student reactions to the presentation up until this point.

Politicized Trust: Negotiated in Practice

First, it is critical to note that Scott and Stacey are both in Excelsior, while Lidiya is not. Taking this into consideration, Lidiya’s challenge regarding the implicit assumption about Black students wanting to be in Excelsior in the first place may be rooted in personal experience or sentiment. Next, I highlight the important point that Lidiya did not begin participating in this particular segment of interaction from a critical

stance, evidenced by her raising her hand and participating in the interactive component of the group's presentation. The manner of her participation expressed a measure of good faith and interest in the topic of the presentation, indicating a level of initial, if tentative, trust she granted Scott and his co-presenters. Based on these observations, I argue that Lidiya's emergent critical line of questioning and commentary on the presentation up until this point was not pre-determined, but rather emerged through the activity and discourse that unfolded in the first few minutes of the presentation, and is therefore reflective of solidarity as something that is socioculturally produced through discourse and interaction. At the onset of the presentation, Lidiya's receptiveness (along with that of the rest of the class) was an opportunity for solidarity to take hold, and was aided by Scott and his group's apparent good intentions and good faith effort to address equity issues in the school. However, good intentions ultimately confronted the reality of the race and power dynamics present in the classroom. Scott, as a White male in Excelsior speaking in broad strokes about the "problem" of not enough African-Americans in that program to an audience that includes several African-American students who are themselves not in Excelsior, including Lidiya, and some who are, including Stacey, triggered the challenges levied so far and also set the stage for an unraveling of the shaky solidarity that may have been present at the onset of the presentation.

Politicized Trust: Called into Question

As soon as Scott and his group concluded their presentation, I opened the floor for questions and comments from the class. Mr. Mayson, standing in the back of the classroom, was quick to offer his feedback, mostly praise, seemingly intended to offset the growing tension in the class. Applauding the presentation's focus on diversity, Mr. Mayson emphasized the importance of diversity in relation to the design of apps: "If a certain group of people are making apps, then apps will only reflect the values of that particular group, but if you bring in different groups, the apps will accommodate different perspectives...the technology and computers of tomorrow should have input from all different groups." Building upon Mr. Mayson's remarks, I too offered some generally positive feedback of my own that emphasized the less problematic aspects of the group's presentation. I then opened the floor a second time, this time clearly imploring other students to contribute to the feedback. It was quiet for several seconds before Teresa, a Latina student seated in the front row, while looking down at the ground, in a somber tone asked, "How come you guys didn't interview a Latino student?" Scott was quick to respond, "probably just by coincidence...we didn't mean to offend anybody." Only seconds passed before Patti, an Asian girl seated adjacent to Lidiya (and a close friend of Lidiya) asked in an accusatory manner, "why did you change the names?" (referring to the pseudonyms given to students the group had interviewed). These successive student critiques set the stage for the extended exchange, which is described below, in which the nature of students' challenges to Scott and his group span the ideological and methodological. However, importantly, all these critiques are rooted in what I argue is the absence of solidarity, and thus an absence of politicized trust, between Scott and several of the students of color featured in the exchange..

1 Lidiya: Okay. So just out of curiosity. You like - I like with that one question it

2 was like why don't African Americans, like I don't know exactly what
3 you said aren't in [Excelsior], but you guys are talking about diversity
4 overall so why did you...why did you single out a single group?
5 Scott: Well they're the - they're basically African American - the African
6 American is uh African American racial group is actually the majority
7 in our umm in our school so we were just wondering why that the
8 majority of our school was misrepresented as a minority in this
9 classroom - in [Excelsior].
10 Lidiya: But they're a majority in fashion and art though.
11 Scott: Yeah but Paidea's actually one of the - one of the ummm, it's not it's not
12 An academy. It's umm, it's one of the courses where you actually see
13 this racial divide, this radical difference between like our school – our
14 Entire school demographics.
15 Lidiya: Yeah but I was just trying to say like [Excelsior] doesn't define you, or
16 doesn't define this school as a whole like ...
17 Scott: It doesn't. And that's completely true. But it's often regarded as a very
18 rigorous course, and we wanted just to bring that up.
19 Teresa: That's what people are known - that's what Tech's -
20 Yeah. Tech is known for things like the engineering academy and
21 Paidea and it's kind of
22 *(boy in background says, "racist")*.
23 *(Teresa whispers "white kids")*.
24 It's messed up, but, ...
25 *(Lidiya grimaces)*.
26 Sepehr: Okay, let's go here, okay, go ahead Stacey...
27 Stacey: I actually wanted to answer Lidiya's question. In my [Excelsior] class
28 there
29 are.. Daniel and I are like the only other Black people
30 So I understand why they would ask that question, there are a lot of
31 other minorities in the classroom that are represented and barely
32 any African Americans so I can understand why they would ask that
33 question.
34 Scott: Yeah we should have probably said other minority groups but sorry it
35 came out that way. I don't mean to offend anybody.
36 *(takes a few steps backwards, shakes hand in the air in an apologetic
37 manner)*.
38 Sepehr: Okay - right here.
39 Student: Uhh quick question: like what would be your ideal breakdown for all of
40 the academies or like classes here at Tech like, 'Cause you showed a lot
41 of statistics, and pie charts and stuff but like what would be your ideal
42 breakdown?
43 Scott: The ideal breakdown is one that's simp – like almost completely
44 representative of what our actual entire school's demographics is
45 So basically it should - basically it should match up with the total
46 school's demographics. The percentages should be the same.
47 Sepehr: Mmm..hmmm..yeah.

- 45 Student: What was your funnest part of the research?
46 *(classroom laughter)*
47 Scott: What?
48 Student: What was the funnest part of doing the research?
49 *(classroom laughter)*
50 Asian: Probably, yeah, procrastinating. That was fun.
51 *(smiling)*
52 Student: Yeah, well, don't. Don't procrastinate kids.
53 Sepehr: Oh Yep, Daniel, Daniel...
54 *(calls on student in the back who had his hand raised).*
55 Daniel: Why did you choose this problem? Like what does it actually mean to
56 you?
57 *(seated in the back of the classroom, looking directly at Scott).*

In this segment of interaction, despite Scott's good intentions and his articulation of liberal/multicultural perspectives on equity issues consistent with most other students of color in the class, the already contested solidarity between him and the class suffers further losses, particularly the fragile solidarity that had existed between him and Lidiya. Though on the whole this segment exemplifies a classroom learning community that lacks a shared sense of politicized trust, a closer look reveals the ebbs and flows of solidarity, moments where it seems to make a come back, and how its ultimate decline was mediated by the racial and power dynamics of the classroom. To deepen my understanding about specific moments within the stretch of interaction above, I aid my analysis below with comments gathered from Lidiya during a debrief interview I conducted with her directly after the episode.

Let us begin with the opening exchange between Scott and Lidiya. Picking up where she had left off in their communication during the presentation, Lidiya resumed her critical questioning about Scott and his group's approach to addressing diversity and equity in the school. She challenged the singular focus on African-American students (3-4), to which Scott responded by restating the widely-known disparities in the Excelsior Academy that most acutely impact African-American students (5-9). For context, I note here that the underrepresentation of African-American students in particular academies including Excelsior is also the topic focus of Lidiya's group project. We can therefore eliminate the possible explanation that Lidiya's critiques of Scott and his group are based on her lack of awareness of the equity issues they are raising. In fact, if we were to examine Scott and Lidiya's ideological stances on issues of diversity and equity at Prep, we would find more common ground than difference. Rather, the source of the tension, which I examine in more detail below, is rooted in questions of authority, authenticity and recognition, critical aspects for solidarity, and politicized trust, between students.

Lidiya is not only aware of inequities impacting African-American students in her school, but is constantly raising these issues in class, and, as mentioned earlier, is part of a racial-justice after-school club that is explicitly taking action on these issues. Thus, to Scott's statistically factual claim that African-Americans are the most underrepresented group in [Excelsior], her response, "Yeah, but...[Excelsior] doesn't define you" (15-16) reveals a deeper philosophical rejection of the way in which Black identity is being imagined and framed by a White male student who lacks an experiential connection to

the issues being raised. During the debrief interview, I started by asking her to explain how she was feeling after Scott and his group presented. She explained:

I don't know how to phrase this academically... but its that, it was more of that..white guilt, like that white savior aspect, like oh, we messed this up, the governments messing this up, lets go back and fix it, its just like you're so far out (*uses both hands to display distance*) and you're trying to look in (*uses her left hand to display "looking in"*)

What is important to note in Lidiya's critique is that she is not taking issue so much with the content of Scott and his group's equity analysis, but rather *how* they are talking about these issues.

Cuz the way they were phrasing that was realllly disrespectful, and like...its like oh minorities this..its like why do you phrase it like that? and then it was like trying to make it like "pity on them" like oh...like you know how (*gestures with her hands*) they were like (*continues to gesture*) "oh we're doing a good thing" so its just like it was like arrgghhhh.

At the heart these critiques lay questions of legitimacy and authority, which are clearly mediated by dynamics of race, but also by Scott's participation in the very academies his group was attempting to call out:

And the irony aspect is you're in (*furrowed eyebrows*) [Excelsior], in these academies taking part so...who are you to speak on this?

"Who are you to speak on this" is an equivocal challenge to Scott's authority as a White male in Excelsior to focus on the lack of African-Americans in Excelsior, and mirrors the challenge made by Daniel (also African-American) at the end of the episode above when he asked, "Why did you choose this problem? Like what does it actually mean to you?" (55-56). Daniel's compelling question, coming at the close of Scott and his group's presentation, along with several other students of color in the class making comments during the presentation, which include terms such as "White kids" and "racist" (22-23), reflect a near complete breakdown in politicized trust between Scott and students of color. This is noteworthy given that Scott's initial relationship to the class during his presentation could be characterized as positive, with several students of color including Lidiya genuinely participating in the interactive components of his presentation. However, as the presentation unfolded, the fledgling trust and solidarity that he may have been initially accorded evaporated as serious challenges to his authority took hold with multiple students.

The momentary relief to the otherwise uniform challenge to his authority came when Stacey, responding to Lidiya, offered her own presence as an underrepresented Black student in [Excelsior] as evidence to support and legitimate Scott and his group's focus on African-American students (27-32). This moment represents at least a *partial* restoration of solidarity. However, this was not because Stacey's assertion constituted anecdotal "data" in support of the statistical claims about the lack of Black students in

[Excelsior] (which was never under question to begin with, despite Scott's repeated rendering of these realities). It reestablished a measure of solidarity because it amounted to a defense of the integrity of Scott's inquiry, and underscores the complex roles of race and power in the negotiation of solidarity between students (Vakil, McKinney de Royston, Nasir, & Kirshner, in press). Stacey's statement, "so I understand why they would ask that question," (32) constitutes a statement of racialized authority on the matter, granting a kind of permission to Scott and his group that had been confiscated through the challenges to authority advanced so far by Lidiya and other students of color in the class. However, the recovery is far from complete, as evidenced by Scott's defensive statement "I don't mean to offend anybody," while waving his hands in an apologetic gesture (34-35). Such gestures signal that despite Stacey sticking up for him, Scott was still keenly aware of the challenges to the solidarity between him and "anybody," which, in this case, was meant to indicate students of color who had taken issues with the presentation.

I want to close by returning to the role of good intentions in mediating how solidarity and politicized trust was (de)constructed throughout the interactions in the classroom episode under examination. For solidarity to exist, good intentions, particularly in the context of cross-racial partnerships, are necessary. Indeed, it was Scott and his group's good intentions that allowed for solidarity to take hold, however tentatively, at the beginning of their presentation. Beyond my own and Mr. Mayson's subjective interpretation of Scott and his group's good intentions, Lidiya explicitly referenced the issue during my interview with her:

That's why I'm just kinda like, and like they may have good intentions, but the way they're phrasing it...if you're gonna bring stuff up like that (*slows down for emphasis*) you have to respect it (*face looks serious, somber even...*)

Further underscoring her belief in Scott and his group's good intentions (or lack of bad intentions), Lidiya goes on to elaborate:

yeah, I know like he, they don't mean it, you know what I mean? (*tilts head for emphasis*) but like, they don't like, but that presentation (*points with her hand*) really reflected their views though...it did, it did reflect their views so it can't really be like, oh, this is just a grade but you're really putting your effort into it so, its your views...

Even so, while the presence of good intentions was critical in creating the possibility of solidarity, they were ultimately not sufficient in maintaining or growing the seeds of solidarity between Scott and Lidiya. I closed my interview with Lidiya by asking her to comment on why Daniel, who is typically not eager to participate in class conversations, asked the challenging question in the way that he did (55-56). Her answer indicates she viewed his question as being in the same vein as her own challenges and critiques to Scott and his group:

Yeah, Daniel did ask that, but its not like we're trying to attack them but, it shouldn't come off as attack if they're like attacking us too (*head tilts downward for emphasis*) they're trying to make us the blame like with the whole like "why

aren't there African American students in [Excelsior]?" I really found that, really offensive (*tone changes for emphasis*)

Feeling offended, attacked and blamed are hallmarks of a relationship that is sorely lacking in trust and solidarity. In the weeks following the episode examined in this paper, students proceeded, mostly within their groups, along a design process to create computational artifacts reflecting their sociopolitical stances on the equity issues they were aiming to address through technology. Partially due to the original design of the DEP unit, but also due to the unanticipated tensions that have been discussed in this paper, I organized the remainder of classroom activities primarily around group work (minimizing opportunities for further tension in classroom-wide discussions). As a result, Scott's interactions with Lidiya, and most other students of color in the class, were limited. Within the confines of their own groups, Lidiya and Scott proceeded to design technologies that addressed equity issues at Prep. Scott and his group used HTML/CSS programming practices to design an informational website that aimed to educate teachers, students, and parents about the stark realities of racialized and gendered inequities across the various learning pathways of the school. Lidiya and her group created an innovative mobile app designed for incoming 9th graders hoping to shadow current Prep students, with the intent of empowering students of color hoping to access particular academies and pathways of the school that they may otherwise feel alienated from or intimidated by (a more detailed discussion of the "Shadow App" is included in the previous chapter of this dissertation).

Discussion and Concluding Thoughts

From a traditional STEM education perspective, given the generally successful final technology artifacts students created in the DEP unit, one might downplay the breakdown in trust and solidarity between students that has been the center of the analysis presented in this paper. The argument may go something like this:

Perfect classroom harmony may be desirable, but it is unrealistic. Conflict is natural in any learning environment. In any case, despite the lack of trust between them, Lidiya and Scott each ended up creating impressive technological designs, which is (and should be) the priority in a computer science classroom.

This perspective suffers from several blind spots and ultimately compromises core values and principles of social justice and radical educational approaches (e.g., Freire & Macedo, 2005; Giroux, 1983; Ladson-Billings, 1995). I offer several further points for consideration.

First, the absence of politicized trust may have been especially apparent between Scott and Lidiya, but was in varying degrees characteristic of Scott's relationship with other students of color in the class, potentially shaping his and other students' future trajectories of relationships with one another. If the goal of learning - *all* learning - is fundamentally about creating democratic learning communities (Sengupta-Irving, 2014), which is central to the educational philosophy at the heart of social justice education, then we must be pedagogically and analytically distressed when there is a breakdown of such

communities, *even* when other forms of rich learning and thinking may be taking place. Related to this, we may ask, because of the lack of politicized trust and solidarity, what opportunities for collective thinking and learning were missed? Political and racial solidarity opens up new possibilities for student relationships, which in turn can breathe creative energy into students' collective political imaginations and capabilities to affect social change, through technology or otherwise. While Lidiya, Scott, and their respective groups created impressive technological artifacts, we will never know what ideas they, (and we), missed out on as a result of the missed opportunities to build meaningful forms of solidarity and trust in the classroom. Finally, and perhaps most importantly, a social justice approach in education centers upon and prioritizes the desires, needs, and experiences of the most marginalized groups. In the episode reported on in this paper, this stance necessitates a critical examination of the particular ways in which the breakdown of trust and solidarity impacted students of color in particular. For example, this would entail more deeply attending to the implications for students of color such as Lidiya, who, despite acknowledging Scott's good intentions, ultimately perceived his presentation on equity issues as an unwelcome intrusion, or to use her own words, an "attack" that was "really disrespectful." The ways in which these moments of racialized micro-aggression (Solorzano, Ceja, & Yosso, 2000) may do more harm than good, potentially stigmatizing or triggering youth, needs to be a central consideration in participatory and equity-oriented design-based research and other educational interventions rooted in social justice values.

To close, I remind readers of the current events referenced at the beginning of this paper: the Flint water crisis and the public debate between the FBI and Apple, both serving as obvious examples of how STEM topics so readily lend themselves to questions of race, power and social justice. The social design experiment described in this paper joins an emerging yet rich tradition of STEM educational projects with the explicit goal of empowering students, in particular students of color, towards the learning of STEM disciplines in ways that are politically and personally relevant, and ultimately transformative. However, the analysis presented argues that without student relationships in place that are rooted in politicized trust and solidarity, there are potential pitfalls and dangers that arise when addressing highly charged sociopolitical issues in the classroom. Nevertheless, the goal of this study was not to simply warn against such approaches. Rather, the goal has been to explore the complexities and inherent tensions of sociopolitical approaches to STEM - in this case computer science instruction, particularly in racially diverse urban settings. Directions for future research include exploring the pedagogical and learning conditions under which politicized trust can thrive, and the resulting learning and STEM-related identities that may become possible in the presence of politicized trust between students.

Chapter 5: Conclusion

Computer science (CS) as a body of knowledge and set of practices is playing an increasingly vital role in the world. From an educational standpoint, it follows that we must attend to how, where, by whom and to whom, and for what purposes, CS is being taught. Taken together, the three articles that comprise this dissertation represent both a critical reflection upon the state of computer science education research and practice in the United States, as well as an attempt to consider new possibilities for computer science learning rooted in social justice, educational equity, and critical pedagogy perspectives. In this conclusion I revisit each of the articles, offering additional thoughts that highlight contributions, limitations of the studies, as well as implications for future research and practice.

Chapter 2: Towards a Sociopolitical Approach to Computer Science Education

I began Chapter 2 by noting the recent surge of interest in CS education – in the media, in academia, in school districts, and increasingly in the political realm. Reviewing extant literature about mainstream CS education research, I advance a radically different framework I refer to as a *sociopolitical approach to computer science education* research and practice. I organize the framework around three issues: (a) ethics in CS curriculum, (b) conceptualizations of teaching and learning, and (c) the framing of CS learning environments. The purpose of the framework is two-fold: first, to offer policy-makers, researchers, and educators a way to critique and challenge dominant ideologies and practices of particular computer science learning environments, and second, to provide some framing ideas that can guide critical scholars and researchers in imagining and designing socio-politically transformative CS learning environments.

In elaborating the elements of the framework, I interweave a case study of the Computer Science and Technology (CST) academy at Bay Prep, a large, racially diverse urban high school in the San Francisco Bay Area. The case study serves as both an introduction to the CST (where the studies described in the next two chapters are also based), and also as an example to illuminate how the framework I have articulated can be applied to critically assess an actual learning environment.

At the center of the article is an argument to conceptualize equity in CS education in ways rooted in social justice and critical pedagogy perspectives. More specifically, a sociopolitical framing of equity in CS education rejects neoliberal, militaristic, or corporate motivations (Giroux, 2005) for expanding CS in schools, even when those calls are accompanied (as they often are) by a diversity rationale. Rather, a sociopolitical approach imagines CS learning as a tool for empowerment and social transformation, and connects the learning of specific concepts and practices in CS to broader political-ideological projects anchored in the liberatory visions, dreams, and desires of marginalized communities.

To the extent the three components of the framework (ethics in curriculum, conceptualizations of teaching and learning, framing of CS learning) aided in more precisely articulating this alternative approach to CS, the article achieved its goals. Even so, despite my effort to articulate the components of the framework by drawing on

diverse sources (curricular documents, current events, research literature), I am concerned that readers, particularly educators, may at times find the framework to be overly abstract, or even worse, as presenting a false binary between “good” and “bad” approaches to CS teaching and learning. Anticipating this potential criticism, the CST case study interwoven through the paper was an attempt to ground the framework in an actual learning environment in which I was involved on multiple levels. It is my hope that the case study illuminated the utility of the framework for engaging deeply with how issues of equity manifest in complex and nuanced ways in the context of an actual learning environment. I acknowledge that while the case study provides an overview of the academy by drawing on the perspective of Mr. Mayson as well as those of several students, it was derived primarily from my own observations and experiences of researching and teaching within the academy. A more ethnographically rigorous treatment than could be conducted in this project would systemically examine a larger number of stakeholder perspectives and experiences – student, teacher, parents, administrators, and community members.

Finally, a sociopolitical approach to CS learning environment, particularly within the context of public schools, is only possible to the extent that there are qualified teachers of computer science who are deeply committed to issues of equity and social justice. Given the national shortage of CS teachers, this would be a tall order, for it would require innovative approaches to teacher education and ongoing professional development. Future work in these areas is critical if computer science education is to move in equitable and socially just directions.

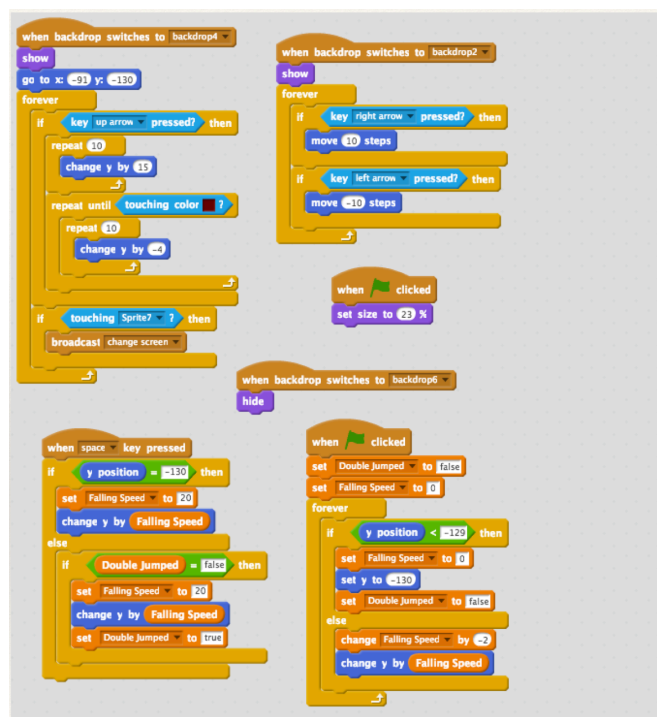
Chapter 3: Designing Technology for Social Change: Identity Trajectories and Transformations in a Computer Science Classroom

For readers wanting to see an example of the sociopolitical approach in action, Chapter 3 describes a 10-week curriculum unit, *Designing for Equity at Prep* (DEP), that I designed and taught alongside Mr. Mayson, who was the primary teacher and director of the CST academy. The design of the DEP unit was informed by my previous research at Bay Prep (Nasir & Vakil, in press) as well as by my earlier research and teaching in various educational settings (Vakil, 2014; Van Wart, Vakil, & Parikh, 2014). The goal of DEP was to provide an opportunity for 10th grade students in Mr. Mayson’s *Introduction to Computer Science* course to experience the learning of CS in ways that leave their whole identities intact. The primary pedagogical goals of the unit were: (a) for students to learn how to identify and analyze social issues in their school, (b) to design technological artifacts that addressed these issues in creative and innovative ways, and (c) to do (a) and (b) while being their authentic selves. To elaborate the latter goal, my hope was for students’ multiple social identities (e.g., girl, Latina/o, Black, activist, feminist, etc.) to feel not only welcome but also relevant in the context of a CS learning environment. My study examined the complex interplay between students’ sociopolitical and disciplinary identities in computer science. Drawing on sociocultural perspectives in the learning sciences, my findings generally support the theoretical notion that all learning environments carry identity affordances and constraints. More specifically, that learning and identity processes are mutually constitutive. Through detailed case studies of two students, Lupe and Stacey, I demonstrated that students’ identities became critical

resources as they worked towards designing socially relevant technologies. Perhaps more importantly, the process of designing socially relevant technologies also shaped students' identities in consequential ways. The significance of these findings is that carefully designed computer science learning environments can be both intellectually rigorous as well as being socioculturally and politically transformative spaces.

There are (at least) several ways to move this work forward. I anticipate that despite the DEP unit being part of an introductory course, some CS educators and CS education scholars may take issue with the relative lightness of traditional computer science concepts and practices in the unit. It is true that, despite some students' use of advanced computational ideas in their final designs (see Figure 6 below), the explicit goal of the DEP unit was not focused on developing conceptual mastery of specific computer science ideas and practices.

Figure 6. Code example from Stem Gal



I think it is a fair (and empirical) question to ask how advanced CS concepts and practices can be taught while maintaining an equity and social justice focus. However, I would emphasize that the question is not “if” but rather “how” CS can be taught in ways that are socio-politically transformative in the context of advanced computer science. I remind readers of ideas I presented in Chapter 2 that make the point that all CS learning is political. The implication here is that the absence of current CS learning opportunities at multiple levels that are aligned with social justice principles is not a reflection of what is possible, but rather of limitations in what the CS education community has heretofore

imagined to be possible. These limitations open up exciting new directions for research and practice at all levels of CS education.

As a final note, I believe that equity and social justice approaches to computer science should be wary of the tendency towards what has come to be referred to as “solutionism,” which has become more common in recent years. Solutionism is defined as the belief that all problems can be solved through technology. Technology critic Morozov criticizes a dominant ideology in Silicon Valley that recasts deep philosophical and political issues in society as merely technical challenges to be solved by an “app” or other kinds of computational technology (Morozov, 2014). I wholeheartedly agree that Morozov’s critique of solutionism provides an important tempering to what is often an overzealous impulse amongst technologists to solve all problems with technology. However, I simultaneously worry his critique and other similar perspectives may be used in ways that limit or discourage the collective epistemological, pedagogical, and political project of reimagining how specific technologies (and associated processes of knowledge production) can be used as tools for social empowerment. I would argue for redirecting aspects of the solutionism critique to problematize the insular nature of dialogue within technology circles as well as a culture within CS education (K-12 and higher education) that fails to consider intellectual and analytical connections to the humanities or social sciences. The DEP unit described in this chapter was a (small) step in the direction of integrating CS learning with nontraditional social topics (educational equity in an urban school).

Chapter 4: “You’re so far out, and you’re trying to look in”: Exploring Politicized Trust in a Racially Diverse Computer Science Classroom

In Chapter 4, I problematize particular aspects of the DEP design. In particular, having noticed tensions between white students and students of color, I examined the nature of inter-racial student relationships in the class. I found generally that there were strained relations amongst students, and that interactions became particularly strained during classroom discussions regarding race and racism within the school. Using video data from one specific episode, I argue that tensions between two students, Scott (a White male) and Lidiya (a Black female), despite appearing ideological in nature, were rooted in the lack of *politicized trust* between students. I developed the notion of politicized trust in an earlier study that examined power and race relations between researchers and communities (Vakil, Mckinney de Royston, Nasir, & Kirshner, 2016). Adapting the concept to examine student relationships in classrooms, I argue that dynamics of race and power mediate student relationships, particularly so in racially diverse classrooms. Even more, these dynamics play an increasingly significant role in learning environments that have equity and social justice goals.

Ultimately, this chapter aims to make an important theoretical contribution to equity research in STEM education generally and to CS education in particular. In the literature review, I argue that while analytical attention to student interactions and discourse has become more common in STEM education research, particularly in research informed by sociocultural perspectives, this is often done merely as a secondary concern (at best). In other words, student relationships/interactions/discourse are often (implicitly) framed as important only insofar as they are a means towards conceptual

mastery or disciplinary learning, and less often conceptualized as an end in and of themselves. I argue that cultivating (through careful design of learning environments) positive student relationships rooted in trust and solidarity between students is not only critical for expansive forms of collective learning (Engestrom, 2001), and essential for the development of democratic learning communities (Sengupta-Irving, 2014), but also an ethical responsibility of educators and researchers. In the DEP unit, although students created impressive technological designs, the lack of trust between students limited possibilities for collective thinking and action. Worse still, this lack of trust resulted in Lidiya and other students of color experiencing discomfort and feeling violated. This is an unacceptable outcome for any learning environment, and particularly disappointing for a learning environment motivated by equity and social justice goals.

Related to these concepts, I offer two final thoughts for consideration. First, the question of cultivating trust and solidarity between students, in particular in racially diverse schools like Bay Prep, can be a profoundly difficult and complex task. I think it is important to situate student relations in schools in broader contexts that attend to the specific histories and experiences of communities. Within these histories, we may find key insights into the nature of existing tensions, as well as opportunities and openings for solidarity between racially diverse students in a particular school.

Second, it is not clear who is *qualified* to perform this task, or when, how, and towards what ends it can or should be attempted. If we accept the notion that student identities and relations should be a design and research priority, it follows that researcher and teacher positionality should also be questioned and critiqued (Milner, 2007). For instance, I have to consider my own outsider status as a Middle Eastern male of Iranian descent, an ethnic category that is not represented in the school. Therefore, despite residing in the same city as many of Bay Prep's students, belonging to a stigmatized group in American society, and identifying as a man of color, I do not have the same lived, community, or historical experience as many of the students in Mr. Mayson's class. As such, I would argue there are limitations to the types of political or solidarity work I can conduct with the degree of legitimacy and authenticity that is critical to the social justice education tradition (hooks, 2000; Freire, 2000; Ladson-Billings, 1995). The question of who is qualified (or what it takes) to teach in social justice oriented educational settings is complex, and cannot be reduced simply to matters of shared ethnic, racial, or gender membership (ross, 2016). Future theorizing and research is needed in this area, and has significant implications for the future of teacher education and professional development in equity approaches to education - including but not limited to computer science and STEM education.

Final Notes: Bay Prep, the CST Academy, and Future Possibilities

During the time of this study and into the present, the San Francisco Bay Area has been and continues to be in the midst of a rapid, technology-fueled gentrification, which is leading to the displacement of thousands of working-class families of color. Gentrification is a complex issue and cannot be reduced to a single cause, but there is widespread agreement amongst local activists and community members that the technology boom is causing severe demographic changes, particularly in low-income communities of color (Stehlin, 2015). Of course, schools such as Bay Prep are not

protected from these changes. Bay Prep is situated in a neighborhood that has experienced particularly high degrees of gentrification, resulting in dramatic changes to the demographics of the school. Only a few years ago, Bay Prep was a predominantly Black school. By contrast, during the time of this study, Black students were still the largest group, but less than half of the total population.

It is my hope that this dissertation will lead us to pause and reflect on what these changes mean for the purpose and future of computer science education at Bay Prep. At its heart, an equity and social justice agenda in computer science education challenges any educational ideology that encourages youth of color to cast their career aspirations in future job prospects linked to industries that are in turn gentrifying their communities. It is also my hope that this dissertation has shown alternative possibilities for CS learning and practice. The DEP unit, despite its challenges described in Chapter 4, provided an opportunity for the 10th-grade students in the CST academy to experience CS learning in a radically different way. And, perhaps more importantly, to experience their own identities in new ways relative to the discipline of computer science.

This was not only a consequential empirical project. I knew on a general, conceptual level, even from the beginning of this project, and now in a more specific sense, that this dissertation was a deeply personal endeavor. My multiple identities connect with this project in several distinct ways. I connect with the work as somebody who is deeply concerned with the moral character of the nation in which I was not born, but am now a citizen. As somebody who has studied engineering and practiced engineering in companies that profit from the endless wars in a part of the world to which I am deeply linked - through immediate family, recent memory, historical memory, and my ancestors. I also connect with it as a scholar who genuinely believes in the power and promise of education as a powerful force for social good in the world.

As I conclude this dissertation, I am packing my bags to move with my family to Texas to begin a new position in the fall as Assistant Professor of STEM Education at the University of Texas at Austin. As part of this position, I am assuming the role of Associate Director for Equity & Inclusion at the Center for STEM Education, which has recently collaborated with the White House on the “Computer Science For All” initiative. The findings and implications from this dissertation lead us to ask: What are the equity and social justice dimensions of an initiative funded by the federal government (with a budget of \$4 billion for the entire nation) to expand CS learning “for all?” What are the tensions and possibilities within these kinds of initiatives? How can we establish a research agenda that openly embraces the possibilities for such initiatives to expand rigorous and transformative learning opportunities to the most marginalized youth in our society, while at the same time remaining critical of ideological projects that are not necessarily in the best interests of the communities of which these youth are a part? This dissertation has been an attempt to begin the work of thinking about some of these pressing concerns. As I move towards a faculty career, I humbly and dutifully look forward to a research agenda that continues to shed light on topics related to equity and social justice in computer science and STEM education.

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Appendix A: Description of Key Activities in DEP Unit

Identity Memo

The identity memo, inspired by the researcher identity memo in Maxwell's qualitative research methods (Maxwell, 2012), asked students to write 1-2 page biographical statements that contextualized their chosen equity issue drawn from their own lived experiences. Students were asked to situate their equity topic within their current as well as past schooling experiences. The goals of this assignment were that students tap into their own histories as a resource for understanding their topic and develop a deep, meaningful, personal connection to their equity issue.

Problem Analysis Presentation

Group work was emphasized throughout the unit. After identifying important equity issues that students cared about, groups of 4-5 students worked to identify a "theoretical framework" which helped them analyze the root causes of the equity topic chosen. For example, while various groups decided to examine diversity within various pathways, students' reasoning about diversity varied widely. Some students identified structural or systemic causes for racial/gender inequities in the school and others characterized student apathy or lack of motivation as underlying explanations for lack of diversity in certain academies or pathways. The problem analysis presentation was a group assignment that culminated in a presentation to the class to highlight the significance of the problem identified and the way the group identified root causes of the problem.

Design Ideation and Politics of Technology Memo

This activity marked the turning point in the unit. At this point, student groups were asked to brainstorm various technological "solutions" for their equity issue, and identify how their solution was framing the problem they were attempting to address. In other words, *the politics of their technology*. There was significant whole class discussion and accompanying activities that led up to this assignment, which helped students understand how various solutions, technologies, and artifacts have political values and sociocultural worldviews embedded within them. A salient example of this is a group of Asian American males whose equity issue was interpersonal racism experienced by Asians in the school. Their solution was to install video cameras throughout the school, including the bathrooms, to increase surveillance and thus security for Asians at the school. In discussing the politics of their solution, the students discussed the tradeoff between student safety and privacy, ultimately arguing that while they recognize their solution compromises the overall freedom and privacy of other students, it is worth it because "safety comes first." The goal of this assignment was precisely this -for students to name the tensions, contradictions, and possibilities inherent in the various solutions they had identified for their final projects -and to ultimately understand and be able to articulate the politics of their technologies.

Final Designs and Portfolio

The final three weeks of the unit were devoted to students working in smaller groups, with the intent being to first create “mock-ups” of their solution using the Balsamiq wireframing software. Students then designed initial prototypes using either Scratch programming environment, web development using HTML/CSS, or application development using visual Basic.net. At the end of the unit, students were asked to compile all of the class assignments, along with their final projects, into a comprehensive design portfolio.

Appendix B: *DEP Survey*

Instructions:

Please answer the questions below to the best of your abilities. You may skip any questions that make you feel uncomfortable or that you do not wish to answer.

Background Information

First Name: _____ Last Name: _____

What is your gender?

- Male
- Female
- Other: _____

Which race/ethnicity best describes you? (you can choose more than one)

- Hispanic or Latina/o
- Black or African American
- Native American or American Indian
- Asian
- South Asian
- Middle Eastern
- Pacific Islander
- White
- Other: _____

Equity Orientation

Please answer the following questions to the best of your ability: please make your thoughts/argument clear.

Please describe how and why you selected the Computer Science and Technology Academy (Were there other academies you applied for? What were the main factors in your decision?)

What are some of the barriers to academic achievement in your school? Which students are most disadvantaged, and why?

Using the key below, please indicate the extent to which you disagree or agree with the following statements.

Key:

1 = Strongly Disagree

2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly Agree

Inequalities in my school are the result of racism.

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

Please explain your answer. (How do you define racism? Why or why not is it a factor at your school?)

Inequalities at my school are caused by student laziness and lack of motivation.

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

Inequalities at my school are a result of parents who do not care enough about education.

	1	2	3	4	5	
Strongly Disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

Inequalities at my school are the result of teachers and programs at the school that exclude certain students.

1 2 3 4 5

Strongly Disagree Strongly agree

My school should do more to support African American, Latina/o students, and low-income students.

1 2 3 4 5

Strongly Disagree Strongly agree

Technology Views, Experiences, and Identity as Technology Activist

Please answer the following questions to the best of your ability: please make your thoughts/argument clear. Please provide a thorough/complete answer.

Do you think it is important for all students to learn computer science? Why or why not? Please explain.

What is the role of computer science in society? What are the main ways that computer science or computing is used in our country? In our world?

What do you plan to do with your knowledge of computing and technology?

Where and from whom do you learn about computer science and/or technology? (other than in the Computer Academy)

Name two examples of technology that are inspiring to you. Explain why.

I can use my knowledge of computing to create social change in my school and in my community.

1 2 3 4 5
Strongly Disagree Strongly agree

I feel that computing and technology can effectively address equity issues in our school.

1 2 3 4 5
Strongly Disagree Strongly agree

I view myself as “smart” in computer science.

1 2 3 4 5
Strongly Disagree Strongly agree

I can see myself pursuing a career in computer science or computing.

1 2 3 4 5
Strongly Disagree Strongly agree

I can see myself using computer science and technology as a way to participate in activism (e.g. Ferguson activists using Twitter to organize #BlackLivesMatter protests).

1 2 3 4 5

Strongly Disagree ○ ○ ○ ○ ○ Strongly agree
