ABSTRACT

Title of Dissertation: ENACTING "EQUITABLE" COMPUTER SCIENCE: HOW U.S. PK-12 DISTRICT AND SCHOOL LEADERS INTERPRET EDUCATIONAL POLICY

Kristina Kramarczuk, Doctor of Philosophy, 2023

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As technology continues to permeate all aspects of modern society, it is critical for PK-12 students to participate in computer science (CS) learning opportunities that prepare them to navigate and leverage technology in their future careers. However, research consistently shows that Black, Hispanic/Latino/a/x, and Native American students, students who qualify for the National School Lunch Program, and rural students are significantly less likely to attend a high school that offers foundational CS courses like Advanced Placement CS A (APCSA) or Advanced Placement CS Principles (APCSP). One way to challenge inequities within PK-12 public CS education is for federal, state, and local leaders to develop and enact CS education reform that specifically addresses disparities in CS education across racial, socioeconomic, and geographic lines. This dissertation unpacks how local leaders–central office leaders and public high school principals–perceive the expansion of CS education in their local contexts and how they leverage their power to bring CS to *all* students, not just the White and Asian elite. This study includes three articles: 1) an exploratory factor analysis and multiple regression analysis of national Google and Gallup (2020) survey data on U.S. PK-12 superintendents' and principals' perceptions of CS education in their local contexts, 2) a multiple case study analysis of interview data with 30 central office leaders and high school principals from six distinct school districts in two states on the East Coast, and 3) a policy brief that summarizes findings from the first two

studies and proposes federal, state, and local level policies that can address disparities in U.S. public high school CS education.

Findings from the first study revealed that U.S. superintendents and high school principals express positive support for CS education but do not feel that other stakeholders in their school districts, like school board members, parents/guardians, teachers, and students, are equally supportive. Perceptions of stakeholder support were lowest for leaders in the Western part of the U.S. and for leaders who oversee majority low-wealth students. Using the Capacity for, Access to, Participation in, and Experiences in CS framework (CAPE) by Fletcher and Warner (2021), as well as the educational debt theory proposed by Ladson-Billings (2006), the second study showed that support for CS education is fragmented between the state and local levels, even in a state with robust CS education policy in place. Interviews with central office leaders and high school principals confirmed that mainly White, male, and college-bound students are enrolling in APCS courses. Additionally, White-identifying central office leaders, despite recognizing these disparities, placed the blame on students rather than the lack of infrastructure for CS education in their school divisions; they claimed that without enough student interest in elective APCS courses, it is difficult to justify allocating district resources for CS. Whereas in larger school districts, leaders were aware of disparities and actively working to dismantle disparities in CS education. Any challenges that these advocates faced were most likely due to capacity issues, such as a sparse CS teacher workforce or limited funds to establish concrete CS education units at the district level.

Five policies are recommended for federal, state and local leaders to enact: 1) federal leaders should develop CS education mandates that require U.S. states to create comprehensive plans for PK-12 CS education, 2) federal and state funds should be allocated towards district and school leadership professional development for CS education, 3) states should develop state-specific CS course sequences for PK-8 education that prepare all students for advanced high school CS coursework, 4) states should consider creating longitudinal data systems that track student enrollment in middle *and* high school CS courses, and 5) school districts should distribute funds to hire a CS advocate who oversees CS course expansion in the district. Researchers can use the data from this dissertation to develop interventions that address the unique needs of different U.S. PK-12 educational leaders and promote productive relationships between CS education policy and practice.

ENACTING "EQUITABLE" COMPUTER SCIENCE: HOW U.S. PK-12 DISTRICT AND SCHOOL LEADERS INTERPRET EDUCATIONAL POLICY

by

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Dedication

For my grandmothers, Bapsha (Irene) and Baba (Maria), and my uncle Dunio (Walter).

Acknowledgements

I want to start by saying thank you to my grandmothers, Bapsha and Baba, who taught me the true value of education. After being forced from their homes in Ukraine during World War II, they made it their life goal to create educational opportunities for their children and grandchildren in the U.S. Even as they aged, Baba continued to teach me how to roll pyrohy dough and cherish my Ukrainian heritage while Bapsha read me hand-written letters from friends across the world and taught me the value of friendship. Thank you Bapsha and Baba for the experiences that you shared with me as a child.

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Mom, thank you for being a role model in my life. I did not quite understand it as a child, missing you as you worked, but now I see the tremendous strength you showed as a mother of four having to navigate a male-dominated field that always challenged your worth. You are a champion in my life and the reason why I put mentoring and supporting others over my own success. The world can be tough, but you showed me that Hordinsky blood is tougher.

Dad, thank you for being my rock. You have always been there, through the good times and the bad, to cheer me on. I don't think you missed one soccer game since I started playing at the age of five. You were there for my first heartbreak in college, ready to pick up the pieces and help me continue on. You let me cry ridiculous tears over getting one question wrong on an

organic chemistry test in college, reassuring me that perfection isn't everything. You are amazing dad. You are my best friend.

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Thank you, Bianca, for being another strong female role model for me growing up. Your endless compassion, creativity, and love for your family continues to inspire me. Bianca, please don't ever change. As a kid, and still today, I believe that you of all people deserve a world of peace and happiness. You have gone through so much and still never failed to be there for our family. You are an amazing mother to Drew and Peri.

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CS	Computer Science
BLNA	Black, Hispanic/Latino/a/x, and Native American/Alaskan Native Students
PK-12	Pre-kindergarten to 12th grade
APCS	Advanced Placement Computer Science
APCSP	Advanced Placement Computer Science Principals
APCSA	Advanced Placement Computer Science A
CAPE	Capacity for, Access to, Participation in, Experiences in CS Education
EFA	Exploratory Factor Analysis
PAF	Principal Axis Factoring
MLR	Multiple Linear Regression

Chapter 0: Personal Statement

My journey into computer science (CS) education followed an untraditional yet typical path. I was personally excluded from CS throughout my entire educational career due to my gender; CS was not available to me because it was consistently labeled as masculine, only taught to students who had college-level math abilities, and did not “fit” my overly gendered empathetic and caring identity. As a result, I pursued “softer” sciences such as biochemistry and microbiology because I could later pursue a career in a “humanistic” field such as medicine (doctor or nurse). I was thrown into CS by chance, and I am so glad that I was. I think my story is an important reminder that stereotypes can push young women out of CS and that there are cultural and structural systems in place that prevent important change in the computing workforce. My story also highlights the prevalence of whiteness and its association with privilege. I am going to tell my story with all of its messy parts. Only through this truth can I explain my strengths and limitations around the research that I propose.

The Journey

From a young age, I loved to understand the world around me and immerse myself in experiments. As the youngest of seven children, I learned science from my family - my sister the researcher, my mother the dermatologist, and my sister the hairdresser. Even with family members who did not pursue science, I still was able to learn about the world from them and investigate new phenomena that I may not have discovered on my own. I was a young girl encouraged by my little world to be a scientist.

Once I began college, I immediately pursued a science path. As a pre-medical student, I was required to take chemistry, biology, and biochemistry classes. I fell in love with biochemistry and decided to pursue a major in it. When I went to the biochemistry advisor, I was explicitly told that I would not be able to handle the rigor of the coursework. The male advisor looked at me, failing to see my interest in biochemistry, and made me feel like I didn't belong. My hard work–my experience working in a biochemistry research lab, my success in my science classes, my support systems–all disappeared into a void. Disheartened, I pursued microbiology as a major because most of the professors were women, and the major requirements were more accommodating to my desire to double major in Spanish. Microbiology was actually my first introduction to formal CS in the form of computational genomics, or the use of computers to sequence DNA from living organisms. However, I recoiled from the assignment and told myself I couldn't complete it because it seemed too difficult. I defaulted to my partner to handle the coding while I analyzed the DNA sequences instead.

My experiences as a microbiology major were foundational to my transition from science to education. One female professor taught me that *teaching* science was different from *knowing* science. I looked up to this professor as a mentor because she was both knowledgeable in science content *and* pedagogy. She also helped me to see that throughout my whole life, I was not just "good" at science, but I was also good at teaching. One day, my professor asked me if I wanted to pursue a Ph.D. because it was clear that I both loved learning and teaching. I said no but that I was considering teaching. When my college graduation arrived, I shocked my family by joining Teach for America (TFA) to teach high school chemistry in Miami, Florida. My microbiology professor wrote my TFA recommendation letter.

My career change from scientist/doctor to educator was one of the most important decisions of my life that propelled me into the field of computing education. While teaching, I felt energized and excited by each day, looking forward to teaching my students electron behavior and acid/base chemistry. I even brought my mom in as a guest speaker to teach my students about dermatology, the process to get into medical school, and the chemistry behind her career. One day while teaching, I received an email about becoming a summer computing instructor for high school young women across the country. The job would train me to understand coding languages *and* how to teach them. I applied, was accepted, learned how to code, and taught CS. My summer coding experience made me realize that CS is not a mysterious or exclusive field. It also introduced me to the cultural impact of computing –the impact of artificial intelligence on individuals of color and the importance of increasing diversity in tech.

Following my first CS summer teaching experience (I went back to teach CS again the following summer), I met another female professor in my master's program who asked me if I planned to pursue a doctorate in education. She commented that I wrote like a researcher. Taking her advice, I applied and was accepted into the Science Education specialization in the Department of Teaching, Learning, Policy, and Leadership at the University of Maryland. Still, though, CS education was in the back of my mind and science at the forefront.

I didn't truly commit to CS education research until I started my doctoral program. One day, the director of my program forwarded an email regarding a research assistant position through the CS Department and mentioned that I might be interested in it. The position was to perform research on survey data obtained from K-12 students participating in summer computing programs hosted through an initiative housed within the CS Department. I was intrigued by both the research and the initiative, the Maryland Center for Women in Computing (MCWIC). I applied, was accepted, and worked with MCWIC, now called the Iribe Initiative for Inclusion and Diversity in Computing (I4C), since 2020 as a graduate research assistant. Through I4C, I taught undergraduate CS majors how to teach CS to K-12 students, identified research areas that need explicit attention in the CS education community, attended CS education research conferences, and developed relationships with faculty and staff in the UMD CS Department.

Through my late introduction to CS, I was able to observe the nascent characteristics of the computing field in terms of its age as a discipline and the disconnect between CS, society and education. My experiences have also shown me that CS is highly unique from other science, technology, engineering, and mathematics (STEM) disciplines; almost half of PK-12 students in the U.S. do not have access to foundational CS courses (e.g., Introduction to CS, Advanced Placement CS, etc.) and many U.S. states do not have CS education policy in place (Code.org, 2022) while other STEM subjects are federally or state-mandated graduation requirements.

My experiences may explain how I entered the CS education research field, but my story is still incomplete. I must explicitly mention my racial identity–how I experience race as a white woman and how my identity as a white woman impacts others–to fully understand how I arrived at this dissertation. By outlining the racial component of my identity, I can ensure that my readers understand the privileged and neoliberal white gaze that I bring to the research.

Positionality: Race Matters

As a white woman, I have racialized experiences that make me an outsider to communities of color and their experiences with structural and interpersonal racism. My introduction into teaching through Teach for America, highlights this disconnect. Although often embarrassed that I was a TFA corps member, I think it was important for me to confront the white savior identity that TFA promotes and to learn ways to challenge white saviorism in education, especially through my own teaching. I was a white teacher of primarily Black and Hispanic/Latino/a/x students and personally witnessed the disconnect between my personal experiences and those of my students. In my first year of teaching, I quickly realized that I would always be an outsider; I could care and build relationships with my students, but to an extent. I could listen to them but not always give advice. I could employ teaching practices that centered their cultures and experiences in the classroom, but I could not always participate or lead those conversations. What I definitely could not do, was promote low expectations. I remember a distinct moment when I was sitting exhausted and alone in my classroom during my first year of teaching because my students did not want to come to my class. A biology teacher stopped by my classroom and when I told him what was happening, he simply said, "the second you lower your expectations you will lose their respect." It was that simple and short statement that kicked me into gear; I recognized the profound impact that my whiteness had on my classroom and the unspoken power I had to determine the success and failure of my Black and Brown students. However, to let whiteness monopolize how I interacted with my students–to choose to be an inauthentic and harmful role model with them–would be to give into white guilt and believe that I could have no impact as a white female educator.

Instead, my teaching experiences offer a lens of an educator who is passionate about achieving racial justice. I am committed to this work because I have observed and taken part in the structural and systemic systems that are harmful to my former students: exclusionary school tracking patterns (e.g., placing certain students into more advanced tracks based on state test scores), unfair punishment of students, lowered expectations of students based on their classroom behaviors, and overwhelmed school staff whose hands were tied by district-level accountability demands. My educational experiences push me to address the cultural and structural barriers that place math and reading test scores over students' humanity. I am propelled to research ways to make school less exhausting, disheartening, and exclusionary for administrators, teachers, *and* students.

I also expand my scholarship beyond gender discrimination to recognize the intersectional forms of marginalization that are widely prevalent within the CS community (Crenshaw, 1991; McGee, 2021; Rodriguez & Lehman, 2018; Rankin et al., 2020). By taking an intersectional lens to my work, I acknowledge that my experiences with sexism do not, whatsoever, equate to the types of oppression students face at the intersections of gender, (dis)ability, social class, and especially, race. Racism is a unique kind of oppression linked to a lack of racial privileges that protect and give power to White students throughout various levels of society. The unique hegemony that race holds over society requires me to acknowledge it in my studies and propels me to expand my work beyond my personal experiences. Therefore, I am committed to work that acknowledges the intersectional experiences of students of color in CS and that evaluates current practices within the CS education pipeline that perpetuate inequities.

Chapter 1: Introduction

The number of U.S. public high schools offering foundational computer science (CS) courses has increased from 35% to 53% since 2018 (Code.org, 2022). Despite this promising increase, Black, Hispanic/Latino/a/x students, and Native American/Alaskan Native (BLNA) students, as well as students who attend schools with high populations of students on the National School Lunch Program are the least likely to have access to these courses (Code.org, 2022). The current state of CS education reveals that the fast-growing "Computer Science for All" or CSforAll movement is broadening student participation in computing but only for certain student populations - mainly the white and Asian elite[1]. CSforAll is an executive branch program created under the Obama administration that encourages researchers and research practice partnerships (RPPs) to prepare high school teachers to teach rigorous CS courses, provide PK-8 teachers with the necessary resources to effectively integrate CS into their existing curricula, and/or ensure that schools and districts have the resources they need to create accessible CS education pathways (Kurose, 2017, NSF, 2022). Current data highlights that CSforAll efforts are not enough to address the deep cultural and systemic structures embedded within the CS computing that prevent meaningful BLNA student participation in PK-12 CS education (Dubow et al., 2020; Goins et al., 2021; Scott et al., 2019).

Racial segregation across the PK-12 CS education pipeline demonstrates that BLNA students continue to experience and accrue what Ladson-Billings (2006) calls the *educational debt*, or the accumulation of oppressive historical, economic, and sociopolitical practices that

[1]For the purpose of this paper, Asian will consist of students who either immigrated from or are children of immigrants from Northeast Asian countries such as China, Japan, and Korea. I am creating this distinction since Asian students are no longer considered underrepresented in computing. I challenge this broad grouping of Asian students to account for the severe underrepresentation of Southeastern Asian students from countries like Laos and the Philippines in computing.

lead to differences in educational opportunities across racial and socioeconomic lines. Black student participation in PK-12 CS has remained stagnant (Goins et al., 2021), and BLNA students are the least likely to take CS courses even when they are offered at their schools (Code.org, 2023; Warner et al., 2022). To address the educational debt, Ladson-Billings (2006) suggests that educational researchers investigate the *root causes* of differences in academic achievement and stop relying on short-term, surface-level solutions. In the context of CS education, policy is an important starting point for targeting the educational debt; research shows that PK-12 CS education policies directly influence student access to CS (Code.org, 2023; Warner et al., 2022). Typically, states with CS education policies in place are more likely to have school district leaders who will promote CS course access in their schools (Warner et al., 2022). A recent report by the Kapor Center that examines the state of tech diversity for Black computer scientists argues that change begins with policy and how that policy is enacted by district actors: "Until administrators, educators, policymakers, and advocates implement and embrace policies and practices to address the systemic factors limiting Black student participation and success in K-12 CS education, progress on inclusion and representation will remain stagnant" (Goins et al., 2021, p. 7). The authors highlight a key point: dismantling racism and other forms of discrimination within the CS education community can, and should, occur at all levels of the education system, but true change can only occur when CS education policy centers BLNA students and is communicated to and embraced by school leadership. Effective implementation of CS education reform also requires that school leaders invest in, understand, and enact this policy in partnership with educators, parents, and students, a term known as policy coherence (Johnson et al., 2014).

Despite the important role that U.S. PK-12 central office leaders and principals play in expanding CS education in their local contexts, national survey data indicates that 58% of U.S. PK-12 superintendents believe that CS is a top priority in their school districts while 28% of principals and 18% of teachers feel the same (Google & Gallup, 2020; Wang et al., 2016). These statistics emphasize a disconnect across U.S. PK-12 educational leaders and their perceptions of stakeholder support for CS education. Both central office leaders and principals hold substantial decision-making power in translating CS education policy in their school districts and schools (Cohen et al., 2018; Proctor et al., 2019; Richard, 2022; Santo et al., 2020; Santo et al., 2019) but their seeming lack of unity around CS education can have negative consequences of CS education reform efforts. As education researcher Vakil (2018) warns, "Without a clear political vision, the individual components of the [CS movement] framework risk becoming isolated efforts and thereby lose their potential to become critical components of a larger effort to significantly refocus the direction of CS education toward justice" (p. 42). In addition to current research efforts that focus explicitly on PK-12 teachers and students in CS, CS education research must also look into *why* central office leaders and principals are disconnected in their beliefs around CS education and *develop* actionable policies that prepare these leaders to develop unified visions of CS education.

To address existing gaps in the literature (Santo et al., 2020), this dissertation leverages the Capacity for, Access to, Participation in, and Experience of equitable CS education (CAPE) framework (Fletcher & Warner, 2021) to interrogate how central office leaders and high school principals interpret and enact CS education policy in their local contexts. The CAPE framework provides a clear definition of equity that is threaded throughout this dissertation: equity in CS is not just about access and participation, but rather how varying aspects of the system function in tandem. Equitable CS course expansion depends on the capacity of states and school districts to implement CS programs, the distribution of CS courses across school districts once capacity is established, the demographics of students who enroll in these courses, and the personal experiences of students in CS. Fletcher and Warner argue that CS research

> must engage actors at all levels of the system and not solely focus on questions related to curricular or professional development design, issues that occupy the attention of many in the CSed community. Such activities are situated in broader institutional systems that must be both understood by researchers and contended with by policymakers, content providers, and, most centrally, school-based practitioners from the classroom to the central office engaged in CSed work (Santo et al., 2019, p. 18).

When looking at district and school leaders' decision-making around CS education reform, the CAPE framework constructs a comprehensive picture of how each leader describes their personal investment, as well as additional school district stakeholders, to develop capacity for CS education and address BLNA students' access to, participation in, and experiences in CS educational environments. The next chapter (Chapter 2) outlines the context, background, and structure of the research. Therefore, this research is an opportunity to really look into the minds of school district leaders who play a pivotal role in equitably expanding CS education.

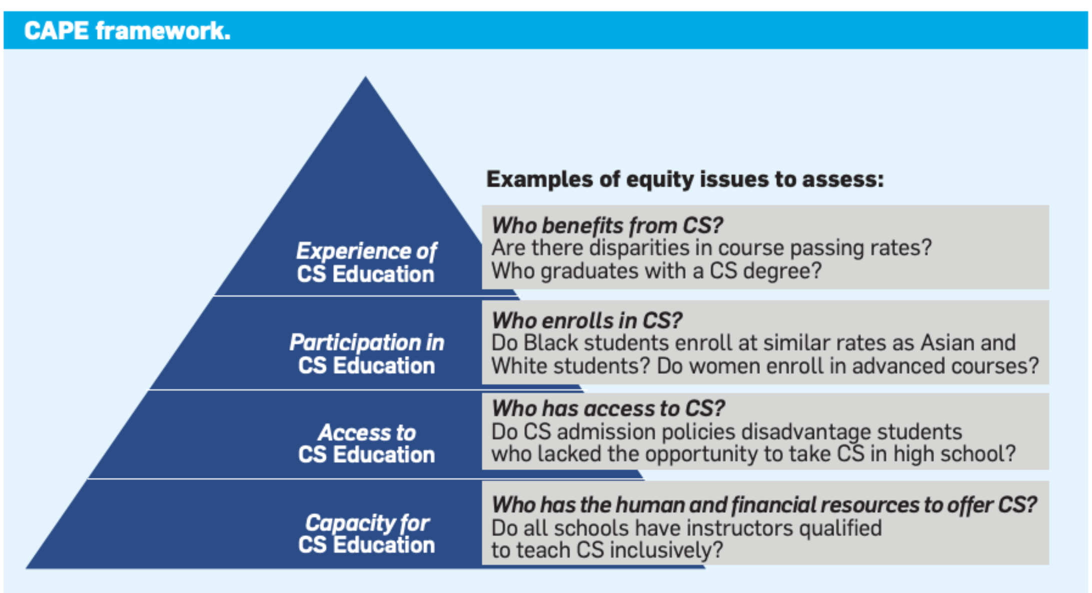


Figure 1. The CAPE framework developed by Fletcher and Warner (2021).

Chapter 2: Context, Background, and Structure of Dissertation

In addition to my Personal Statement, Introduction, and Context and Structure of Dissertation chapters, this dissertation consists of a quantitative study (Chapter 3), a qualitative study (Chapter 4), and a policy brief (Chapter 5). Each chapter has its own proposed methodology. Both the quantitative and qualitative studies inform the content of the final policy brief. Although separate studies, the two research projects were tied together through the Capacity for, Access to, Participation in, and Experience of equitable CS education (CAPE) framework (Fletcher & Warner, 2021).

The first three research questions explore the *capacity* of U.S.PK-12 leaders to implement CS in their respective areas (Table 1). The second research question looks at *access* to CS education in two states in the Eastern U.S. The third research question investigates school district and school leaders' decision-making around student *participation* (enrollment) in CS courses in each of the two states. For the final research question focused on the *experience* level of the framework, I push the CAPE framework beyond the students and suggest looking at student experience from a leadership lens; I investigate how student experience in CS depends on leaders' perceptions around who *can* and *should* benefit from and succeed in CS courses. In addition to the CAPE framework, I use the *Education Debt Theory* (Ladson-Billings, 2006) to apply a critical analytical lens to the data.

Research Questions	**CAPE Component**	**Methodology**
How do PK-12 superintendents and principals vary in their beliefs and perceptions around CS education?	Capacity	Quantitative
How do district/school size, socioeconomic status, years of leadership experience, urbanicity, general location (Northeast, West, Midwest, South), and average income level of a district/school explain variations in superintendent and	Capacity	Quantitative

principal beliefs, attitudes, and perceptions towards CS education?		
What structures do school districts have in place to establish high school CS course sequences in their high schools?	Capacity	Qualitative
How do district- and school-level decision-makers decide how they expand secondary CS course access in their respective districts and schools?	Access	Qualitative
How do district- and school-level decision-makers decide which students can take foundational CS courses and which students cannot?	Participation	Qualitative
How do district- and school-level decision-makers perceive BLNA student interest and success in taking CS courses if they are (or were to be) offered in their districts/schools?	Experience	Qualitative
How do current perceptions of CS *(quantitative)* help to explain how superintendents and principals support BLNA student access to, participation in, and experience in secondary CS courses *(qualitative)*?	All	Policy Brief

Table 1. Structure of the dissertation by research question, methodology, and CAPE framework component.

Chapter 3 is a quantitative study that consists of two parts: 1) a principal axis factoring (PAF) of publicly accessible Google and Gallup (2020) survey data[2] and 2) a multiple linear regression (MLR) of the extracted factors from Part 1 on five other independent variables – district/school enrollment numbers, district/school location, average socioeconomic status of students in the district/school, urbanicity of the location of the district/school, and the number of years the superintendents or principals have worked in their positions. PAF is an exploratory factor analysis technique that examines the underlying relationships within a group of observed

[2] The Google Inc. and Gallup Inc. survey is a multiyear, comprehensive research project that aims to better understand how PK-12 U.S. superintendents, principals, teachers, parents, and students perceive CS education. Students, parents, teachers, superintendents, and principals each took a survey designed for their respective group (e.g., students took the student survey, principals took the principal survey, etc.).

variables (questions or items) called latent constructs, or factors (Beavers et al., 2013; Fabrigar & Wegener, 2011). In Chapter 3, PAF is performed on 15 Likert-scaled survey items to create standardized scores for MLR. MLR is the main quantitative piece in Chapter 3 that turns the descriptive Google and Gallup (2020) findings into more nuanced explanations of US PK-12 superintendent and principal beliefs around CS education. Chapter 3 explains in detail the Google and Gallup survey data as well as the PAF and MLR methodologies.

Chapter 4 is a qualitative multiple-case analysis (Yin, 2002) of central office leaders' and principals' beliefs and decision-making around CS education in school districts across two states in the Eastern part of the U.S. Each school division/county and their respective participating central office and school leaders represent an individual case. The primary sources of data used to develop each case were semi-structured interviews, publicly accessible information regarding the demographics of each school division/county, and contextual information pulled from district/county and school websites.

Together, the quantitative and qualitative studies allowed me to assess how different district and school leaders address the educational debt of their BLNA students and to write a policy brief (Chapter 5) on how to support them in implementing equitable CS education reform. The results of this study are useful to policymakers, educational researchers, district leaders, and educators. As CS education policy expands, my dissertation can inform future policy decisions that align with the diverse needs of U.S. PK-12 stakeholders. My analyses also illuminate the role that central office leaders and high school principals play in the CS education system. CS education researchers can use findings from this dissertation to develop interventions that address the unique needs of different educational leaders across the U.S. and promote productive relationships between CS education policy and practice. If different groups of superintendents and principals can receive the support they need to recognize and address the cultural, systemic, and marginalizing barriers that widen gaps in access and participation between BLNA and white and Asian students, a more comprehensive and unified vision of equity and justice centered computing may arise. Consequently, educational stakeholders will be more inclined to focus on the educational debt rather than achievement gaps (especially high stakes testing that fuel these gaps) and promote effective systems change throughout the CS education pipeline (Kania et al., 2018).

Chapter 3: U.S. PK-12 Superintendent and High School Principal Beliefs, Attitudes, and Perceptions of Computer Science Education

Despite the growing role that technology plays in society, few U.S. states have established the structures needed to expand PK-12 computer science (CS) education (Code.org, 2023). Even in states where substantial CS education pathways are in place, low-wealth students and Black, Hispanic/Latino/a/x, and Native American/Indigenous (BLNA) PK-12 students have less access to high school CS courses (Code.org, 2023; Kapor Center, 2022). Multiple cultural factors (e.g., stereotypes about who can and cannot do CS, classroom structures) and structural factors (e.g., school funding for CS, the availability of CS teachers) contribute to disparities in CS education (Kapor Center, 2022). Additionally, in an extended codebook of the Capacity for, Access to, Participation in, and Experience of CS education (CAPE) framework (Fletcher & Warner, 2021), Gransbury and colleagues (2023) list administrator beliefs, attitudes, and perceptions of CS education as factors that influence the capacity, or the ability, of school districts to create equitable outcomes in PK-12 CS education. Despite the impact that these leaders' beliefs have on developing equitable PK-12 CS education pipelines, 58% of U.S. PK-12 superintendents reported that CS education is a top priority in their school districts while only 28% of principals and 18% of teachers felt the same (Google & Gallup, 2020).

There are various factors that might influence central office and school leaders' attitudes towards, beliefs, and perceptions of CS education. Due to the decentralized structure of the U.S. education system, where school systems operate under local education systems, large school districts or those located within city centers are likely to experience limited coordination between central office leaders, school administrators, and teachers (Cohen et al., 2017). Therefore, it is often challenging for larger school districts to develop the capacity to enact equitable CS education reform (Cohen et al., 2017). Additionally, current narratives that focus on "achievement gaps," or differences in standardized test performance between students of color and white students, may influence leadership perceptions of student ability in CS (Hung et al., 2020; Koshy et al., 2021). The important roles that PK-12 superintendents and principals play in expanding and cultivating an inclusive culture for CS education begs a deeper analysis into the factors outside of these leaders' locus of control (e.g., district/school size, location) that influence their beliefs, attitudes, and perceptions around CS education.

This quantitative study analyzes publicly accessible Google and Gallup (2020) survey data to determine the extent to which U.S. PK-12 superintendents and principals support CS education and how their beliefs, attitudes, and perceptions of CS reflect their capacity to support CS education in their local contexts. I explicitly explore the relationship between their beliefs and the contexts in which they work: the size of their school districts/schools (student enrollment), the average income-levels of families attending their schools, the region of the US in which their schools are located (e.g., Northeast vs. West), the amount of time they have been in their leadership position, and the urbanicity of their school district/school's location. While this particular study doesn't specifically unpack race and socioeconomic status, the larger purpose of this research is to understand access for minoritized groups, specifically BLNA students, who, data consistently show, are under-resourced within the computer science education space. Findings will inform CS education researchers and policymakers on how to support these different groups of leaders in promoting equity in CS. Focusing on the capacity level of the CAPE framework (Fletcher & Warner, 2021), I will answer the following two research questions:

1. How do PK-12 superintendents and principals vary in their beliefs, perceptions, and attitudes towards CS education?
2. How do district/school size, socioeconomic status, years of leadership experience, urbanicity, general location (Northeast, West, Midwest, South), and average income level of a district/school explain variations in superintendent and principal beliefs and perceptions of CS education?

Literature Review

When district and school leaders establish a system that accommodates and encourages the expansion of CS education, they can then assess how this capacity translates to student access and participation in CS courses and student experiences in CS classrooms (Gransbury, 2023; Fletcher & Warner, 2021). Superintendents, who are leaders of public-school divisions, can directly influence district culture and definitions of equity in many cases simply through their level of coordination with school board officials, district and school staff, and community members (Hutchings Jr. & Brown, 2021; Tienken, 2021). That stated, the extent to which superintendents work with other leaders in their school community can influence how CS education reform is perceived and enacted in their districts (Santo et al., 2019). Similarly, on a smaller scale, principals are agents of change within their schools and have power over school policies, class scheduling, and school budgeting. When principals work in tandem with teachers and counselors to bring CS learning to their students, student enrollment in CS courses is more likely to happen (Parker, 2023).

To adequately study superintendent and principal beliefs around CS education, it is critical to understand the current CS education policy landscape and how this policy impacts the everyday work of superintendents and principals. Therefore, this literature review explains the relationship between national CS education policy and how US PK-12 superintendents and principals approach CS education in their respective areas.

CS Education Policy, Implementation, and a Disconnected Landscape

The effective enactment of CS education reform is dependent on how district and school leaders interpret and execute CS education policy in their respective contexts (Dunton et al., 2022; Santo et al., 2019; Vogel et al., 2017; Warner et al., 2022). However, when looking at CS policies nationally, only 31 states have adopted or revised CS education policy to expand foundational CS courses to their students (Code.org, 2023). Without adequate state-level policies and support for CS education, superintendents and principals can receive mixed messages on whether CS is even a priority for students to learn (Santo et al., 2020). Vakil (2018) and Santo et al. (2020) claim that national, state, and local-level policy visions of CS lack consistency and become more fragmented as they move through the PK-12 educational leadership pipeline.

Even when states adopt policies in support of CS education, school districts with high populations of BLNA students or students on the National School Lunch Program receive less funding from the state and local taxes to implement CS courses (Kapor Center, 2023; Margolis & Goode, 2016). Additionally, U.S. public schools are subjected to federally mandated accountability pressures and limited funding that impact the urgency to implement CS education reform. As Johnson (2013) highlights in a study evaluating the impact of policy on science education reform in large school districts, federal accountability policies and funding create an "educational turbulence" within school districts that makes it difficult to implement science reform initiatives. Johnson (2011) defines educational turbulence as the ''interplay of external variables that directly influence school reform'' (Johnson, 2011, p.15) and the enactment of macro and micro-educational policy. In the case of CS education, school districts and schools are finding it difficult to accommodate new CS courses and curricula (**micro**) into an already financially and structurally unstable public education system that requires public schools to constantly meet federal accountability requirements (**macro**) in math and reading (Margolis & Goode, 2016; Tate et al., 2018). In 2020, Code.org researchers warned that funding for CS was being used to fund other school programs and that many states were removing state funding for CS education from their 2021 fiscal year budgets. In fact, both U.S. superintendents and principals claimed that the main reason they do not include CS in their schools is because they must devote most of their resources to standardized tested subjects (Google & Gallup, 2016). This emphasis on funding other school subjects, especially tested subjects, suggests that federal mandates and closing achievement gaps are more important than preparing students for a tech-centric society.

Beliefs, Attitudes, and Perceptions: How They Impact Equity

In addition to structural and economic issues, superintendents' and principals' beliefs, attitudes, and perceptions of CS education impact the prevalence and enactment of CS education reform. U.S. PK-12 superintendents and principals, like everybody else, bring personal identities into their workspaces that can shape how they view CS and implement CS education reform. In some instances, these leaders' racial and gender identities lead to biases toward students and their academic abilities (Jarvis & Okonofua; 2019; Kowalski & Brunner, 2011). Years of experience in their role also impacts how superintendents approach their work; for example, a study by Kowalski and colleagues (2009) showed that novice superintendents face unique challenges compared to experienced superintendents because they must learn how to balance preparation and theory with practice and implementation. Novice principals face similar pressures, especially around managing high-stakes testing (Levin et al., 2020). When considering race, over 80% of U.S. superintendents are White men (Joseph, 2023). With a majority White and male leadership, it is important to consider *how* these leaders may shape the culture of districts and stakeholder support for CS education, especially when focusing on Black, Hispanic/Latino/a/x, and Native American/Alaskan Native students (Joseph, 2023; Tienken, 2021).

Several studies show that superintendents and principals must hold a unified vision for CS education that resonates with students, teachers, parents, and other educational stakeholders in order to effectively implement equity-centered CS education policies (Gransbury et al., 2023; Koshy et al., 2021; Parker, 2023; Santo et al., 2019). For instance, Proctor and colleagues (2019) discovered that a small public school district in California found it difficult to design a comprehensive PK-12 CS program because stakeholders defined CS differently, conflicted in how they believed CS should be taught, and struggled with resolving these tensions. As Koshy et al. (2021) claim in their report on the CS teacher landscape in the U.S., "Developing an effective strategic plan to implement equitable CS programming within schools is more likely to be successful when school districts—including leadership, teachers, parents, and students—show a collective commitment and shared buy-in to prioritizing CS education." However, without cohesion across different educational stakeholders, well-designed CS education policy can lose its intended impact (Code.org, 2022; Koshy et al., 2021; Parker, 2023; Proctor, 2019; Warner et al., 2022).

To move from short-term reform (e.g., increasing access to CS) to reform that specifically confronts the systemic exclusion of BLNA students in CS learning spaces (Vakil, 2018; Warner et al., 2022), as previously stated as a rationale for this study, CS education researchers and stakeholders must take into consideration the factors that influence superintendent and principal attitudes, beliefs, and perceptions towards CS education. For example, district leaders, including superintendents, may design a CS curriculum or teacher professional development that aligns with how they view their teachers and students (Santo et al., 2019). A study by Santo and colleagues (2019) found that district leaders and school administrators across five school districts define equity in CS education in three different, but interconnected ways and each of their personal definitions is influenced by the needs and priorities of their own schools. Their work further emphasizes the role that context plays in expanding CS education. Despite being broadly located in the Northeastern region of the U.S., the specific and unique locations in which the leaders worked shaped how they defined equity in CS.

Kania et al. (2018) argue that a key component of effective equity-based changes in systems like the PK-12 CS education pipeline involves altering the conditions that are holding the problem—in the context of this study, this refers to the internal and external barriers that superintendents and principals face when trying to implement CS education reform. Superintendents and principals must be prepared to see how their own ways of thinking may be contributing to the problem and be open to changing their current practices. Therefore, this study is a first step into understanding where superintendents and principals from a variety of contexts currently stand in their beliefs around CS education in order to effectively support them to leverage their agency to enact equity-centered CS education reform.

Theoretical Framework

With equity at the center, this study focuses on the capacity level of the CAPE framework. The CAPE framework (Fletcher & Warner, 2021) shifts equity from being an end product of CS education initiatives to an integral component of all CS education research.

Fletcher and Warner (2021) define capacity as the availability of qualified CS teachers, funding for CS education, and state level policy to enact equitable CS education. They argue that "questions about capacity address issues that can impact, at a very early stage, whether traditionally marginalized students have opportunities to engage in CS education" (p. 24). To further emphasize what it looks like to do research on capacity, Fletcher and Warner give the following research question as an example: Are there differences based on student socioeconomics in the proportion of schools that employ certified CS teachers? This question, and other examples of capacity-related research questions, focus explicitly on broad resource availability which gives context to this equity-centered work.

Expanding Fletcher and Warner's (2021) CAPE framework, Gransbury and colleagues (2023) created an extended CAPE codebook that includes administrator investment in CS education as a part of capacity. I will use this extended definition of CAPE to focus specifically on PK-12 superintendent and principal beliefs, attitudes, and perceptions of CS education: whether they personally support CS in their district/school, how they feel their local school stakeholders are invested in expanding CS education, and how local factors (district/school size, socioeconomic status of their communities, years of leadership experience, urbanicity, general location [Northeast, West, Midwest, South], and average income level of parents in the district/school) may impact their perceptions of CS education. The addition of superintendents' and principals' attitudes, beliefs, and perceptions towards CS education builds on research that currently exists concerning district leadership and CS education (csedresearch.org, n.d.). Superintendents (Björk et al., 2014; Kowalski & Brunner, 2011; McLeod et al., 2015) and principals (Machado & Chung, 2015; McGarr et al., 2021) play an important role in determining what happens in classrooms, especially when it comes to technology integration and introducing new curriculum. Superintendents are also playmakers in integrating digital technologies into school buildings (McLeod et al., 2015) and translating equity-centered educational policy to practice (Coviello & DeMatthews, 2021). Similarly, principals influence how technology is integrated into their schools (Machado & Chung, 2015; Ganon-Shilon & Schechter, 2019) making a case for the importance of understanding principals' and superintendents' dispositions toward CS in PK-12 spaces.

Methodology

This study consists of quantitative analyses of Google and Gallup (2020) surveys administered to U.S. PK-12 superintendents and principals. Survey items underwent an exploratory factor analysis (EFA) followed by multiple linear regression (MLR) analysis. The specific type of EFA applied in this study is principal axis factoring (PAF). PAF takes a set of variables and finds the total common variance across the variables. The purpose of this process is to reduce a large number of items from a survey instrument to a smaller number of factors. In turn, these factors can be used to uncover latent dimensions, or abstract meanings, that underlie the data (DiStefano et al., 2009). Once the underlying latent dimensions are determined, new standardized scores, also called factor scores, for each participant can be developed that represent the relationship between each individual and the factor (Watkins, 2018). Factor scores can be used in more complex follow-up analyses, like MLR, to identify significant statistical trends and correlations in the data and to answer larger research questions (DiStefano et al., 2009). I describe the survey data, EFA, and MLR methodologies in greater detail in the following sections.

Data Sources

Google & Gallup (2020) created five different surveys for educational stakeholders that were separately administered to each stakeholder group: PK-12 parents, students, superintendents, principals, and teachers. The publicly accessible survey data was part of a larger research project to identify stakeholder perceptions of CS education and access to CS education across the US. Survey data was collected online by the Google & Gallup research team between Feb. 5 and March 2, 2020, prior to the COVID-19 pandemic. Given the context of this study, I specifically looked at the superintendent and principal survey data. For the principals, I analyzed only the high school principal data. I focused explicitly on this demographic of principals because high school students who are exposed to foundational CS courses are more likely to pursue computing majors and careers (Kapor Center, 2022, Sax et al., 2023). For context, each survey also included a definition of CS to help superintendents and principals answer each question (Table 1).

For this survey, "computer science" means the study of computers, including both hardware and software design, development and programming. This does NOT include just using or having access to a computer in general. For the purposes of this study, computer science includes learning about or doing things like: - Hardware and software design - Programming a computer - Writing and running computer code - Machine learning and artificial intelligence Computer science does not include: - Simply using a computer, tablet or smartphone - Conducting online research - Creating documents or presentations on the computer

Table 1. Google and Gallup (2020) CS Definition Provided to Superintendents and Principals.

The superintendents and principals who completed the surveys are representative of diverse areas in the U.S. (all 50 states) and work in urban, suburban, small town, or rural areas (Table 2). Table 2 provides a demographic breakdown of the superintendents and high school principals who completed the surveys and the various independent variables that will be used in each PAF and MLR. The independent variables–urbanicity, enrollment, average income level, region, and years in role—were all categorical variables. Principals are considered high school principals if they indicated on the survey that they oversee 9-12th grade. Separate analyses will be performed on each survey data set: a PAF followed by an MLR of the superintendent data and a PAF followed by an MLR of the principal data.

Superintendents		**High School Principals**	
Total (n)	1479	Total (n)	539
Urbanicity		**Urbanicity**	
City	92 (6%)	City	115 (21%)
Suburb	293 (20%)	Suburb	141 (26%)
Town	309 (21%)	Town	89 (17%)
Rural	785 (53%)	Rural	194 (36%)
Enrollment (District-Level)		**Enrollment (School-Level)**	
<1,000	725 (49%)	<100	12 (2%)
1,001 - 2,000	336 (23%)	100-500	227 (42%)
2,001 - 5,000	238 (16%)	501-1000	141 (26%)
>5001	180 (12%)	>1000	159 (30%)
Average Income Level		**Average Income Level**	
Low-wealth	736 (53%)	Low-wealth	269 (50%)

Middle-wealth	591 (43%)	Middle-wealth	244 (45%)
High-wealth	51 (4%)	High-wealth	24 (4%)
NA	4 (<1%)	NA	2 (<1%)
Region		**Region**	
Northeast	224 (15%)	Northeast	84 (16%)
Midwest	644 (44%)	Midwest	177 (33%)
South	345 (23%)	South	185 (34%)
West	266 (18%)	West	93 (17%)
Years in Role		**Years in Role**	
<5	650 (44%)	<5	155 (29%)
5-9	454 (31%)	5-9	150 (28%)
10+	366 (25%)	10-19	167 (31%)
NA	9 (<1%)	21+	64 (12%)
		NA	3 (<1%)

Table 2. Demographic data as indicated by U.S. superintendents and principals. Categorical independent variables for the superintendent and principal MLRs are highlighted in bold in the table.

Region	
Northeast	New York, New Jersey, Pennsylvania, Connecticut, Massachusetts, New Hampshire, Vermont, Maine
Midwest	Illinois, Minnesota, Wisconsin, Michigan, Iowa, Indiana, Ohio, North Dakota, South Dakota, Nebraska, Kansas, Missouri

South	Maryland, Virginia, Washington D.C., Oklahoma, Texas, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, North Carolina, South Carolina, Tennessee, Kentucky
West	California, Oregon, Washington, Montana, Idaho, Nevada, Wyoming, Colorado, Utah, Arizona, New Mexico, Alaska

Table 3. Google & Gallup's grouping of U.S. states by region.

Data Analysis

Principal Axis Factoring

Principal axis factoring (PAF) is a type of exploratory factor analysis that is used to determine the number of underlying latent constructs that cause the variables to covary (Costello & Osborne, 2005; Fabrigar & Wegener, 2011). PAF is different from principal component analysis (PCA) because it is used when there is an existing idea of how the variables may be related (Beavers et al., 2013; Costello & Osborne, 2005). For the Google & Gallup (2020) data, the survey items were designed to focus mainly on superintendents' and principals' beliefs and attitudes towards CS education. I explore patterns and relationships in the superintendents' and principals' responses to 15 categorical survey items on their respective surveys (Table 4) to determine the underlying latent constructs that describe the two groups' responses.

Item #	Superintendent Survey	Principal Survey
Q4A	Computer science education is currently a top priority for my district.	Computer science education is currently a top priority for my district.
Q4B	My school board is committed to offering computer science in our schools.	My school board is committed to offering computer science in our schools.
Q4C	Students should be required to take a computer science course if it is available at school.	Students should be required to take a computer science course if it is available at school.
Q4D	Computer science education should be incorporated into other subjects at school.	Computer science education should be incorporated into other subjects at school.

Q4E	People who do computer science work make things that help improve people's lives.	People who do computer science work make things that help improve people's lives.
Q4F	Parents/guardians in my school district are eager to have their children pursue a career in computer science.	Parents/guardians in my school are eager to have their children pursue a career in computer science.
Q4G	Having computer science education would significantly improve the future career options for students **in my school district.**	Having computer science education would significantly improve the future career options for students **at my school.**
Q5A	In the last three years, teaching computer science has become a higher priority for my **school district.**	In the last three years, teaching computer science has become a higher priority for my **school.**
Q5B	Teachers in my **school district** incorporate computer science education into their lesson plans.	Teachers in my **school** incorporate computer science education into their lesson plans.
Q5C	Teachers' efforts to teach computer science concepts are highly valued in my **school district.**	Teachers' efforts to teach computer science concepts are highly valued at my **school.**
Q5D	It is extremely important for all students to learn computer science.	It is extremely important for all students to learn computer science.
Q5E	Credits earned for high school computer science courses should count toward fulfilling core course requirements for graduation.	Credits earned for high school computer science courses should count toward fulfilling core course requirements for graduation.
Q5F	Computer science is used in a lot of different types of jobs.	Computer science is used in a lot of different types of jobs.
Q5G	**My district** would invest more in computer science education if we had the funds to do so.	**My school** would invest more in computer science education if we had the funds to do so.
Q5H	There is someone in **each school in my district** who is able to advise students about pathways to a computer science career.	There is someone in **my school** who is able to advise students about pathways to a computer science career.

Table 4. Thirty survey items (variables), fifteen for the superintendent data and fifteen for the principal data, analyzed in the principal axis factoring. Any noticeable differences between each survey are bolded.

The survey items are five-point scale Likert items (5 = strongly agree; 1 = strongly disagree); researchers have shown that 5-point or greater Likert-scales are possible with EFA methods, but scales measured with 9 to 11 responses are more reliable (Batterton & Hale, 2017; Tarka, 2015). With this information in mind, I performed a variety of procedures to confirm that the data were suitable for a PAF. First, I cleaned each dataset and determined the best approach to handling missing data. There are two widely used ways of dealing with missing data: 1) ignore the missing values using just the complete cases or pairwise complete observations or 2) multiple imputation (Goretzko et al., 2020). Multiple imputations are a way to mathematically generate valid inferences of the missing values by using existing values in the datasets. Researchers typically recommend imputing missing data over simply deleting and removing the missing cases (Goretzko et al., 2020; Hughes et al., 2019; Stavseth et al., 2019). This is especially true for data that is missing at random (MAR), where missingness is dependent on the observed variables (Goretzko, 2021). For example, a superintendent or principal choosing not to answer one question may have nothing to do with the other missing values but could be a result of some other variable (e.g., the superintendent did not know how to answer the specific question or forgot to answer the question). In this study, I used R (v3, 16.0, van Buuren & Groothuis-Oudshoorn, 2011) to first determine the number of missing cases in each dataset and then assess if there are any patterns between the missing data (e.g., superintendents and principals tended to leave specific questions blank, or the same individual is the cause of the missing values). For both groups, over 97% of the items are complete. Despite the small number of missing cases, I still performed a multiple imputation with the MICE package in R to minimize bias that could arise from a complete case analysis (Goretzko, 2021).

Once the dataset was cleaned, I looked at the correlations between the different variables (Figure 1). Correlation matrices revealed strong positive relationships between the variables except for Q4A in the superintendent data where no relationships were observed. It is possible that Q4A did not correlate with any of the other variables because responses to that item varied substantially.

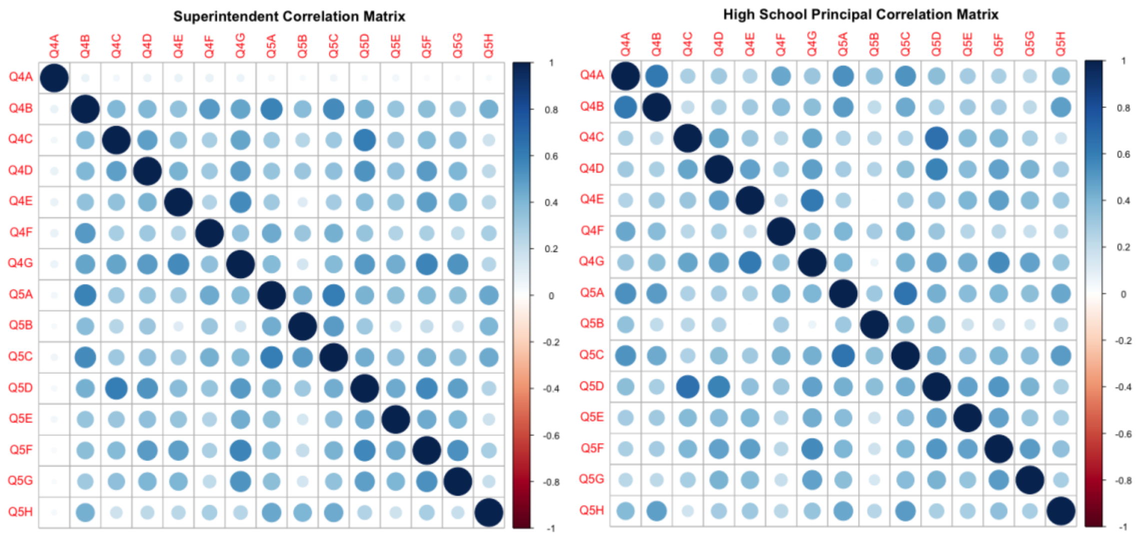


Figure 1. Correlation plot for the superintendent and high school principal variables.

After exploring the relationships between the variables, I performed individual PAFs on each dataset. To determine the number of factors to retain, I generated scree plots for each dataset (Figure 2). Scree plots are one of the most common ways to determine the number of factors to extract in a PAF (Schreiber, 2021). For both groups, it appeared that two or three factors could be extracted. I first performed a PAF with two factors for each dataset and then another set of PAFs with three factors to further determine the number of factors that should be extracted. Given that the factors are most likely correlated to one another, as is common in social science research, I performed an oblique rotation on each analysis (Osborne, 2015). To verify whether I should extract two or three factors from the high school principal data, I looked at the loadings for each variable on each factor. For the three-factor model, no variables loaded strongly on the third factor; variables with loadings above 0.4 were considered to load strongly (UCLA, 2021).

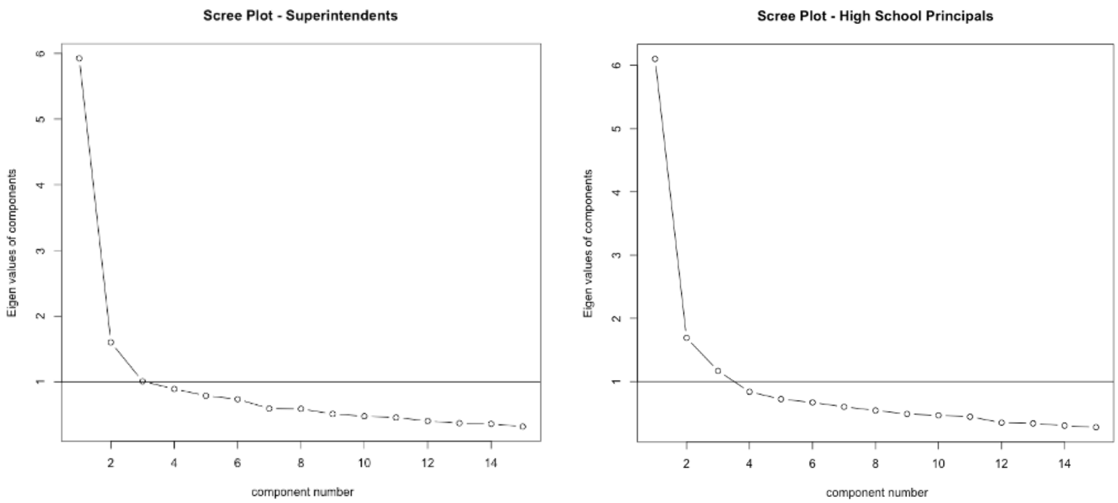
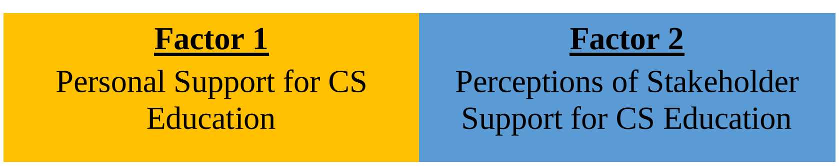


Figure 2. Scree plots of the superintendent and high school principal data.

For the superintendent data, the first component contained survey items that seemed to describe superintendents' ***personal support*** for CS education. The second component contained survey items that focused more on the superintendents' ***perceptions*** of how other stakeholders (e.g., school board and teachers) supported CS education (Figure 3). The high school principal data resulted in very similar factors, the only difference being that the second factor of principal perceptions included question 4A: Computer science education is currently a top priority for my district (Figure 4). Standardized factor scores for each participant were generated and used in subsequent MLR analyses (DiStefano et al., 2009; Thorpe et al., 2019), which are described in the following section. Factor scores were calculated using non-refined methods, specifically the sum of scores method (DiStefano et al., 2009). The sum of scores method was chosen and applied because a straight forward simple structure was observed with no cross-loaded items. Limitations associated with this methodological decision are described in the limitations section.



Q4C: Students should be required to take a computer science course if it is available at school.	**Q4B:** My school board is committed to offering computer science in our schools.
Q4D: Computer science education should be incorporated into other subjects at school.	**Q4F:** Parents/guardians in my school district are eager to have their children pursue a career in computer science.
Q4E: People who do computer science work make things that help improve people's lives.	**Q5A:** In the last three years, teaching computer science has become a higher priority for my school district.
Q4G: Having computer science education would significantly improve the future career options for students in my school district.	**Q5B:** Teachers in my school district incorporate computer science education into their lesson plans.
Q5D: It is extremely important for all students to learn computer science.	**Q5C:** Teachers' efforts to teach computer science concepts are highly valued in my school district.
Q5E: Credits earned for high school computer science courses should count toward fulfilling core course requirements for graduation.	**Q5H:** There is someone in each school in my district who is able to advise students about pathways to a computer science career.
Q5F: Computer science is used in a lot of different types of jobs.	
Q5G: My district would invest more in computer science education if we had the funds to do so.	

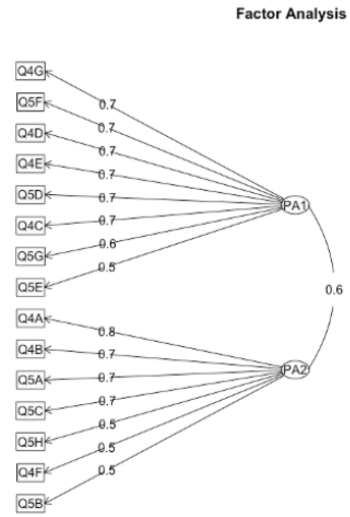
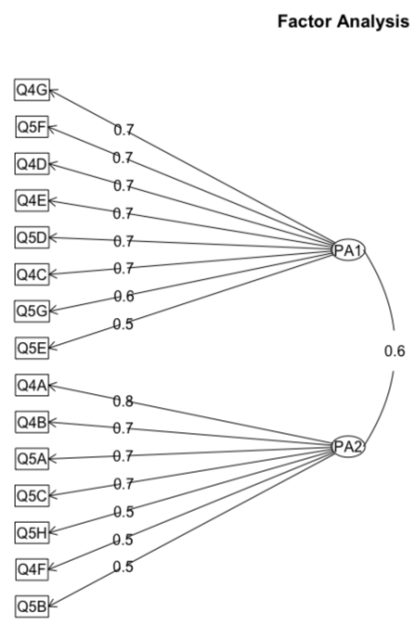


Figure 3. Extracted factors and the loaded variables for the superintendent data.

Factor 1 Personal Support for CS Education	**Factor 2** Perceptions of Stakeholder Support for CS Education
Q4C: Students should be required to take a computer science course if it is available at school.	**Q4A:** Computer science education is currently a top priority for my district.
Q4D: Computer science education should be incorporated into other subjects at school.	**Q4B:** My school board is committed to offering computer science in our schools.
Q4E: People who do computer science work make things that help improve people's lives.	**Q4F:** Parents/guardians in my school are eager to have their children pursue a career in computer science.
Q4G: Having computer science education would significantly improve the future career options for students at my school.	**Q5A:** In the last three years, teaching computer science has become a higher priority for my school.
Q5D: It is extremely important for all students to learn computer science.	**Q5B:** Teachers in my school incorporate computer science education into their lesson plans.
Q5E: Credits earned for high school computer science courses should count	**Q5C:** Teachers' efforts to teach computer science concepts are highly valued at my school.



toward fulfilling core course requirements for graduation.	
Q5F: Computer science is used in a lot of different types of jobs.	**Q5C:** Teachers' efforts to teach computer science concepts are highly valued at my school.
Q5G: My school would invest more in computer science education if we had the funds to do so.	**Q5H:** There is someone in my school who is able to advise students about pathways to a computer science career.

Figure 4. Extracted factors and the loaded variables for the high school principal data.

Multiple Linear Regression

MLR analysis is a useful way to determine if there are correlations between two or more independent variables and to make predictions of the outcome (dependent) variable (Uyanik & Güler, 2013). It is also a useful statistical analysis for education research (El Aissaoui et al., 2019; Reddy & Sarma, 2015; Theobald & Freeman, 2014). Using the sum scores for each factor from both the superintendent and high school principal datasets, I regressed the factor scores on district/school size, years of leadership experience, urbanicity, general location [Northeast, West, Midwest, South], and average income level of parents in the district/school. For example, the predicted outcome variable (dependent variable) of one of the MLR for the superintendent data would be the factor of ***personal support*** while the predictors (independent variables) are district size, years of leadership experience as a superintendent, urbanicity of the district, general location of the district, and average income-level of the students' families. It is important to note that a histogram of the personal support variable for both groups is negatively skewed, meaning that the majority of the individual scores for each superintendent and high school principal reflected mainly positive support for CS education (Figure 5). I chose not to transform the personal support variables for each group because model transformations to achieve normality greatly affect the overall interpretation of the variables and model (Anesthesiol, 2020). Instead, I took into consideration the impact of the negatively skewed data on the regression models, as noted in the findings and limitations.

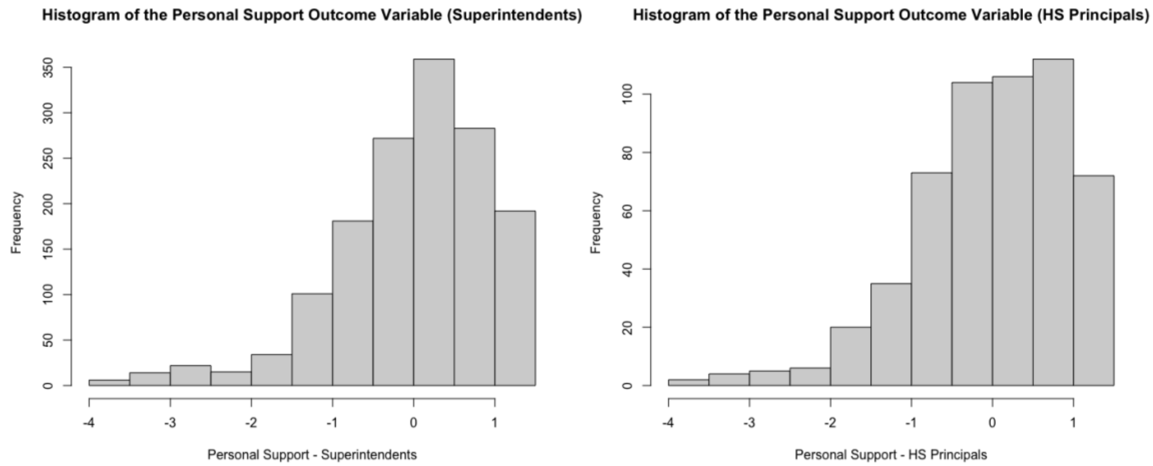


Figure 5. Histograms of the personal support variable for both the superintendent and high school principal factor scores.

Given the similarities between student enrollment numbers and urbanicity (cities tend to have a larger number of students enrolled while rural schools tend to have lower student enrollment numbers), I performed multiple model comparisons to determine the most parsimonious model. Models that have redundant predictors, or predictors measuring similar data, can produce non-parsimonious models that can be biased and overfit the predictors onto the dependent variable (Diaz-Ramirez et al., 2021). For both datasets and dependent variables, I determined the variance inflation factor (VIF) for each predictor to check for collinearity between any of the variables. Typically, VIF values greater than five indicate that there is collinearity. When looking at the superintendent models for perceptions and support, the support model yielded high VIF values (between three and seven) for urbanicity (Table 6). A model comparison test did not find differences in the two models, so I used the more parsimonious model (p = 0.372). Similar problems were found with the superintendent perceptions model and a model comparison preferred the simpler model without urbanicity as well (p = 0.380). Similar analyses were performed on the high school principal models. Although VIFs for the high school principal support model were relatively low (< 2), the simpler model without urbanicity was preferred (p = 0.421). However, the more complex model, with urbanicity, was preferred for the high school principals' perceptions model (p = 0.005). The finalized regression models analyzed in this study are outlined in Table 6.

Superintendents			
Support	**VIF**	**Perceptions**	**VIF**
Urbanicity-Suburb	3.78	Urbanicity-Suburb	3.80
Urbanicity-Town	4.16	Urbanicity-Town	4.16
Urbanicity-Rural	6.05	Urbanicity-Rural	6.05

Table 5. VIF values for the urbanicity variable in each superintendent regression model.

Findings

Multiple linear regression was used to test if the urbanicity of a school district, the years in which a superintendent or high school principal has worked in their role, the average income level of a school district/school, the region in the U.S. where the superintendents and principals work, and student enrollment numbers significantly predicted superintendent and high school principal support and perceptions of stakeholder support for CS education (Table 6). Regression results are separated by dataset (superintendents and high school principals).

Dataset	**Dependent Variable**	**Regression Model**
Superintendents	**Model 1:** Personal Support for CS Education	$Y_{Support} = \beta_0 + \beta_{years\_role}X_{years\_role} + \beta_{income}X_{income} + \beta_{region}X_{region} + \beta_{enrollment}X_{enrollment}$
	Model 2: Perceptions of Stakeholder Support for CS Education	$Y_{Perceptions} = \beta_0 + \beta_{years\_role}X_{years\_role} + \beta_{income}X_{income} + \beta_{region}X_{region} + \beta_{enrollment}X_{enrollment}$
High School Principals	**Model 1:** Personal Support for CS Education	$Y_{Support} = \beta_0 + \beta_{years\_role}X_{years\_role} + \beta_{income}X_{income} + \beta_{region}X_{region} + \beta_{enrollment}X_{enrollment}$

	Model 2: Perceptions of Stakeholder Support for CS Education	$Y_{Perceptions} = \beta_0 + \beta_{urbancity}X_{urbancity} + \beta_{years\_role}X_{years\_role} + \beta_{income}X_{income} + \beta_{region}X_{region} + \beta_{enrollment}X_{enrollment}$

Table 6. The two multiple regression models analyzed for each group–superintendents and high school principals.

Superintendents

Regression results for both Model 1 and Model 2 are outlined in Table 7. The overall regression for Model 1 was statistically significant ($R^2 = 0.027$, $F(10,1457) = 3.34$, $p < 0.001$). When looking at the individual predictors, schools with less than 1000 students enrolled significantly predicted U.S. PK-12 superintendents' personal support for CS education. Superintendents overseeing school districts with less than 1000 students total reported lower levels of support than superintendents of very large school districts ($b = -0.332$, $p < 0.001$). The other variables did not significantly predict superintendents' personal support for CS education.

The overall regression for Model 2 was statistically significant ($R^2 = 0.055$, $F(10,1457) = 8.452$, $p < 0.001$). It was found that, when comparing to superintendents who have worked less than five years in their role, superintendents who have served more than 10 years in their position had significantly more positive perceptions of stakeholder support for CS education ($b = 0.125$, $p < 0.033$). Additionally, the income level of each school district significantly predicted how superintendents perceived the level of stakeholder investment in CS education. In comparison to superintendents who oversee school districts serving majority low-wealth families, superintendents serving students from middle class families ($b = 0.137$, $p < 0.007$) and wealthy families ($b = 0.321$, $p < 0.011$) report more positive perceptions of their community's support for CS education. Interestingly, superintendents from the Western U.S. (where major CS education initiatives are located - CSforCA and the Kapor Center) reported significantly lower perceptions of stakeholder support for CS when compared to the perceptions of superintendents who work in the Northeastern U.S. (b = -0.265, p < 0.002). Similar to the findings for Model 1, district size also significantly predicted superintendent perceptions with superintendents from larger school districts having more positive views of stakeholder support for CS education.

	Model 1 *Personal Support*		Model 2 *Perceptions*	
Effect	**b**	**SE**	**b**	**SE**
Years in Role (vs. <5 years)				
5-9 years	-.098	.057	.102	.055
10+ years	-.060	.061	**.125***	.059
Income (vs. low-wealth)				
Middle-wealth	-.065	.052	**.137****	.050
High-wealth	.051	.131	**.321***	.126
Region (vs. Northeast)				
Midwest	-.119	.074	-.108	.072
South	-.088	.084	-.032	.081
West	-.081	.087	**-.265****	.084
School Enrollment (vs. <5001+ students)				
<1000 students	**-.332*****	.079	**-.446*****	.076
1001-2000 students	-.108	.087	**-.277****	.084
2001-5000 students	-.066	.093	**-.280****	.089

Table 7. Multiple Regression Results for the Superintendent Data (*p < .05, **p < .01, ***p < .001).

Principals

Regression results for both Model 1 and Model 2 are outlined in Table 8. The overall regression for Model 1 was not statistically significant (R^2 = 0.032, F(11,524) = 1.293, p = 0.225), indicating that there are no significant linear relationships between PK-12 principal support for CS education and the location in which they teach, the average income of level of the communities they serve, the years they have served in their role, the urbanicity of the area where their school is located, and the number of students enrolled in their school. Therefore, the presented values in Table 6 are most likely biased and include error.

The overall regression for Model 2 was statistically significant ($R^2 = 0.108$, $F(14,521) = 4.482$, $p < 0.001$). A closer look at the individual predictors revealed that principals who work in towns have more positive perceptions of stakeholder support for CS education compared to principals who work in large cities ($b = 0.358$, $p < 0.008$). Principals who serve students from wealthy backgrounds also have more positive perceptions of stakeholder support for CS education ($b = 0493$, $p < 0.012$). The locations in which principals worked had significant effects on principal perceptions of community members and educators and their support for CS education. When compared to principals who work in the Northeastern U.S., high school principals in the Midwest ($b = -0.317$, $p < 0.008$) and in the West ($b = -0.505$, $p < 0.008$) reported significantly lower perceptions of stakeholder support for CS education. Additionally, high school principals who oversee fewer students also held more negative perceptions of stakeholder support for CS education compared to principals serving schools with greater than a thousand students. For example, there was a significant difference between the perceptions of principals who work in schools with less than a thousand students and principals who serve more than 100 students ($b = -0.760$, $p < 0.005$).

	Model 1 *Personal Support*		**Model 2** *Perceptions*	
Effect	**b**	**SE**	**b**	**SE**
Urbanicity (vs. City)				
Suburb	N/A	N/A	.018	.115
Town	N/A	N/A	**.358****	.102
Rural	N/A	N/A	-.055	.120
Years in Role (vs. <5 years)				
5-9 years	-.103	.108	.035	.102

10-19 years	-.067	.106	.091	.100
20+ years	-.149	.141	-.140	.134
Income (vs. low-wealth)				
Middle-wealth	.060	.088	.137	.084
High-wealth	.160	.204	**.493***	.196
Region (vs. Northeast)				
Midwest	**-.326****	.125	**-.317****	.121
South	-.226	.126	-.232	.121
West	**-.366***	.144	**-.505*****	.137
School Enrollment (vs. >1000 students)				
< 100 students	-.068	.283	**-.760****	.271
100-500 students	-.168	.102	**-.379*****	.111
501-1000 students	-.058	.110	**-.329****	.112

Table 8. Multiple Regression Results for the High School Principal Data (*p < .01, **p < .05, ***p < .001).

Discussion

This study recognizes the complexity of the capacity level of the CAPE framework, especially the role that beliefs, attitudes, and perceptions inform how leaders (i.e., principals and superintendents) support CS education movements in their local contexts. Overall, PK-12 superintendents and principals vary in the contextual factors that influence their personal support for CS education and their perceptions of stakeholder support for CS education. From a regional standpoint, the findings reveal that both superintendents and high school principals in the Western U.S. do not feel that their school boards, teachers, parents, and other community members support CS education as much as superintendents and high school principals from the Northeastern U.S. The cause of this difference should be further explored, especially since most tech-companies and start-ups are on the West Coast as well as some of the largest CS education organizations (e.g., CSforCA and the Kapor Center in Oakland, California). There is a narrative that exists in PK-12 education and higher education about the Northeast as it is a region with the highest standardized test scores in the U.S. (e.g., Massachusetts). As well, it is home to a cluster of highly-ranked colleges and universities, including most of the Ivy League institutions that may have contributed to the differences in regional perceptions (Hung et al., 2020; The Nation's Report Card, 2019). CS education reform efforts in California, where a large portion of students are located in the Western U.S., have also made substantial progress since 2020 (CSforCA, 2023). Therefore, it is possible that these differences may not exist today.

Another notable finding from this study is the relationship between district/school size and superintendent and principals' perceptions of stakeholder support for CS education. Superintendents representing larger school districts were found to hold more positive perceptions of stakeholders and their commitment to CS education compared to superintendents of small divisions with less than 1000 students. A similar trend occurred in the high school principal data. Superintendent and high school principal perceptions of support also varied by the income level of the families in the districts they serve. Superintendents and principals serving students from middle- to high-wealth families hold higher perceptions of stakeholder support for CS education compared to those in districts where students primarily come from low-wealth backgrounds. These findings suggest two things: 1) perhaps more collaborative conversations about CS education are happening in larger school districts and schools and 2) superintendents and high school principals may hold biases toward their low-wealth students and their families, especially their commitment to CS education. Both of these potential realities are concerning because they conflict with data showing that the majority of parents in the U.S. believe that CS is important for their children to learn (Google & Gallup, 2020). Additionally, it is important to consider the implications of these findings on the success of equity movements in CS education. Collaboration and coordination between stakeholders is a key part of successful CS education reform (Grandsbury et al., 2023), or any type of educational reform in general (Cohen et al., 2018; Johnson et al., 2014).

This study also suggests discrepancies between superintendent and high school principal perceptions of stakeholder commitment to CS education based on the income levels of the populations that they serve. For both groups of leaders, superintendents and principals overseeing students from high-wealth backgrounds were more likely to have positive perceptions of stakeholder commitment to CS education. This finding is striking because it suggests that support for CS education may more likely occur in high wealth areas, potentially reinforcing and widening gaps in student access to CS education across the U.S. (Kapor Center, 2022) and in particular for BLNA-identifying students. It also raises the question as to *why* superintendents and principals who serve majority low-wealth students might hold lower perceptions of stakeholder commitment to CS education in their communities. If leaders are perceiving low-wealth students and their families as being less invested in CS education, they can subsequently reinforce biases about who can and cannot learn CS.

Limitations

A limitation of this study is that I used survey data collected by a separate entity, Google and Gallup (2020). I interpreted the variables based on the content provided by Google and Gallup researchers. Therefore, the data is limited to how Google & Gallup (per the 2023 NCES definition) classified the districts and schools that superintendents and principals work in by urbanicity and regional location. It is possible that if a different definition of these terms is applied to the data, the results may change. Additionally, as noted in the methodology section, the personal support variables for both groups of leaders were negatively skewed, most likely due to survey design. When asking superintendents and principals questions like *It is extremely* *important for all students to learn computer science*, they will most likely respond positively to the question. Therefore, it is not surprising that a distribution of the personal support variable indicated that respondents reported mainly positive support for CS and perhaps created ceiling effects. Even though Model 1 for the superintendent data was significant, the very low proportion of variance in the dependent variable that is explained by the independent variables (R^2) suggests that further analyses are needed.

Survey design and reliability were also measured by Google and Gallup. For example, the research team states that both the superintendent and principal samples were weighted to correct for unequal selection probability and nonresponse (Google & Gallup, 2020). They state that, “the data are weighted to match known targets for years of experience, school enrollment size and region, according to the National Center for Educational Statistics.” They also describe that for the principal data, the margin of sampling error is ±3.2 percentage points at the 95% confidence interval and for the superintendent data, the margin of sampling error is ±2.7 percentage points at the 95% confidence interval. It appears that the Google and Gallup team used the matching technique (Mercer et al., 2018) to weigh their surveys but it is not completely clear from the information provided.

Another important limitation to highlight is the use of unrefined EFA methods to extract factor scores for multiple regression. Non-refined factor scores are dependent on the characteristics of each individual survey item. As a result, some of the survey questions may have contributed more to the factor scores than others. Further multiple regression analyses of refined (standardized) factor scores are needed to eliminate potential biases in the regression estimates. This study should serve as a beginning to understanding the relationship between local contextual factors on superintendent and principal beliefs and perceptions of CS education.

The sample size for the high school principal data is another potential limitation of the study. For example, the sample sizes for some of the high school principal data were relatively small (less than 30 observations), which could impact the results. None of the predictors analyzed in this study significantly predicted high school principals' personal support for CS. This finding does not necessarily mean that these variables do not play a role in informing principal beliefs, attitudes, and perceptions of CS education, but that the dataset may have been limited in its statistical power and ability to yield significant and unbiased results. However, it may be possible that these variables in fact, do not play a role in predicting high school principals' support for CS education. More research replicating similar methods as this study is needed to confirm or reject these findings.

Conclusion

This study shows that 1) U.S. PK-12 superintendents and high school principals vary in their beliefs, attitudes, and perceptions towards CS education and 2) their perceptions of stakeholder commitment to CS vary by contextual factors. Broadly stated, although superintendents and principals may support CS education, their perceptions of stakeholder support for CS vary by their district and school size, the region of the U.S. in which they work, the students they serve, and the years they have served in their role as principal or superintendent. These varying perceptions have implications for equity movements because they can influence the level of leadership commitment to CS education and the groups of students who are more likely to experience learning environments in support of CS education. The findings from this study are a first step to uncovering how superintendents and high school principals are perceiving community commitment to CS education and areas in which they may need more support to mobilize CS education reform efforts.

Chapter 4: Understanding How District and School Leaders Interpret and Enact Computer Science Education Policy

Computer science (CS) education is expanding across the United States (U.S.) with over half of U.S. states now requiring high schools to offer foundational CS courses. Although it is important for students to learn CS throughout all levels of the PK-12 education pipeline, high school CS courses, especially Advanced Placement CS (APCS), directly influence whether a student intends to pursue a computing major (Kapor Center, 2022; Sax et al., 2023). For example, students who take APCS are eight times more likely to major in CS (Kapor Center, 2022). Despite the importance of these courses, Black, Hispanic/Latino/a/x, and Native American/Alaskan Native (BLNA) students are proportionally less likely than White and Asian students to attend schools that offer an APCS course (Code.org, 2022; Kapor Center, 2022). Similar gaps in access exist between low-wealth and high-wealth students (Kapor Center, 2022).

The 2022 Code.org State of CS Education report claims that federal and state policy hold extensive power in designing equitable CS education pathways that meet the needs of all students. However, policy can both increase CS course access *and* fail to address the systems and structures in place that impact the meaningful participation of BLNA students in CS (Ladson-Billings, 2006; Scott et al., 2019). Researchers have repeatedly shown that the racialization of CS education excludes BLNA students from enrolling in CS courses (Goins et al., 2022; McGee, 2021; Nasir & Vakil, 2017) and that national and/or state accountability pressures, rigid pacing guides, limited resources, high teacher turnover rates, and lack of administrator support for CS education reform all impact equity movements in CS education (Margolis & Goode, 2016; Kapor Center, 2022; Santo et al., 2020). As a result, BLNA students continue to accrue what Ladson-Billings (2006) calls the *educational debt*, or the accumulation of historical, sociopolitical, economic, and moral factors that maintain disparate learning outcomes between White students and BLNA students.

Using a qualitative multiple-case analysis methodology (Yin, 2002), this study first uses the Capacity for, Access to, Participation in, and Experience of equitable CS education (CAPE) framework (Fletcher & Warner, 2021) to compare how district- and school-level leaders across six school districts from two states in the Eastern part of the U.S. interpret and enact equitable CS education reform in their local contexts. After outlining each case, I perform a case-synthesis analysis using the educational debt (Ladson-Billings, 2006) as a theoretical lens to interrogate how each group of leaders describe their CS education efforts in relation to their BLNA students. The research questions are organized by the levels of the CAPE framework, which is broken down into four sections: 1) the *capacity* of states and schools to implement CS programs (do they have the resources, teachers, and structures in place to expand CS), 2) the level of CS course *access* across varying levels of the education pipeline, 3) the level of student *participation* in CS courses, and 4) student *experiences* in CS courses. The research questions are:

1. What structures do the school districts have in place to establish high school CS course sequences in their high schools for BLNA students? (*Capacity*)
2. How do the district- and school-level decision-makers decide how they expand secondary CS course access in their respective districts and schools to all students? (*Access*)
3. How do the district- and school-level decision-makers decide which students can take foundational CS courses and which students cannot? (*Participation*)
4. How do the district- and school-level decision-makers perceive BLNA student interest and success in taking CS courses if they are (or were to be) offered in their districts/schools? (*Experience*)

Literature Review

CS education scholars contend that policy is a critical first step to ensuring racial equity in CS because the amount of CS education-related policy a state has in place is correlated to the amount of CS courses a state offers (Code.org, 2022; Goins et al., 2022; Warner et al., 2022). However, policy that centers the experiences of BLNA students must gain the support of education leaders–superintendents, members of the superintendent's cabinet, and school administrators–who play a key role in shifting policy to practice (Cohen et al., 2018; Proctor et al., 2019; Richard, 2022; Santo et al., 2020; Santo et al., 2019). Additionally, state, district, and school leadership must be committed to promoting racial equity in CS (Scott et al., 2019) and understand that there are structural, social, economic, and historic barriers in place that make it difficult for BLNA students to meaningfully engage with CS at all levels of the educational pipeline (Ladson-Billings, 2006). Without strong coordination between state, district, and school leadership, CS education reform efforts can inadvertently exacerbate what Ladson-Billings (2006) calls the *educational debt*, or the accumulation of oppressive historical, economic, and sociopolitical practices that lead to differences in educational opportunities across racial and socioeconomic lines.

To incite equitable change in CS education, CS education reform efforts must promote the growth of public PK-12 CS education *and* support educational stakeholders (school leaders, teachers, students, and parents) with creating and sustaining an inclusive CS community (Davis et al., 2021; Goins et al., 2022; Santo et al., 2020). Sustainability means advocating for policy that directly prioritizes funding schools serving primarily BLNA students and high populations of students on the National School Lunch Program (U.S. Department of Agriculture, n.d.) as well as implementing “Large-Scale Policies and Initiatives that Address Systemic Educational

Inequity Affecting Student Outcomes across Subject Areas" (Scott, 2019, p. 8). According to Warner and colleagues (2022), these policies could look like: 1) mandating foundational CS courses, BLNA access to advanced CS courses, and CS as a graduation requirement, 2) integrating CS across subjects, 3) providing substantial funding to meet CS-related mandates, 4) addressing the lack of representation in the CS teacher workforce by investing in programs to prepare, support, and retain Black CS educators and administrators, 5) ensuring the adoption of culturally responsive CS pedagogical standards in teacher preparation, certification, curricular development, and professional development with a direct focus on validating the interests, cultures, and identities of BLNA students, and 6) expanding reliable, affordable, high-speed broadband to ensure Black students are equitably connected to the Wi-Fi needed for in-school and out-of-school educational and economic opportunities. However, the extent to which these policies are created and enacted across the U.S. varies by state, school divisions, and even schools (Code.org, 2023; Parker, 2023).

Policy Coherence in CS Education

The level of coordination between states, districts, and schools is often defined as coherence (Cohen et al., 2017; Johnson, 2011). In the case of CS education reform, coherence varies greatly by state, school division, and school (Code.org, 2022; Parker, 2023). Although federal funding for CS education is provided through the Every Student Succeeds Act (ESSA, 2015), state-level funding for CS depends on local educational agencies (LEAs) to file local plans that may or may not include CS. Without formal state plans in place, school systems can use ESSA funds for other subjects (Code.org, 2022). This decentralized and context-specific structure of the education system can end up influencing superintendents, members of the superintendent's cabinet, and school administrators' priorities, shifting them towards or away from CS education.

At the local level, central office leaders and school administrators play an important role in translating CS education policy to practice because they are "critical change agents and system players" (Ganon-Shilon & Schechter, 2017; Johnson et al., 2014). However, their power is dynamic and even conflicting depending on state policies in place for educational reform. For example, the complex structures of U.S. school systems often lead to tensions between central office leaders and school administrators, especially in larger school districts or city areas (Cohen et al., 2017; Johnson et al., 2014). In their paper discussing the dilemmas of U.S. educational reform, Cohen and colleagues (2017) state that school systems,

> face environmental pressures for coherent, improved instruction and school outcomes, yet their organizations and environment also contain powerful pressures for differentiated programs and organization. This conflict is fundamental, because school systems are open systems and depend on their environments for students, funds, political support, guidance, and legitimacy, among other things. Yet they operate in a complex and pluralistic institutional environment that contains different and often divergent pressures for action (p. 6).

The authors highlight key components of U.S. school systems: 1) they face competing priorities, 2) they are open systems that depend on stakeholder support, and 3) they operate based on their unique environments. A concrete example of this complexity in action is the process of hiring qualified PK-12 CS teachers. Superintendents and their cabinet members typically oversee district-wide hiring initiatives for CS teachers, while principals assist with the individual-level hiring process. However, their decision-making power is bound by the availability of CS teachers or funding for CS courses (Fletcher & Warner, 2021, Google & Gallup, 2016, Margolis & Goode, 2016).

Policy Coherence: A Focus on Equity

As the CS community develops and evolves, definitions of CS, and equity in CS, can impact how leaders attend to CS education policy (Santo et al., 2019). Broad definitions of CS as a subject are evident in how CS courses are distributed and measured across states and school districts. For states that successfully created policies in support of expanding CS education, CS courses can fall under either mathematics or career and technical education (CTE) departments, and sometimes even both departments. States also vary in whether they allow CS to count as a high school graduation math, science, CTE, or technology credit (Code.org, 2022; Garvin et al., 2019). The complexity of computing, and potentially why it is difficult for PK-12 stakeholders to classify within existing curricula (especially its connection to mathematics, CTE, technology, or science), stems from its history (Guzdial, 2015; Guzdial, 2022; Hazzan et al., 2020; Knuth, 1974). CS as a discipline has unique characteristics when compared to other science, technology, engineering, and mathematics (STEM) subjects because it is a relatively new field, plays a critical role in helping society function, and holds an intricate relationship with corporate America (Margolis, 2010; Vakil, 2020). CS can also act as a standalone discipline or a series of topics that are integrated across multiple disciplines (Guzdial, 2022).

While stakeholders work to define CS PK-12 education, they are also negotiating definitions of equity in CS (Santo et al., 2019). The number of existing definitions of equity in CS makes it difficult for district and school leaders to develop collective ideas of what equitable CS education looks like in practice (DeLyser & Wright, 2019; Goins et al., 2021; Santo et al., 2020; Santo et al., 2019; Scott et al., 2019). For example, a study by Santo and colleagues (2019b) revealed that district actors across the Mid-Atlantic region of the U.S. had three broad and interrelated ways of defining equity in CS education in their districts: 1) equity in *who* CS is for, 2) equity in *how* CS is taught, and 3) equity in *what* CS is taught. Each district varied in the extent to which they implemented each of the three types of equity due to the level of coherence between central office leaders and school administrators. In a system where CS education reform is both top-down and bottom-up (Code.org, 2022; Garvin et al., 2019; Margolis et al., 2015; Warner et al., 2022), this study provides an opportunity to understand the policy-to-practice process by exploring the levels of coherence between central office leaders, high school principals, and their personal interpretations of CS education.

Theoretical Framework

I apply Ladson-Billings' (2006) education debt theory as a critical lens for the multiple-case analysis the East Coast school districts. The goal of the multiple-case analysis is to understand how central office leaders and high school principals across the two states interpret and enact CS education policy in their local contexts with a focus on BLNA student access to CS, participation in CS, and experiences in CS. According to Ladson-Billings (2006), BLNA students continue to accrue an educational debt that is composed of a historical component (the historical endorsement of BLNA students being "inferior" to white students despite abundant contradictory evidence), an economic component (funding disparities between high-poverty and low-poverty schools), a sociopolitical component (exclusion of BLNA communities from the civic process), and a moral component (what human beings owe to each other but fail to give). She also argues that the intense focus on what scholars call "the achievement gap" is misplaced and does not acknowledge the root causes of achievement differences.

The educational debt theory has been used to design and promote equity-based, justice-centered, and anti-racist policies and practices at a leadership level. For example, it has been used to define the role educational leaders play in developing and enacting education policy (Diem & Welton, 2020; Horsford et al., 2018). Across these studies, researchers argue that policymakers, scholars, and practitioners who intentionally attend to each aspect of the educational debt can promote effective long-term reform that leads to high-quality educational opportunities for all students. I use the educational debt to understand how district- and school leaders define BLNA student access to, enrollment in, and experiences in CS.

Methodology

This study is a qualitative multiple-case study analysis (Stake, 2013; Yin, 2002) of six school districts in two states, three in each, in the eastern part of the U.S. According to Yin (2012), a qualitative multiple-case study analysis draws conclusions from patterns across multiple contexts (cases). Each school district–including the participating district leaders and high school principals–serve as the individual cases. The purpose of this qualitative multiple-case analysis is to elucidate *why* district leaders and high school principals in different contexts vary in their perceptions of CS education and provide ways for researchers to *support* each type of leader in ensuring they implement equitable CS reform.

I structure this multiple case study analysis following Ryan's (2012) two common ways to approach a case study: "the first being a search for that intrinsic to a given situation and the second being an orientation to the comparative" (p.550). Therefore, this study has two levels of inquiry: 1) a multiple case study design with a question-and-answer format (Yin, 2012) to understand how data from the individual cases answer the research questions of the study (with each aligning to the CAPE framework) and 2) a cross-case synthesis applying Ladson-Billings' (2006) educational debt theory to observe patterns in the within-case results. Yin (2012) also states that "Cross-case syntheses can be performed whether the individual case studies have previously been conducted as independent research studies (authored by different persons) or as a predesigned part of the same study" (p. 164). In this study, the cross-case synthesis follows descriptions of the individual cases.

Participant Recruitment

Purposive sampling techniques were mainly used to recruit district and school leaders for this study. Purposive sampling, also called judgment sampling, and convenience sampling, are nonrandom sampling techniques (Etikan et al., 2016). I used purposive sampling by selecting participants who work as a central office leader or as a public high school principal. I focused on the high school level because advanced placement CS courses, APCS Principles (APCSP) and APCSA, directly impact student trajectories in CS majors (Kapor Center, 2022; Sax et al., 2023). APCSP is a relatively new course that was launched in 2016 to broaden participation in computing. It is designed to be an introductory CS course that aligns more closely with student interests (Cuny, 2015). APCSA mirrors a college-level introductory CS course. I also narrowed my recruitment to two specific states on the East Coast because of key differences in the number of high school CS courses they offer and the amount of CS education policy they have in place. For example, 98% of high schools in State-1 offer CS compared to 75% of high schools in State-2 (Code.org, 2023). Although purposive sampling techniques dominated the study, I also relied on convenience sampling when contacting individual participants. Convenience sampling happened naturally and depended on whether my applications to conduct research in multiple school districts were approved.

Participants

In total, I submitted research applications to 20 counties and school divisions and 11 were approved (Table 1). State-2 school divisions rejected the majority of applications. Based on their written replies, divisions declined the research for two main reasons: 1) they did not feel that I would get any worthwhile information from the school district since CS education was *not* a top priority or 2) they wanted to be conscious of their administrators' time. Following a string of rejections from State-2 school divisions in Spring 2023, I removed words like equity, race, and diversity from the applications to align the applications more with the more conservative State-2 political landscape. All applications that did not mention equity, race, or diversity were accepted. The implications of changing my application process are noted in the limitations section.

	State-1	**State-2**
Total Applications Submitted	8	12
Total Accepted	5 (62%)	6 (50%)
Total Formal Rejections	3 (38%)	5 (50%)
Total No Response	0	1 (8%)

Table 1. Research Application Approval Statistics by State

Overall, 47 leaders from 13 different counties and school divisions agreed to participate (Table 2). All county, division, and individual names were anonymized. Central office leaders represented a variety of roles and titles (Figure 2). When looking more closely at the demographics of the central office leaders interviewed, 21 (84%) of the central office leaders were White and 4 (16%) were Black. All of the Superintendents were White men. Only nine (36%) of the central office leaders were women. Lastly, 14 (70%) of the high school principals were White, six (30%) were Black, and six (30%) were women. Participants' racial identities were stated during the interview. All participants of color stated their race while White appearing individuals, with the exception of one White woman, stated that they were White.

School	**State**	**# of High Schools**	**# Participating Central Office Leaders**	**# Participating High School Principals**
Freesia County	State-1	1	1	0
Iris County	State-1	9	2	2
Orchid County	State-1	21	2	2

Peony County	State-1	5	2	2
Sunflower County	State-1	10	2	3
Carnation County	State-2	5	2	2
Tulip School Division	State-2	6	1	0
Rose School Division	State-2	3	1	3
Marigold School Division	State-2	3	3	3
Hyacinth School Division	State-2	5	2	0
Lily School Division	State-2	12	3	4
Gardenia School Division	State-2	1	1	1
Daisy School Division	State-2	7	3	0
		Total	25	20

Table 2. Participating School Districts, the Number of High Schools they Serve, and the Number of Participants recruited from each.

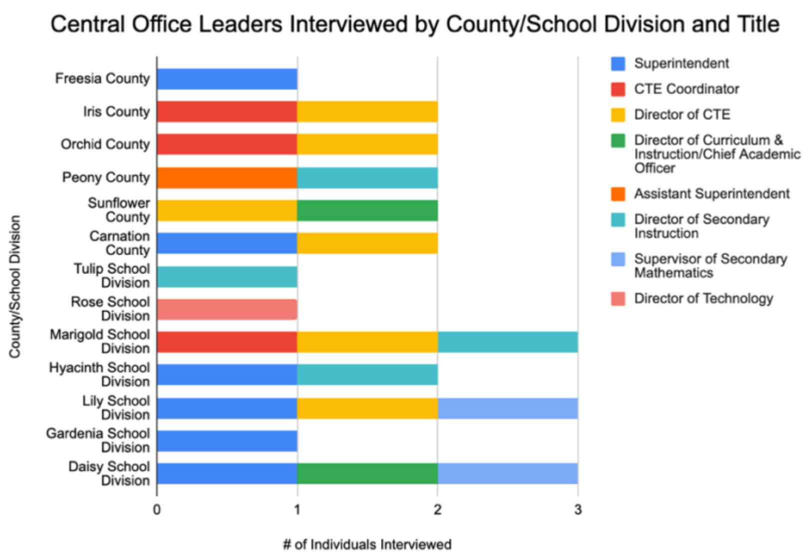


Figure 2. Titles of Central Office Leaders Interviewed by School District.

Data Sources

Impactful case studies collect rich data that captures the complexity of a case (Stake, 1995). As a result, semi-structured interviews were the primary sources of data—each interview is critical for investigating *why* central office leaders and principals in each state, and subsequently each school district, think disparities in CS education occur and *how* they are mitigating disparities (Table 3). I also purposefully avoided questions related to race, gender, and other identity markers to see if the leaders would naturally discuss the relationship between student identity and CS education. I felt that it was important to get an overall assessment of how the leaders describe CS education, which factors they pay attention to the most when discussing CS, and whether student identity is something they consider. Each of the 45 interviews ranged from 30-minutes to one-hour long and were conducted over Zoom between March 2023 and August 2023. Given that I was unable to recruit both central office leaders *and* high school principals from some of the school districts, I narrowed the case study analysis to six school systems with representative interview data: Sunflower County (State-1), Orchid County (State-1), and Peony County (State-1), Lily School Division (State-2), Marigold School Division (State-2), Rose School Division (State-2). Demographics for each are described in Table 4.

Central Office Leaders	High School Principals	Both
How do you typically acquire computer science resources (e.g., necessary technology or coding platforms) for high schools in your district?	How would you describe teacher attitudes towards CS?	Describe yourself and how you ended up in your current position.
How often do you coordinate with high school principals in your district to implement and expand student access and enrollment in AP CS courses?	How often do you coordinate with district leaders/central office to implement and expand student participation in CS courses in your school?	What are your thoughts about computer science education and its place in the general high school curriculum?
How do you make CS a part of the conversation in your county/school division?	What do you find most helpful in bringing CS learning to all of your students?	Can you describe the students who are interested in taking high school CS courses or who typically take CS courses in your district?
How does your district decide course requirements for AP CS courses (both APCSA and APCSP)?		
What are the state requirements for CS?		

Table 3. Semi-structured Interview Protocol for Each Group of Leaders – Central Office Leaders and High School Principals.

School County/Division	**Orchid County**	**Peony County**	**Sunflower County**	**Rose School Division**	**Marigold School Division**	**Lily School Division**

Location	State-1			State-2		
Total Students Enrolled	131146	14664	46899	13970	11642	65550
% Black	52	36.8	13.8	11.9	18	23
% White	3.9	38.3	50	59.1	54.4	45.5
% Hispanic/Latino/a/x	40	12.8	20	15.8	15.2	13.6
% Asian	2.7	2.9	6.8	7.2	2.8	6.2
% Multiracial	1.4	8.3	6.5	5.8	9.2	11
% American Indian	0.3	0.5	0.2	0.1	0.3	0.5
% Native Hawaiian/Pacific Islander	0.2	0.2	0.1	0.1	0.1	0.2
% Girls	49	49	49	49	48	48
% Boys	51	51	51	51	52	52
% Multilingual Learners	23.8	9.5	7.3	11	7.3	4.5
% Special Education	10	10	11	12	16	12
% Free & Reduced Lunch Eligible	60.1	62.2	25.1	30	32.9	39.5

Table 4. Individual demographics for each of the six case studies.

I then compiled public information contextualizing the demographic data and context of each school division. I looked at county and school division web pages to identify themes in their missions and determined if each school system offers APCS courses. Demographic data for each state, school district, and school was pulled from publicly accessible state-level data. Together, the interview and descriptive data created a "holistic" image of central office and principal decision-making around BLNA student access to, participation in, and experience in high school CS courses (Saldaña, 2014; Stake, 1995).

Data Analysis

Interviews were transcribed using the Otter.ai platform and then analyzed using NVivo. The first step to qualitative data analysis is to discern patterns across all data sources through coding (Saldaña, 2014). Therefore, the first round of coding was inductive/bottom-up (Bingham & Witkowsky, 2022). The goal of the inductive analysis was to gain an initial understanding of themes across the central office leaders' and principals' comments. In case study research, Yin (2012) describes this inductive approach as an explanation-building process. Since the purpose of the study is also to deconstruct how U.S. PK-12 leaders describe BLNA student access, participation, and experience in CS, I applied a deductive (a priori) approach (Bingham & Witkowsky, 2022); using Ladson-Billings' (2006) educational debt theory as a lens, I compared how the leaders support BLNA student access to CS from system, access, participation, and experience levels.

Findings

This section includes within-case findings organized by the four levels of the CAPE framework (research questions): each district's *capacity* to sustain and offer CS education, CS course *access*, student *participation* (enrollment in CS), and student *experiences* in CS. Then, I provide multiple-case comparisons of the school districts to show how they attend to the educational debt. Tables 5-6 provide an overview of the central office leaders (Table 5) and high school principals (Table 6) for each case. All names, school systems and individuals, are anonymized. Personal pronouns were obtained from publicly available information.

School System	Name	Title	Race
Orchid	Dr. Rowan	Director of CTE	Black
	Mrs. Blake	Instructional Supervisor of CTE	Black
Peony	Dr. Parker	Assistant Superintendent & Chief Academic Officer	White
	Mrs. Avery	Secondary Math Supervisor	White
Sunflower	Dr. Lyle	Chief Academic Officer	White
	Mr. Ripley	Coordinator of CTE	White
Lily	Dr. Lennon	Superintendent	White
	Dr. Karmen	Director of CTE	White
	Mr. Ray	Mathematics Coordinator	White

Marigold	Dr. Emerson	Assistant Superintendent	White
	Mrs. Harper	Director of School Counseling and College and Career Readiness	White
	Mrs. Rae	CTE Coordinator	White
Rose	Beck	Director for Learning Technology Integration	White

Table 5. Case-specific participating central office leaders

School System	Name	Title	Race	School	Total Students	Student Demographics
Orchid	Dr. Elliot	Principal	Black	Maple Park High	1082	66% Black, 32% Hispanic, 2% White, 68% NSLP
	Dr. Quinn	Principal	Black	Whitewater High	1159	87% Black, 8% Hispanic, 2% Multiracial, 2% White, 42% NSLP
Peony	Dr. Cameron	Principal	White	Promise High	1343	39% White; 35% Black; 14% Hispanic/Latino/a/x, 6% Multiracial, 6% Asian, 46% NSLP
	Dr. Riley	Principal	Black	Heritage High	1325	49% Black, 20% White, 19% Hispanic, 8% Multiracial, 3% Asian, 1% Native American, 66% NSLP
Sunflower	Mr. James	Principal	White	Edgewood High	848	68% White, 13% Hispanic, 10% Black, 6% Multiracial, 2% Asian, 0.2% Native American, 20% NSLP
	Dr. Madison	Principal	White	Northview High	1659	42% Hispanic, 25% Black, 23% White, 5% Asian, 5% Multiracial, 0.3% Native Hawaiian, 0.1% Native American/Indigenous, 51% NSLP
	Dr. Finley	Principal	White	Silver Oak High	1519	76% White, 10% Hispanic, 5% Black, 4% Asian, 4% Multiracial, 0.3% Native Hawaiian, 0.1% Native American, 13% NSLP
Lily	Mr. Myler	Principal	White	Mountain High	1989	43% Black, 27% White, 15% Hispanic, 9% Multiracial, Asian 6%, .4% Native Hawaiian, .2% Native American, 68% NSLP
	Dr. Hollis	Principal	Black	Valley High	2229	35% White, 26% Black, 14% Hispanic, 13% Multiracial, 11.8% Asian, .7% Native Hawaiian, .2% Native American, 39% NSLP
	Mr. Gray	Principal	White	Lake High	1721	49% White, 19% Black, 11% Hispanic, 10% Asian, 10% Multiracial, .6% Native Hawaiian, .3 Native American, 33% NSLP
	Dr. Frederick	Principal	White	Seaside High	1886	76% White, 8% multiracial, 8% Hispanic, 4% Black, 3% Asian, 1% Native Hawaiian, 0.2% Native American, 11% NSLP
Marigold	Mr. Robin	Principal	Black	Timber High	1232	63.6% White, 16.9% Hispanic, 9.7% Black, 6.9% multi, 2.7% Asian, .2% Native American, .1% Native Hawaiian, 25.7% NSLP
	Mr. Taylor	Principal	White	Forest High	1213	50.4% White, 22.2% Black, 16.2% Hispanic, 7.3% Multi, 3.3% Asian, .3% Native Hawaiian, .1% Native American, 40.5% NSLP
	Mrs. Sawyer	Principal	White	Maple High	1325	54% White, 20% Black, 12% Hispanic/Latino/a/x, 10% Multiracial, 3% Asian, .3% Native Hawaiian, .1% Native American, 35.5% NSLP
Rose	Mr. Bailey	Director	White	STEM Center	N/A	N/A
	Mrs. Skylar	Principal	White	Fairview High	1163	84.1% White, 6.7% Hispanic, 3.9% Asian, 3.7% multi, 1.3% Black, .3% Native American, .1% Native Hawaiian, 12.1% NSLP
	Mr. Vere	Assistant Principal	Black	Union High	1235	61% White, 17% Hispanic, 12% Black, 7% Multiracial, 3% Asian, .1% Native Hawaiian, 0% Native American, 57% NSLP

Table 6. Case-specific high school principal participants and school-based student demographics (Student Data is from the 2022-2023 school year).

Within-Case Analyses

Orchid County (State-1)

Orchid County is a large school system that serves mainly Black students. The school division's website promotes a mission of excellence in equity, 21st century skills, student brilliance, and inclusivity. Four individuals were interviewed in Orchid County: two central office leaders from the CTE division, Dr. Rowan (Director of CTE) and Mrs. Blake (Instructional Supervisor of CTE), and two principals, Dr. Elliot (Principal of Maple Park High) and Dr. Quinn (Principal of Whitewater High). Dr. Rowan is a Black man who reports to the Chief Academic Officer. Mrs. Blake is a Black woman and is the leader of Orchid County's CS education efforts. Dr. Elliot is a Black man and has worked in Orchid County for 20 years. Dr. Quinn identifies as a Black, Cuban woman and has worked at Whitewater for six years. Whitewater is classified as an International Baccalaureate (IB) School.

Capacity for CS. Orchid County offers both APCSA and APCSP, but APCSA–which is linked to student enrollment in CS majors–is only offered online or at high schools with specialized academies or magnet programs. Both Maple Park and Whitewater offer APCSP but not APCSA. Despite Orchid County's overall support for CS education, Instructional Supervisor of CTE Mrs. Blake, expressed stress and frustration towards having little support to bring CS to all students. She said,

> I need to have someone who can just dedicate a little time to move in these initiatives, because a lot of it is coming down the pipe quickly. As you know, CS is changing, technology is changing. And so really out there for us to learn and to have our students get prepared for…I'm spread all over the place, emails, directions.

According to Mrs. Blake, having staff committed to CS is critical for keeping up with a fast-changing technology-centered society and making CS accessible to all students.

Access to CS. Both Orchid County central office and high school principals believed that CS is important for students to learn, but they shared different perceptions of how the county is expanding CS. In alignment with state-level policy, Mrs. Blake said, “Every student has to take Foundations of Technology or Foundations of CS for a graduation credit.” However, she added that she is “really pushing for the foundations of computer science in the younger grades, 9th and 10th grades,” especially for students who “don't want to study computer science as their career.” That way, “if they do want to take a [CS] course or two, they can learn coding.” Her comment shows that she wants to push state policy further and make CS accessible to every student, not just students interested in CS.

Dr. Rowan, the Director of CTE, felt that negative perceptions of CTE limits the equitable expansion of CS education. He said, “For the longest time it's been go to college or fail. If you're a bad kid, go to CTE because somebody needs to pick up the trash. I always felt like that was the absolute wrong series of messaging.” He cited negative historical perceptions of CTE and then shared stakeholders need to see the relationship between CTE and CS to make CS accessible to all students:

> How do we bring CTE into the technological world? One of the programs we offer is automotive technology. I said, oh, automotive technology, *tech*. Ya know, in auto tech, we just do brake pads and oil changes and spark plugs and maintenance. My goal is to augment that baseline thinking and say, let's start talking about building electric cars. Let's start talking about how we program things. Let's talk about how we develop street sensors for self-driving cars...If we do not do a better job of embedding [CS] skills and that understanding into everything, people are going to be at a disadvantage.

In his example of automotive technology, Dr. Rowan wanted to embed CS throughout CTE so that all students are equipped with future-ready skills.

Dr. Elliot, Principal of Maple High, explained how he coordinates with Dr. Rowan to bring advanced CS courses to his school. He said, “We meet with Rowan and his staff every single month, and then after that it's as needed." In fact, Dr. Rowan chose Dr. Elliot to be a part of an APCSP rollout program because, according to Dr. Elliot, "Maple Park High has historically been a CTE building, where with the initiative funds, [CS] was able to expand." When referencing other schools, Dr. Elliot noted that "a neighboring high school might not have as much as I do because we have the [initiative]." Dr. Elliot provided evidence that CS course access depends on how the central office views school leadership and that not all Orchid high schools have APCS.

Participation in CS. When describing student enrollment in CS, the central office leaders' perceptions of students differed from the high school principals' perceptions. Both central office leaders, Dr. Rowan and Mrs. Blake, believed that student enrollment in APCS courses is tied to the elective nature of CS. Mrs. Blake clarified, "We don't have any prerequisites for our standalone elective courses right now. They can just enroll. We do have it where students can get credit for taking APCSA; they can take it as a math credit. Or it's part of their CTE computer program pathway." Based on her comment, APCSP and APCSA do not have prerequisites, any student can enroll in the courses, and APCSA counts as a graduation math credit. Students that are a part of specialty computing programs will also enroll in APCSA courses. Dr. Rowan further expanded on specialty programs and how they work, "so for us once you're in a program, you're in a program. There's no double-dutch. Because of the way the courses are set out, if you start and you invest a year, you can't go back and do something different." He spoke specifically about a program that "is focused on just computer science" as an example. Dr. Rowan's comments suggest that students must commit to CS when they first enter high school if they want to enroll in APCSA.

The high school principals both recognized the elective nature of CS but also explained how student enrollment is linked to how the course is marketed to students and familial support/exposure. Dr. Quinn, Principal of Whitewater High, said, “I think it doesn't get as good of a rep. Because I think the word science in it, it kind of reminds me like of math, so a lot of people as soon as they hear the word math, they're like, oh, I'm not good at that.” Dr. Quinn suggested that although her school offers APCSP, definitions and perceptions of CS courses might impact enrollment. In response to a question on whether CS should be a mandatory course, Dr. Quinn stated, “I just don't think [CS] is for every student.” She added that the students enrolled in APCSP have families that “are prepping them and encouraging them to go to college. So, you know, they're in that course on purpose.” Dr. Quinn believed that student enrollment was tied to prior exposure to CS, student math ability, and familial support. Dr. Elliot expressed similar perceptions of student enrollment in CS as Dr. Quinn. He said,

> This could have been part of the package of how we sold the program but all of them want to be millionaires. They all see the end result where tech, math and computer science especially makes a lot of money. Right out of school especially. They all have that aspiration. They all have decent math skills.

Dr. Elliot believed that student enrollment in APCS courses is driven by financial motivation, STEM ability, and parental encouragement.

Experiences in CS. Orchid County central office leaders described student experiences in CS courses as relatively positive. Dr. Rowan stated,

> Some of them stick with it all the way through and end up majoring in it when they go to college. Some of them take it for the experience. They say, you know, I learned what rigor looks like, I learned how to think and process a different way, but I don't necessarily know that I want to sit in a room by myself all day and not talk to other human beings.

Dr. Rowan described student experiences in APCSA as dependent on a student’s future academic and professional interests. Mrs. Blake didn’t explicitly discuss student experiences in CS, but she shared, “We did have a school win a Diversity Award, so they've had more females enroll in APCSA. I am seeing that trend that we're having more females enroll into our APCS courses, which is good.” In a field that is traditionally male-dominated, Mrs. Blake could be suggesting that having more females enroll in APCSA means that the course is becoming more inclusive, gender-wise. Although Dr. Elliot described APCSA students as “the gamer type,” he added that it’s “not all them. Like I have one, I have a girl that is a dancer.” His comment expands Mrs. Blake’s comments regarding gender parity in CS in Orchid County by providing a school-level picture into the ways that CS is becoming more inclusive of multiple student identities.

Peony County (State-1)

Peony County is a relatively smaller school district in State-1 with a diverse student population. The county includes a downtown city area and rural areas. Peony County’s mission statement stresses giving students the opportunity to develop skills needed to become productive citizens in society. Between 2016 and 2022, 18% of Peony County graduates enrolled in at least one computing related course. 58% of those students enrolled in college full time and 14% declared a computing major. The Curriculum Directory on the county’s website does not list CS as a core subject and instead lists it under high school math.

I interviewed four leaders in Peony County: Dr. Parker, the Chief Academic Officer, Mrs. Avery, the Secondary Math Supervisor, Dr. Cameron, Principal of Promise High, and Dr. Riley, Principal of Heritage High. Dr. Parker is a White man who has worked in his position since 2017. He grew up in Peony County, earned a bachelor’s degree in mathematics, and taught high school math for five years at Heritage High School. Mrs. Avery is a White woman who supervises 6-12th grade teachers. Mrs. Avery clarified that she oversees CS teachers directly in the schools, “[The Supervisor of CTE] provides the PD and the training and stuff like that. But again, it's my teachers who teach." Dr. Cameron is a White woman who just completed her fifth year as principal during the 2022-2023 school year. Dr. Riley is a Black woman who has won awards for her work in developing mentoring programs for Black male students. Both Heritage and Promise offer foundations of computer science, financial computer science, and APCSP. They do not offer APCSA. Overall, Peony County's leadership does not reflect the diversity of the county.

Capacity for CS. According to Dr. Parker, the Chief Academic Officer, CS course offerings depend on teacher availability and "it varies by school, one, because of staffing." Dr. Cameron, Principal of Promise High, also mentioned capacity issues related to teacher hiring at the school-level, "very few teachers that are trained in the county to do computer science." However, her comments diverged from Dr. Parkers when she critiqued how the county is handling CS education: "I don't know that we're changing fast enough. I know that our teachers are trying at their level to keep up, but I think there's probably more that we should be doing as a county to support that growth." Dr. Cameron thought that more can be done at the state and county level to support CS teachers. She also shared,

> I think knowledge about computer science at the district level, unless you've taught computer science or spent some time there, you hear the word, but you might not exactly know what computer science is, like people support computer science, but they don't really know maybe even how to support it.

Overall, students can enroll in APCS courses in Peony County depending on the school they attend and teacher availability.

Dr. Riley, a high school principal, expressed that capacity for CS depends on what is required at the state-level. She said,

> I think that math and reading are the topic of conversation when it comes to education, because those are the main two areas of content that is tested…Math and Reading also drives our state scores, like how our county is ranked throughout the state. Once

> computer science is integrated into that, I feel like that's when it will be essential to have computer science on the same level as math and reading.

According to Dr. Riley, standardized testing drives what gets attention at the high school level, and currently the subjects with the most attention are math and reading.

Access to CS. Only the two central office leaders provided descriptions of CS course access across Peony County. The Secondary Math Supervisor, Mrs. Avery, was enthusiastic about how CS has expanded in Peony County: “We have foundations of tech, which doesn't count as a math credit, but it does lead [students] to take AP Computer Science Principles and APCSA. We do have that available to our students at three of our high schools right now, which we're very proud of.” In addition to her comments on CS course expansion in the county, Mrs. Avery praised partnerships with local community colleges. She said, “we also have a partnership with [Community College], where students can take computer science courses and actually come out by the time they are seniors with associates.” Despite this opportunity, she admitted that “not many students take advantage of it, but it is available to them.” According to Mrs. Avery, Peony County has significantly expanded CS course access, but students are not necessarily taking advantage of CS learning opportunities.

Dr. Parker related CS course access to geography and student interest. He said, “We have three schools that are in town, and that urban part that I was talking about. Then we have one middle/high school out in the rural part. And based upon student interest, the rural school has not had it as much.” Dr. Parker stated that APCS courses are not offered in rural schools in the county because not enough students are interested in the subject. However, he also shared that because Peony County is “not that big a geographic area, we have various programs. If one school doesn't have [CS], their students are able to travel, or we even coordinate travel for them to get it to another school." He suggested that Peony County leaders will bus students to another high school to take CS if needed.

Participation in CS. There was a clear division between how Peony County central office leaders described student enrollment in CS compared to high school principals. The central office leaders connected enrollment with students' identities and math abilities. Dr. Parker described the types of students who enroll in APCS courses as "a lot of our top students are the ones that are taking our computer science class." He further explained what he meant by 'top students', saying, "we have a lot of our, you know, Summa Cum Laude students, top 5% of the class, they're the ones that are mostly enrolled. While I think [CS] does have value for other students, we don't currently see a lot of interest." Similar to his comments on CS course access, Dr. Parker suggested that student enrollment in CS is driven by student interest. Similarly, Mrs. Avery described students in CS as, "a lot of times the students are very introverted. They prefer to just be on the computer screen, you know, in their own little world. A lot of white males, Asian males, not as many females, for sure." Mrs. Avery's comment differed from Dr. Parker's because she directly referenced race and gender. Her description also suggests that CS classes in Peony County maintain homogenous student populations that match the current demographics of the computing community.

Mrs. Avery also expressed that students need to complete a certain level of math before enrolling in CS. She said, "I think currently for AP Computer Science, it's really just being able to make sure you have algebra one and geometry, and that you've taken that foundations course so that you kind of have an idea of what you're really signing up for." She seems to describe math prerequisites as necessary for student enrollment and success in APCS courses, therefore suggesting that math is a necessary barrier to CS. Additionally, Mrs. Avery felt that student enrollment falls onto the teachers and said, “I think the teacher needs to sell the program because they're the ones doing it, right? They really need to be the ones to say, ‘Hey, did you know what we do in this course.’” Unlike Dr. Parker, Mrs. Avery places some of the responsibility of student enrollment in CS on teachers rather than just the students.

At the high school-level, Dr. Cameron and Dr. Riley felt that Peony leaders need to demystify perceptions of who can or cannot do CS, thereby conflicting with Dr. Parker and Mrs. Avery’s statements. Dr. Cameron stated, “I think that we should be tapping into more kids for computer science, and we are not. They don't know what it is. And maybe even the counselors when they're talking about it. Maybe don't do it justice, either.” Dr. Cameron claimed that school leaders, especially counselors, need to actively advertise CS. Dr. Riley also commented on how cultural perceptions of CS might limit student enrollment. She shared,

> I think we need to find ways to spark the interest of computer science across all cultures. I do feel like our students, when they think of computer science, or you know, things of that complexity, that is only for a certain demographic. And I feel like with the world that we live in, we're all capable of doing anything and being anything, but at the same time, we have to make sure that we are giving all kids the opportunities to see what it is.

Dr. Riley described a larger systemic issue, the culture of the CS community, and its impact on student diversity and enrollment in CS.

Experiences in CS. Central office leaders and high school principals expressed different perceptions of student experiences in CS courses in Peony County. Dr. Parker believed that teachers are central to creating positive learning experiences for students enrolled in APCS courses. He shared,

> It’s driven by the teacher having those good relationships with students, right? I know at one of our schools, we have very good computer science numbers. Well, it's because of the teacher, like the kids want to take the class because of the teacher. Then we have four high schools where they're really struggling with their numbers. We all know why nobody wants to take the class with Mr. So and So.”

Dr. Parker linked student enrollment and experiences in CS with CS teacher performance. Mrs. Avery did not comment explicitly on student experiences in CS classrooms.

Dr. Cameron also felt that teachers impact student experiences in computing but added some critiques about how the county is expanding CS. She said,

> I'm not sure what it looks like for other areas, but definitely in the county, I don't know that we're changing fast enough. I know that our teachers are trying at their level to keep but I think there's probably more that we should be doing as a county to support that growth.

She felt that the county is not providing the support that CS teachers need to be successful. Dr. Cameron also described APCSP as an alternative math and science course for students who typically struggle with those subjects: “Some of our kids that are doing physics and all that make great candidates, but they're not always the ones doing [CS]. It's the ones that are, you know, maybe interested in science and math, but are not necessarily always the top kids in those areas.” Dr. Cameron described how CS is an opportunity for Promise High students to feel successful in a STEM course.

Sunflower County (State-1)

Sunflower County’s mission statement emphasizes caring and exceptional learning environments, student potential, and success in a global society. The county is data driven; they have a website tab titled “Equity and Access” which displays a Tableau Data dashboard on school climate data, level of cumulative student enrollment in AP, IB, and CTE courses by racial group, student graduation rates, and more. Sunflower County high schools offer both APCSP and APCSA.

I interviewed Dr. Lyle, the Chief Academic Officer, and Mr. Ripley, the Coordinator of CTE, both of whom are White men. Dr. Lyle has worked in Sunflower County for 26 years. Mr. Ripley initially worked in the investment industry before becoming a CS teacher 23 years ago.

Every person I interviewed in Sunflower County recommended that I talk to Mr. Ripley about CS. When asked to describe himself, he said, “I was sort of the tech problem solver while I was working in [another school district]. If computer science, then everybody reaches out to you. I had the magic hands when it came to CS.” It was clear that Mr. Ripley was passionate about CS.

Three Sunflower high school principals agreed to participate in the study, Mr. James (Edgewood High), Dr. Madison (Northview High), and Dr. Finley (Silver Oak High). All three are White men. Mr. James worked in another State-1 county before coming to Sunflower, where he has worked for five years. Dr. Madison started as a middle and high school music teacher and worked as an administrator in Sunflower for 11 years. Dr. Finley has a doctoral degree in organizational leadership in special education and just completed his first year as principal at Silver Oak High.

Capacity for CS. All participating high schools offered APCSP and APCSA during the 2023-2024 school year. The Chief Academic Officer, Dr. Lyle, explicitly commented on what it looks like to create capacity for CS education in Sunflower:

> If we're going to do [CS], and then course development, there's usually materials that need to be purchased, but also training for teachers…we have to build capacity of teachers to do it. And a lot of them. So not only are we trying to get kids to understand [CS], we're trying to get our teachers to be trained in this stuff.

According to Dr. Lyle, the school system needs to develop a capacity for CS education by securing any necessary resources for CS courses and training teachers to lead CS classrooms.

Access to CS. Both Dr. Lyle and Mr. Ripley, the Coordinator of CTE, believed that CS is a necessary part of PK-12 education. Dr. Lyle attributed the push for CS to recent State-2 education legislation and the intricate relationship between computers and society,

> As we move on to the new legislation, there are robust college and career pathways. We think that some career pathways require that computational thinking[3] and understanding of how computers do their business, even specifically to how do I work, you know, this type of computer-driven technology …so we feel that we need to build that background for all kids, not just the kids who are interested in it.

Dr. Lyle referenced the state legislation as motivation to expand CS to all students. Dr. Lyle also stated, "we actually are envisioning it to have a place in all curricula. We have started to do some early work in elementary, we have a significant program in a middle school that's grown, and then we have it at the high school." Dr. Lyle claimed that CS is integrated throughout the entire Sunflower school system. Mr. Ripley confirmed Dr. Lyle's comments when he said, "since I had a lot of middle school experience, I just thought that that's where we need to start targeting kids. So I was able to put a computer science elective in seventh grade about five years ago." His comment also highlights his personal motivation to expand CS across Sunflower.

Despite Dr. Lyle and Mr. Ripley's avid support for CS, the high school principals noted some barriers impacting the equitable expansion of CS in their schools. According to Dr. Finley, CS course offerings depend on school-based student interest. He shared, "if there's a high enough demand for anything computer science, that's what drives us saying, okay, based on this need, and the registration, we're going to offer these classes." Dr. Madison also described how student interest drives CS course access. He said,

> Just you know, if you're only allotted X amount of teachers, am I going to dedicate one section to computer science if only four kids are going to sign up for it? Now that's one less math teacher I'm going to hire. Now my math [enrollment] numbers are going to be above 31. So getting that balancing act coming through.

Dr. Madison expressed needing to carefully balance student interest *and* teacher availability, therefore commenting on the capacity of the county to offer CS to all students.

[3] Computational thinking draws on foundational CS concepts, such as abstraction and algorithmic thinking, to answer complex problems across disciplines (Grover & Pea, 2013).

Participation in CS. In addition to playing a large role in expanding CS across Sunflower, Mr. Ripley shared that he determines CS course requirements. He said,

> One of the first things I eliminated four or five years ago was in high school, we had about 360 students taking computer science. It was just, the target was, I hate to say it, they were like the nerdy kids, but it was also the nerdy teachers teaching it. It was those kids that are going to be computer science people and they're going to be computer science teachers…I realized the market had to be much broader if we could just get students to experience it. So I eliminated the algebra credit requirement in high school.

Mr. Ripley explained how he removed the Algebra I course requirement for upper-level CS courses. He continued to share, "that really opened up the opportunity for more students to take it, because my theory is if you learn 30% of nothing, it's better than nothing. And if that's what you want to do, that's okay. That's better than a class that you don't want to be in." His comment suggests that he doesn't necessarily believe students have to be successful in CS courses, but rather they should have the option/opportunity to take CS if they are interested in the course.

Dr. Lyle's interview affirmed Mr. Ripley's comments about eliminating math prerequisites for CS. He said,

> I work with my team directly to reduce barriers to student groups being represented. For instance, one of the things that we did quite a few years ago, my team came back with a recommendation to eliminate a mathematics prerequisite for a computer science course. Prerequisites are kind of, I get why they exist, but what we found is they were just an unnecessary barrier. Kids can thrive in computer science and may not be the necessarily quintessential strong math learner. So that opened it up to a lot more students.

Like Mr. Ripley, Dr. Lyle feels that math prerequisites are unnecessary and limit students from exploring, and potentially succeeding in, CS. He appeared to critique current perceptions of CS as being for only strong math students. He also expanded on how he coordinates with leaders invested in CS education,

> I really try to think from a strategic type of level and then I have different people within my department, who are champions, and I don't want to underestimate the use of that term. We know from a lot of the research that champions can matter. They have to be passionate about [CS], they tend to create momentum.

Dr. Lyle stated that he gives power to individuals like Mr. Ripley to drive CS course expansion in Sunflower County.

Although not as distinct of a division as in Peony County, one Sunflower high school principal, Dr. Finley, described student participation in CS differently from the central office leaders. Dr. Finley clarified how discrepancies between Sunflower's course guide and CS courses offered at individual schools might be confusing to students and families who are pursuing CS. He said it's "sometimes confusing for communities when they see the course offering guidebook and then they say, oh they offer computer science, they offer French, they offer German, because everything's listed, but it doesn't mean we actually offer it in a particular school." Dr. Finley confirmed that CS is not necessarily offered at every high school in Sunflower. He also felt that Silver Oak High is unique because of its Engineering and Design Academy: "we have an audience that I think, because they might be here taking, like, you know, engineering and design, CAD, some of the principles of design and computer, we have a natural audience, that you don't have at another school." Dr. Finley alluded that Silver Oak High's specialized academy attracts a 'natural audience' for CS, or students who plan to enroll CS courses.

Experiences in CS. Mr. Ripley commented on student experiences in CS courses while Dr. Lyle did not. Mr. Ripley linked student experiences with teachers,

> My theory is the smartest person in the room is the room itself today. Once you figure that out as a computer science teacher, you can't keep ahead of it. So you have to sort of have the class grow together…we recruit good teachers who have a little bit of passion and a little bit of problem solving skills.

Mr. Ripley believed that good CS teachers are those who can adapt with the times *alongside* their students. When speaking about diversity issues in CS, Mr. Ripley stated, "We have a few diverse students or diverse teachers, but I do not think that's the answer." Mr. Ripley felt that having a racially diverse teacher workforce is *not* a solution to diversity gaps in CS classrooms.

The principals also connected student experiences, and subsequent student enrollment, with CS teachers. Mr. James stated,

> I think with the right teacher, [students] respond very well. You have to have, like any course, an engaging teacher, [the student] might persist if they really like it. You know, just because they know they're gaining something from [the class] or they see themselves going into [CS] but an engaging teacher can make all the difference in the world.

Mr. James' comment shows that he sees teachers as key to engaging students in CS and helping them to stay enrolled in the course. Dr. Madison felt similarly, "the biggest issue that we've had over the past couple of years has been the teachers that we've been hiring, have not been very kid friendly." Like Mr. James, Dr. Madison felt that teachers make or break a CS class.

Marigold School Division (State-2)

According to their website, Marigold School Division is committed to student excellence and success. The division offers CS, and APCSA satisfies both a mathematics and a laboratory science credit. The program of studies for the county has a specific section dedicated to Technology Education that includes both APCSP and APCSA. The formal program of studies also lists technology and computers/information science under CTE.

I interviewed three White women in Marigold's central office: Dr. Emerson, the Assistant Superintendent, Mrs. Harper, the Director of School Counseling and College and Career Readiness, and Mrs. Rae, the CTE Coordinator. Dr. Emerson works closely with the Director of Curriculum and Instruction and Mrs. Harper. Dr. Emerson recommended that I talk to Mrs. Harper, who then referred me to Mrs. Rae. Mrs. Harper and Mrs. Rae work closely with one another and made it clear that CS falls under CTE in Marigold, especially when Mrs. Rae stated, "[CS] has never fallen under math from this division. It's always been CTE." I also interviewed three high school principals: Mr. Robin (Timber High), Mr. Taylor (Forest High), and Mrs. Sawyer (Maple High). Mrs. Harper connected me with Mr. Robin because Timber High has the most thriving CS student enrollment in the division. Mr. Robin is a Black man who “grew up in a family of educators.” Mr. Taylor is a White man and a former history and social studies teacher. Mrs. Sawyer was also a former social studies teacher who previously worked in a larger State-2 school division prior to Marigold.

Capacity for CS. APCS courses are offered at some Marigold high schools, but offerings depend largely on teacher availability. Dr. Emerson stated, “You know, you can only build what you have the staffing for.” She made it clear that the division can’t offer APCS courses if they don’t have the staff for it. Mrs. Sawyer commented directly on teacher hiring from a principal perspective and said “it's hard to find teachers period…and I think, you know, education doesn't pay as much as a lot of our teachers could make it a private industry.” She felt that there aren’t a lot of teachers willing to teach CS in general. However, if students do want to take APCS courses, Mrs. Sawyer shared, “a lot of times our students are forced to take [APCS] through the Virtual [State-2] platform, which the students who are really interested will do, but it hasn't really grown much beyond that.” Mrs. Sawyer made it clear that students need to *want* to take the virtual course, otherwise they will opt out.

Access to CS. The central office leaders’ knowledge of CS was slightly fragmented. Dr. Emerson, for example, did not know if CS fell under CTE or math, “[You’re] asking these questions and I should have looked this up. It's in my Program of Studies…” She explicitly mentioned that she does not know where CS falls in the Division. Mrs. Harper, on the other hand, knew exactly which CS courses are offered, “AP Computer Science A was initially offered my first year here…we typically have sections of it at each high school.” However, even Mrs.

Harper did not know specific details about CS, so she connected me with Mrs. Rae. This disconnected knowledge of CS across the central office did not go unnoticed by Mrs. Rae,

> Everybody looks to me to lead the computer science standards and the integration of those standards for K-8. And then the middle and the high schools have courses, independent courses, standalone courses that cover the content…But because we have computer science courses, everybody thinks, oh, 'that's computer, that's a CTE thing,' and not 'that it's curriculum and instruction'. So we've had a learning process in the division to understand that it is all of us that are responsible for [CS], not just me.

According to Mrs. Rae, Marigold leadership is not unified when it comes to CS education. Mrs. Rae further shared, "I think a lot of people see the need for [CS], but they're just not quite comfortable taking the lead or expanding it." Directly referencing leaders in the central office, Mrs. Rae expressed that central office leaders aren't necessarily prepared to expand CS.

Two high school principals, Mr. Taylor and Mrs. Sawyer, pointed out differences in CS course access in their respective schools. If students are interested in APCS courses, Mrs. Sawyer stated, "we have several different computer science courses that students can take some years, we have more interest than others." She clarified that Maple High offers APCS courses, but course offerings depend on student interest. Meanwhile, Mr. Taylor shared that "instead of telling a kid you can't take the course, we supplement it with virtual," referring to virtual options to take APCS courses. Mr. Taylor shared that APCS courses aren't typically offered at Forest High and instead students need to take the courses virtually.

Participation in CS. The central office leaders and high school principals distinctly varied in how they described student enrollment in CS and the necessary processes that students must go through to enroll in APCS courses in the county. At the central office level, Dr. Emerson and Mrs. Harper explained how student interest and scheduling control both CS course access and student enrollment. Dr. Emerson stated, "The one issue with I guess when it's an elective, things depend on diploma paths. What kids are taking what? You know, do they have room in their schedule.” Since APCS courses are electives, Dr. Emerson explained how taking APCS depends on if there is room in a students’ schedule. When discussing funding for CS, Dr. Emerson shared, “in high school, student requests drive what we offer.” She explained how funding is allocated based on student interest. Mrs. Harper shared a similar perception, “we're not able to always accommodate classes of three kids or five kids, if that's what the interest is. When we look at our division, when we look at offering a new course, no matter the content area, we gauge what is the student interest in this topic?” Mrs. Harper’s comment suggests a bottom-up approach of the CAPE framework, where instead of CS course access driving student enrollment, student enrollment numbers, and subsequent interest in CS, drives CS course access in Marigold. This puts an immense responsibility on the students to bring CS into the division.

Conversely, the high school principals acknowledged disparities in CS and critiqued the process that students must go through to enroll in APCS in Marigold. Across the three high school interviews, CS students were described as “top math students” (Mr. Robin), “mostly boys” (Mr. Taylor), and “upper-level students that are definitely college bound” (Mrs. Sawyer). However, Mr. Robin recognized that CS courses need to be diversified. He shared,

> I don't think the demographic reflects our school. Simply because the population of our building is changing, specifically with our ML population. We're seeing an increased number of students, specifically from El Salvador or Central America. [CS] is not diverse at all.

He added that diversity gaps in CS are a result of not having a “clear road for students who may decide their 10th grade year, ‘hey, I want to try this computer science thing. I wish there was an entry level class for me to take in computer science’.” He suggested that students who want to enroll in CS courses must do so within their first year of high school. Mr. Robin further critiqued Marigold’s pathways for students to enroll in CS. He said,

> I think there are some steppingstones that we could embed in algebra I and some other math and English courses where we could have, I think, a clearer road for students to travel to get to a classic AP Computer Science. We don't really have those roads in our school division. I've seen them in some other school divisions where it is a focus of their CTE program. I hope we can build that out. But I will tell you at Timber High, we've been wrong. I believe one section of APCSA, they're my top math students. But I know there are other students who would love to be in computer science and the job market shows us that we need more people going that route.

He was forward about student enrollment in APCSA at Timber High and the lack of student diversity in APCSA. Mr. Robin's comments directly conflict with Dr. Emerson and Mrs. Harper's comments because he critiques the system, rather than the student, as a factor in CS course enrollment.

Experiences in CS. The central office leaders rarely described student experiences in Marigold CS classrooms. In fact, Mrs. Harper explicitly stated that she can't comment on Marigold students' experiences in CS: "I can't answer that question. I'm not in the classroom. When I look at numbers, I just look at enrollment." Even Mrs. Sawyer, who oversees CS, did not expand on student experiences in CS.

Unlike at the central office level, there was a clear consensus among the principals that teachers play an important role in creating positive CS learning experiences for students. Mr. Robin shared,

> A lot comes from the teacher. [Teacher Name] understands the content in the curriculum. But he also understands kids. I think that's the mark of a good teacher, is knowing your kids and knowing your content…I would argue it needs to be 51% you need to know your kids versus 49% the content and because of that he has students who want to come to the class, and he knows the content really well. I think his strength is his ability to work with kids and make it relevant to student lives.

Mr. Robin, speaking about the APCSA teacher at Timber High, stated that he believes engaging and knowledgeable teachers are key to making CS courses successful. Mr. Taylor also explained how teachers play an important role in recruiting kids into CS,

> We started teaching computer science only because the physics teacher did not have a full schedule, but was mathematics endorsed. He went around and rounded up students. And again, I hate to say it this way, but we had eight kids signed up, we usually don't make a class like that. He got seven guys to sign up and they were all guys.

According to Mr. Taylor, teachers can influence *which* students enroll in CS. Mrs. Sawyer expressed similar sentiments, “if we don't have the right teacher, the right fit for it, in order for it to build, you've got to have the right staff in place. Kids talk, you know, oh, well, you don't want to take it with so and so.” According to all three high school principals, teachers directly impact student experiences in CS.

Rose School Division (State-2)

Rose is a medium sized school division in State-2. Its mission stands out from other State-2 school divisions because it directly mentions ending predictive values associated with race, class, gender, and special capacities. The division also has an anti-racism policy that appears on the navigation pane at the bottom of their webpage. For CS education, both APCSP and APCSA are listed in the division’s course index. Computer programming courses related to robotics, engineering, and design are also described on the division’s CTE website.

All communication with Rose staff was mediated by a central office staff member in charge of external research requests; I needed to consult with this staff member to schedule interviews. He attempted to schedule an interview with the CTE Lead, Mrs. Elisha, but she declined because of her busy schedule. Instead, she connected me with Mr. Beck, the Assistant Director for Learning Technology Integration. Mr. Beck is White and identifies with the LGBTQ+ community. Mr. Beck works closely with Mrs. Elisha. Together, Mr. Beck and Mrs. Elisha regularly attend state-level meetings led by the State-2 CS Coordinator to discuss the K-8 CS standards.

Two principals and one assistant principal agreed to participate in the study: Mr. Bailey, the Director of Rose's STEM Center, Mrs. Skylar, Principal of Fairview High, and Mr. Vere, Assistant Principal of Union High. Mr. Bailey is a White man who founded the STEM Center. I could not access the STEM center's demographic data. Mrs. Skylar is a White woman who initially began a career in sales before switching to education. Mr. Vere is a Black man who oversees "the special education department, the CTE department, and the PE department" at Union High.

Capacity for CS. Rose School Division leaders referenced capacity for CS in relation to the state's commitment to expand CS. Mr. Beck shared,

> At the high school level, our kids are getting most computer science instruction in electives, where students are choosing to take those courses. We do not have any sort of mandated curriculum at the high school level…there's not a set of standards that applies to every child at that level…Now if the [state] would love to develop a set of standards for us and change some graduation requirements, I'm all for it. But we are not there yet.

Mr. Beck felt that without a comprehensive plan for the high school level, Rose School Division is not necessarily ready to expand CS at the high school level. He also argued that "the [state] needs to say that there needs to be CS, we're doing this. Which is easier said than done. Because there's a lot of priorities out there." Again, Mr. Beck thinks that the state needs to play a larger role so that Marigold leaders can see CS as a worthwhile competing priority. In the end, Mr. Beck thinks that "it's too easy to just sweep [CS] under" and not worry about it as a subject for students to learn.

Mr. Beck's comments might explain why Mrs. Skylar explicitly stated, "computer science isn't a priority at our school." Even if Fairview High offered APCS courses, Mrs. Skylar shared, "when we don't have the demand for it, it just goes by the wayside." Her comment shows that student interest drives whether Fairview High offers CS courses or not. She further explained,

> the department chair, who happens to be the computer science teacher, the assistant principal who supervises the director of counseling, and myself, we'll look at enrollment numbers. Sometimes you get an ugly number, right? So if you get 38 or 32 [students], and you only have so many computers in the labs and there are requirements for CTE to have certain caps on class size, that can be really hard for us because that means we have to take that staffing from another elective.

Ultimately, Mrs. Skylar explained that APCS courses can only be offered if a teacher is available, they have enough resources per student enrolled, and they can meet district-level CTE requirements around course implementation.

Access to CS. According to Mr. Beck, CS course expansion across Rose is not uniform. Mr. Beck shared, “Finding dedicated time for every kid to get computer science instruction is one priority among many. I would not say that it's not happening to a degree that I would like to see, but it is happening very strongly in pockets.” Mr. Beck mentioned that Rose school division leaders are figuring out how to expand CS in a way that allows them to simultaneously address competing division priorities. Mr. Beck also mentioned that high quality secondary CS education is mainly occurring “in pockets.” He stated, “there is a lot of awesome computer science instruction happening at the high school level, But again, it's in pockets, in places where students are self-selecting. We do have a really fantastic satellite school.” Sudents interested in CS must opt into APCS courses by applying to attend Mr. Bailey’s STEM Center or attending a high school with a robust CS program. At the high school level, Mr. Vere described APCS course access at Union High. He said,

> We offer a couple different levels, you know, for the students that are entering [CS] for the first time. Then we offer the more advanced level opportunities for our students who have been doing it. Like juniors and seniors that are there have shown more of a passion for it and are a little bit more advanced.

Mr. Vere shared that a variety of CS courses are offered at Union High, and the courses are scaffolded by student skill level.

Participation in CS. Similar to Peony County and Marigold School Division, there were clear differences in how the central office leaders described student enrollment in CS and how the high school principals described enrollment. Expanding on the elective nature of high school CS courses, Mr. Beck described the students who typically enroll in these courses. Mr. Beck shared,

> [The STEM Center] being a great example, that school has been around for a few years now, it was typically White males, the demographic that we see across the country, but that has shifted. You walk over there now there's a lot more racial and gender diversity compared to what I've seen in the past. I can't speak as much to specifically in the schools themselves…but certainly at our academies we're seeing broader diversity and some of that has been with intention on the part of the division.

Re-emphasizing that student enrollment in CS is occurring in specific STEM academies, Mr. Beck also clarified that there has been a division-level effort to diversify student enrollment in specialized academies. Mr. Bailey described student enrollment in his STEM Center similar to Mr. Beck: "Your socioeconomic status, your skin color, your gender identity, none of that should be a barrier to your ability to learn. We take a strong approach here in Rose School Division to make sure that all of our students have equal access to all our programs." Mr. Bailey felt that Rose School Division is committed to breaking down barriers around who can enroll in CS. However, Mr. Bailey also shared that "the computer science itself, the actual course, determines the demographics of that particular course. The ones that are college prep, White." Therefore, despite a commitment to diversify CS at the district and school levels, Mr. Bailey suggested that the CS discipline determines student demographics, alluding to CS as a community for college-bound White students.

Mr. Vere critiqued the process that students must go through to enroll in advanced courses like APCSP and APCSA. Referring to his own son as an example, he shared,

> I feel like students need to know what opportunities they have early in the county. Like I mentioned to you earlier, my son was a part of the [STEM] academy…If I wasn't a teacher in that building, knowing what the application process was, he probably wouldn't have gotten in. He ended up being able to go to [Corporate Name] camp at the University of [State-2], he was in geometry as an eighth grader. He did all the things to build a pretty strong resume, he did really well on his standardized tests. A lot of parents don't know what those things should be in order to give their students those same opportunities.

According to Mr. Vere, getting into academies like the STEM Center requires parents and families to have extensive knowledge about the STEM Center's application process. He also believed that students must be positioned, via support from others, to enroll in APCS courses.

Similarly, Mrs. Skylar felt that student enrollment in CS is limited by course scheduling requirements and how CS is promoted to students. She said,

> I feel like it's the type of field where if a kid doesn't come in interested, it's hard to commit to that for a full year. I'd love to somehow show off electives. I've talked about like, can we have a high school exploratory? What are ways that kids could get connected to computer science? Because I feel like they kind of missed the boat.

Mrs. Skylar felt that students have to enroll in CS right away in high school to even have the opportunity to enroll in advanced CS courses. She further described the role that state-level funding has on student enrollment:

> In our state, we have an econ personal finance requirement. It was heavily lobbied for by the finance industry. Like I've never seen so many curricular resources that were glossy and shiny, and like everyone wants to come. It's an ad, right? It's a big ad. There was a lot of political pressure, then that happened, and that's great but it takes a spot in a kid's schedule. It creates a barrier to graduation. So that's one of the challenges, I think, with the traditional high school schedule."

Mrs. Skylar critiqued how course requirements, like the industry-funded economics course, takes up a spot on a student's schedule and shifts priorities around what students should and should not take.

Experiences in CS. Mr. Beck at the central office level did not comment directly on student experiences and instead referred me to the Office of Community and Engagement which "has really done a lot of work around outreach to families. A lot of their work is around the resources that we put in front of the kids so that they can see themselves in the curriculum, if that makes sense." He seemed to suggest that the Office of Community and Engagement could help me understand student demographics in CS because they play a large role in making K-12 education inclusive for all students.

Unlike Mr. Beck, the high school principals were aware of student experiences in CS. Mrs. Skylar expressed concern towards student performance in APCS courses. She said,

> For us, it's been an area that I feel like is challenging. There are kids who know they're interested, and they gravitate towards it, but it's a challenge to keep staff current. That definitely is an area that I've actually tasked my assistant principal, who supervises our current tech department, like how do we make sure our computer science teacher who's great…but I definitely feel like kids aren't performing as well as they used to. So helping to keep a professional development focus because the field changes so rapidly."

Mrs. Skylar's comment is multifaceted- she is expressing challenges with ongoing CS teacher professional development (PD) and how limited PD impacts student performance in CS.

Mr. Vere described student experiences in CS in relation to student ability. He explained that "the math part for some students could be overwhelming" if they haven't completed upper-level math coursework. For students who have completed advanced math courses, he felt that "those are the students that tend to enjoy [CS] more" and further explained,

> I have one student who was just talking about how their parents are coders. They've been exposed to it. Those types of students are more likely to be involved…Our county is a little bit unique, because when you get to those higher-level STEM-type classes, they're held at what we call the [STEM Center], which is a separate sort of Academy.

He felt that students feel more successful in CS when they have had some prior exposure to CS.

Lily School Division (State-2)

Lily School Division is one of the larger school divisions in State-2. Its mission centers on building relationships with local communities, empowering students to become life-long learners, and global citizenship. Lily has a diversity, equity, and inclusion (DEI) office. The DEI web page mentions critical race theory and explicitly states that critical race theory is not a part of the work being done in the division. There is not a lot of information provided about CS in the division except in the program of studies, which states that APCSA satisfies a math graduation requirement.

I interviewed Dr. Lennon, the Superintendent, Dr. Karmen, the Director of CTE, and Mr. Ray, the Mathematics Coordinator. Dr. Lennon is a White man who has won a Superintendent of the Year award. According to Dr. Karmen, Dr. Lennon is "a facilitator of everything that happens [in Lily]. When he came in, he gave us permission to innovate." Dr. Karmen is a White woman who works within the Department of Teaching and Learning. She reports to the Chief Academic Officer of Lily, who is also a White woman. Both Dr. Lennon and Dr. Karmen recommended that I interview Mr. Ray, a White man, about CS education. According to Dr. Karmen, Mr. Ray is "the math guy" who "is the one that knows CS."

I interviewed Mr. Myler, Principal of Mountain High, Dr. Hollis, Principal of Valley High, Mr. Gray, Principal of Lake High, and Dr. Frederick, Principal of Seaside High. Mr. Myler is a White man. He shared, "as a former math person, I like [CS] now. As a principal, I'm pursuing it," therefore expressing support for CS. Dr. Hollis is a Black woman whose high school, Valley High, has the largest population of multilingual learners relative to the other participating high schools. Mr. Gray is a White man who has spent his entire professional life working for Lily. Lastly, Dr. Frederick is a White man who earned a doctorate in digital citizenship. Similar to Peony County (State-1), Lily's leadership demographics did not reflect the overall demographics of the school division.

Capacity for CS. Dr. Karmen, the Director of CTE, stated that student interest *and* teacher shortages impact CS course expansion in Lily. She shared, "I think the barriers they have are do I have somebody to teach it, somebody with the knowledge and the desire to teach it? And do I have enough kids that want it? If the answer is no, we have to take a harder look at why, you know, long term." Mr. Ray, the Mathematics Coordinator, expressed similar sentiments,

> The other really hard piece has been math teachers are hard to find and math teachers tend to be the computer science certified teachers. When the question becomes, do you offer AP Calculus or computer science, because we're down a math teacher this year, guess what they're gonna pick, they're gonna pick AP Calc right?

Dr. Karmen and Mr. Ray considered the impact that teacher hiring, and student interest can have on CS course offerings.

Mr. Myler, the principal of Mountain High, affirmed the impact of CS teacher shortages on his ability to offer CS. He said, "I got a new teacher that I'm trying to support and grow into the profession. I'm not going to dump them in a class that they aren't necessarily passionate about. Now I gotta wait and see what happens next year. It's unfortunate." Mr. Myler understood the realities of hiring teachers for CS and expressed that he would offer CS if he had the staff. His comments are important to note because out of all of the principals, he was the only one to comment on teacher hiring *and* his school serves majority BLNA and low-wealth students.

Access to CS. The central office leaders were aware of disparities in access to CS courses in Lily. Dr. Lennon, the Superintendent, stated, "Definitely seems to be more boy-centric in terms of the interest level [in CS]. I would say there is a broad diversity, at least in terms of like ethnic and socioeconomic." Dr. Lennon suggested that there aren't any striking racial or wealth disparities related to CS course access but did refer to gender imbalances. However, his comment was not consistent with Dr. Karmen's, who said, "We went back and looked at our own enrollments and realized that the higher levels of computer science were not being taught at some of our schools that had higher levels of students with free and reduced lunch. We proved exactly what we were reading from the literature." Dr. Karmen referenced data for the district showing that there are disparities in student access to APCS courses. Mr. Ray affirmed Dr. Karmen's comments,

> when it comes to increasing our female demographic and increasing our African American subgroups. Still not where we want them. There are still huge gaps. I'm not gonna sit here and pretend and be like, it's an equitable experience. You walk into a classroom it's still 80% male, it's still 80% White.

Mr. Ray provided an overview of majority White student demographics in APCS courses.

Dr. Karmen and Mr. Ray also described how they are reducing disparities in CS. Dr. Karmen mentioned how she shares division-level data with principals to highlight gaps,

> I don't think principals always have the big picture of all that data. When we looked at the data…where we looked at students from lower socioeconomic neighborhoods, the principal has that view of their own school. In the central office, we look at all the schools and start to compare them to each other and look for holes and patterns. So it's the 30,000 foot view versus a 10,000 foot view of a principal on their own school. So I think there's some value in sharing and then taking that back to principles.

She explained that change can start with open communication between the central office and high schools. Dr. Karmen also described an informal STEM learning opportunity to build student interest in CS. She said,

> We thought, how do we get Computer Science for All and STEM for all? So this idea of a [STEM event]...15 years ago, we started with a robotics competition with nine schools…the reason we focus that way is we can have 1000 kids doing these STEM activities, not five kids, you know, so schools can have lots of teams. It's that idea of STEM for all.

Dr. Karmen felt that the STEM event can be a way to expose larger proportions of students to CS if they don't have CS in their high schools. It does not, however, fix the issue of not offering APCS courses at some schools in the division.

Participation in CS. The central office leaders shared similar perceptions of student enrollment in APCS courses as principals who serve majority White and wealthy students while Dr. Hollis and Mr. Myler, who work in schools with majority BLNA students and students on the National Reduced Lunch Program, offered differing perspectives. Dr. Lennon, the Superintendent, shared,

> We are finding ways to build interest and help students, you know, kind of see that [CS] can be fun and competitive while they're building new skills. All of that said, [CS] is also still a little bit niche, right? So still, it's interest driven. I mean, we don't force kids to sign up for computer science. They take it if they want it.

Dr. Lennon believed that student enrollment in CS courses is driven by interest, given its elective status, and took a more top-down view of CS course enrollment. Mr. Ray recognized the relationship between student interest and enrollment in CS but also suggested ways to increase enrollment numbers. He said,

> For my [CS] courses, some of them can be math and CTE and science. We just developed a Pathways document that explains which type of course fits which hole. And then oh, by the way, if you take any two of these three, this one and this one, you also get your Completer for CTE credit. One of the things I mentioned about APCSP and APCSA is that they are two sequential two courses that count as your CTE Completer course. So it actually solves multiple problems. And [it counts] as a science credit, and so it's like, Hey, guys, you need to knock out four birds with two stones, guess what? So we've been creating some, some documents with those. I get in front of counselors every November and share that information with them.

Mr. Ray referenced a collaborative effort to develop CS recruitment pamphlets that can help high school principals and counselors see how CS fits into a student's course sequence. His comment highlights his commitment to build sustainable efforts at the student level and the system level that create additional opportunities for students to pursue CS.

The high school principals shared multiple perspectives towards student enrollment in APCS courses. Dr. Frederick, Principal of Seaside High, stated, “Maybe it's what we're calling it. You know, people make sense of it based on what they think it is. We have to then attack that illusion or misconception or that it's more than that” Dr. Frederick added to his comment by explaining how CS is currently seen by others,

> I think we should be talking about it from the standpoint of, because I think what happens is we're sort of saying kids if you want a job, the jobs are in computer programming…but I think it's broader. I think we need to be highlighting all the things that it could be and help you with so they realize that this is a whole language that we may need to speak one day. It's just as important as Spanish.

Dr. Frederick conveyed that he believed CS is important for students to learn, but division leaders need to think about how they describe and advertise CS to students. For Mr. Gray, making CS a larger part of the conversation comes down to clear definitions of equity,

> From an equity perspective, I think it's a matter of not setting the bar low. I think they kind of sell our zoned kids short. So I think we need to encourage our students not only in computer science, but also all of our advanced level classes to try it and then if you need to fall back fine or if we need to scaffold our classroom instruction fine, but we don't put enough into the advanced level classes that we should.

He suggested that some collective “we” is not maintaining high expectations for low-wealth students. Mr. Gray is Principal of Lake High, where 33% of students qualify for the National School Lunch program. Dr. Hollis, who oversees a relatively diverse student body, expressed similar sentiments. Referring to a Black student who enrolled in APCSA but later unenrolled, she said, “I want him to, if he had done well and finished, be a model for individuals. I would like to let [students] see who's in [CS class], who can take [CS classes].” Dr. Johnson’s comment highlights that there is not necessarily diverse representation in Valley High School’s CS courses and that limited diversity might mediate student enrollment in CS courses.

Mr. Myler described how he personally can impact student enrollment in CS. He shared, “I just feel like the principals can be gatekeepers to certain things happening. A teacher down the hall can be extremely passionate about computer programming, and really wanting to try something. If I say no to that, it's done.” He claimed that he held the power to control CS course offerings, and subsequently student enrollment. He also said, “I would love if someone came and said, I want to really explore computer programming. Build that program. Who can I talk to? I got this outside group that wants to partner with me. I feel like that's my job to connect those. I just want to help connect resources.” Mr. Myler expressed a desire to use his power as principal to support teacher advocacy around CS.

Experiences in CS. Mr. Ray and Dr. Karmen made it clear that student experiences in CS are not equitable across the division. This is especially notable in Mr. Ray’s comment stating, “I'm not gonna sit here and pretend and be like, it's an equitable experience.” Despite inequities, Mr. Ray clarified how the central office is working to develop CS course sequences that promote student success in CS:

> We have kind of what we call our base computer programming course. It's a transition from block-based coding into Java. It's a low entry floor, very easy to start with, get the idea of object-oriented design, conception, understand it, and then start to get into the syntax conversation. There's that nice progression. The idea is when you walk out of that class, you should be completely comfortable and ready to tackle APCSA.

Mr. Ray showed that he thinks about CS course sequences and ensuring that students are prepared for advanced CS coursework like APCSA. He added, “We also have an introductory AP, is what we oftentimes call it. Kids just love it. It really has been one of the primary movers when it comes to increasing our female demographics and increasing our African American subgroups.” Mr. Ray, citing his personal observations, believed that Lily’s CS course sequence models have increased diversity in CS.

Dr. Hollis was the only high school principal to explicitly describe student experiences in CS. Referencing a specific Black student who is part of the LGBTQ+ community, she said,

> For me, it's understanding what's out there. What's available, what does it mean? What is computer science? What does it look like? Can I do this? And then if you don't meet that certain level of criteria for the course, per se, how can I help [student name], that's my person, [student name] is all colors, female, male, all of that. How can I help [student name], get into that class? And be serious about it? Because I can't stand just talking. We talk a whole lot. I want to put some action to it."

Dr. Hollis was concerned about how CS is promoted to students and how they receive support once they enroll in CS. She explained that school leaders need to continuously support students to succeed in CS. Dr. Hollis also added, "I like how I see students thrive, thrive in one computer class where they struggled in the math class. I thought that was funny, because we count that as a math credit." Adding to her thoughts on student success in CS, Dr. Hollis saw APCS as an alternative course for students who typically struggle with math.

The other three principals described disparities in CS that alluded to student experiences. For example, Dr. Frederick explained how disparities in student representation in CS at Seaside High are just gender-based, where he sees "a lot of males who are more into the video game scene" in APCS courses. Mr. Gray, also described the racial and gender demographics of students enrolled in APCS courses,

> The makeup of our academy is fairly even male to female. Predominantly White, some Indian. In the computer programming class, a handful of African American students, but again, surprisingly, it is as much females as males, and a lot of times students think it's male. I'm pleased by that. They are breaking down some of those stereotypical barriers. But again, not as much of a diverse representation as we would prefer.

Mr. Gray explained how academy students typically enroll in APCS courses and that the course is typically White and Indian students. His description of students matches current demographics of CS courses, alluding that the culture of APCS courses aligns with the exclusive culture of CS.

Cross-Case Synthesis: The Educational Debt

Deductive coding of the interviews revealed the presence of the educational debt (Ladson-Billings, 2006) in how the district and school leaders described CS course expansion in their respective contexts, Table 7 shows relationships between key trends across each state (Figure 3) and the ways the four different forms of the educational debt—the historical debt, the economic debt, the moral debt, and the sociopolitical debt—overlap with the CAPE framework.

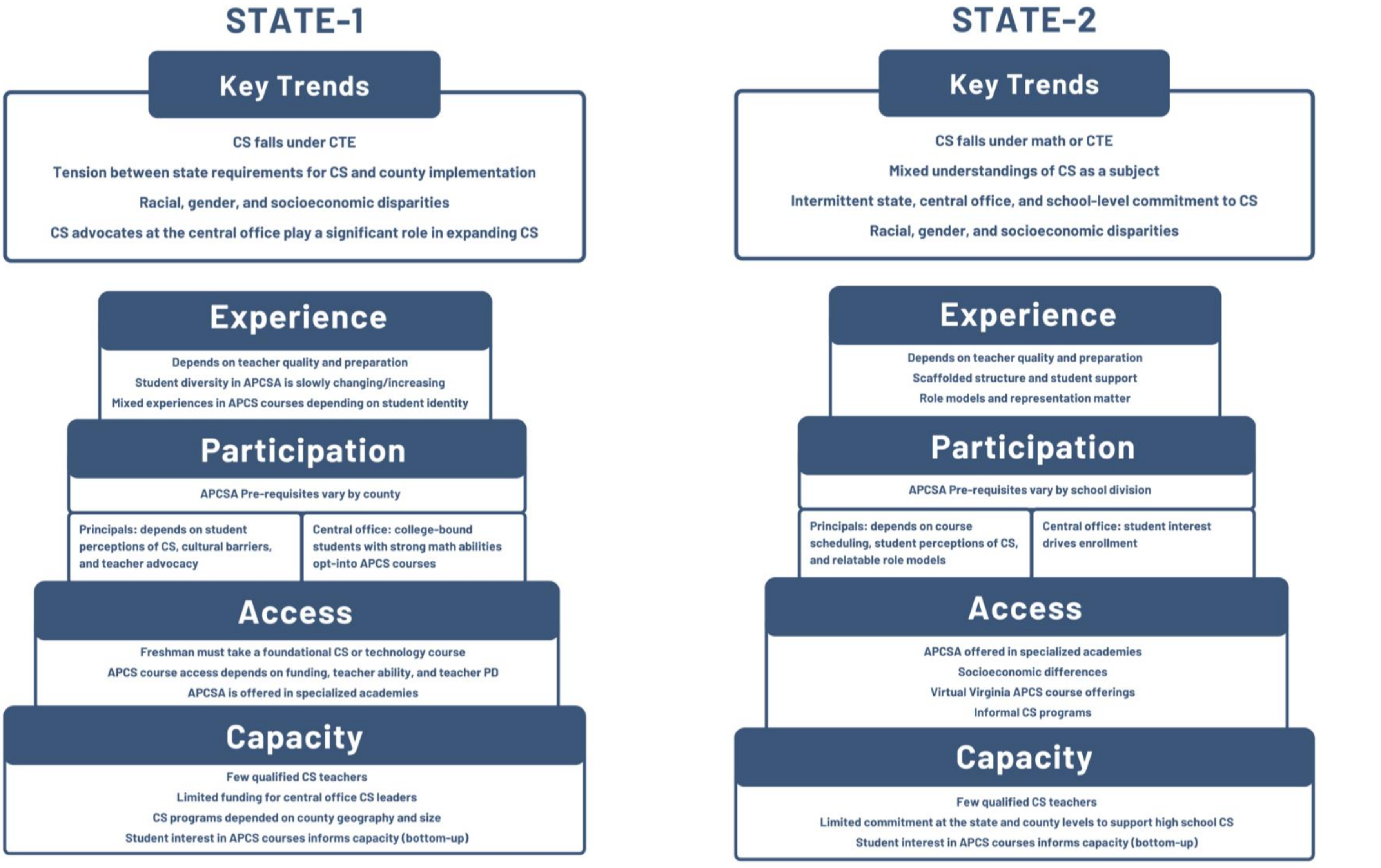


Figure 3. Key themes across the cases organized by the CAPE framework.

The Moral Debt	Description	Sample Quote
Capacity for CS		
Funding CS: Staff	Leaders support CS but do not dedicate enough resources to expand CS	"I need to have someone who can just dedicate a little time to move in these initiatives, because a lot of it is coming down the pipe quickly. As you know, CS is changing, technology is changing. And so really out there for us to learn and to have our students get prepared for…I'm spread all over the place, emails, directions." *-Mrs. Blake (Instructional Supervisor of CTE, Orchid, State-1)*
Action Paralysis	Leaders want to expand CS but don't know how to begin	"People support computer science, but they don't really know maybe even how to support it." *-Dr. Cameron (Principal of Promise High, Peony, State-1)*
The Economic Debt		
CS Course Access		
Socioeconomic Disparities	APCS courses are offered in high-wealth schools	"We went back and looked at our own enrollments and realized that the higher levels of computer science were not being taught at some of our schools that had higher levels of students with free and reduced lunch." - *Dr. Karmen (Director of CTE, Lily, State-2)*
Geographic Differences	Rural high schools have less access to APCS courses	"We have three schools that are in town, and that urban part that I was talking about. Then we have one middle/high school out in the rural part. And based upon student interest, the rural school has not had it as much." - *Dr. Parker (Assistant Superintendent & Chief Academic Officer, Peony, State-1)*
Specialized Academies	Exclusive application-based programs that expose students to APCS courses	"There is a lot of awesome computer science instruction happening at the high school level, But again, it's in pockets, in places where students are self-selecting. We do have a really fantastic satellite school." - *Mr. Beck (Director for Learning Technology Integration, Rose, State-2)*
The Historical Debt		
Participation in CS		
APCSA Student Demographics	Perceptions that APCSA is only for	**"**the computer science itself, the actual course, determines the demographics of that particular

	college-bound math students	course. The ones that are college prep, White." -*Mr. Bailey (STEM Center Director, Rose, State-2)*
Integration	CS should be a topic that all students learn	"How do we bring CTE into the technological world? Ya know, in auto tech, we just do brake pads and oil changes and spark plugs and maintenance. My goal is to augment that baseline thinking...If we do not do a better job of embedding [CS] skills and that understanding into everything, people are going to be at a disadvantage." -*Dr. Rowan (Director of CTE, Orchid, State-1)*
Definitions of CS	Disconnect in how CS is defined by leadership	"Because we have computer science courses, everybody thinks, oh, 'that's computer, that's a CTE thing,' and not 'that's curriculum and instruction'. So we've had a learning process in the division to understand that it is all of us that are responsible for [CS], not just me. -*Mrs. Rae (CTE Coordinator, Marigold, State-2)*
The Sociopolitical Debt		
Experiences in CS		
Leadership Identities	Mainly White and male leaders are making decisions that impact CS learning environments	"We have a few diverse students or diverse teachers, but I do not think that's the answer." -*Mr. Ripley (CTE Coordinator, Sunflower, State-1)*
Disconnected Leadership	Central office leaders with substantial decision-making power are race-evasive or avoid discussing student diversity in CS	"I can't answer that question. I'm not in the classroom. When I look at numbers, I just look at enrollment." -*Mrs. Harper (Director of School Counseling & College & Career Readiness, Marigold, State-2)*

Table 7. Summary of themes across the cases and educational debt subthemes.

The Moral Debt

Ladson-Billings (2006) describes the moral debt as reflecting "the disparity between what we know is right and what we actually do" (p. 8). The moral debt closely intertwined with the capacity level of the CAPE framework through how central office leaders described their approaches to establishing equitable CS education pipelines and the disconnect between these leaders knowing what is needed to bring CS to all students but feeling limited in their abilities to lead reform efforts. A clear example of the moral debt is in Mrs. Blake's quote highlighting her frustration towards being pressured to expand CS in Orchid County (State-1) and keep up with a changing CS education landscape while having few resources and support to do so. Mrs. Blake clearly is passionate about CS education, as well as other leaders in Orchid County, but they are expecting big outcomes from little input.

The moral debt and its connection to capacity was also evident in how the high school principals perceived and described central office support for CS education. High school principals, and some passionate central office CS advocates, felt that they were unable to meet the demands of an ever-changing CS education landscape. In Marigold School Division, Mrs. Harper expressed support for CS but seemed unaware of how overwhelmed Mrs. Rae felt with having all of the CS-related work fall on her shoulders. In both Rose and Marigold School Divisions, CS advocates at the central office level expressed frustration towards the state's lack of a clear plan for high school CS. Mr. Beck felt that without state support, the equitable expansion of CS was shadowed by competing priorities. Mrs. Rae also felt that the state's lack of commitment to high school CS pushed the subject to the wayside. In Peony County (State-1), high school principal Dr. Cameron explicitly stated that advocates for CS education "don't really know maybe even how to support it." Even though leaders across both states expressed support for CS, they do not, or don't necessarily know how to, establish the capacity to expand CS.

The Economic Debt

When describing the educational debt, Ladson-Billings (2006) states, "we must ask ourselves why the funding inequities map so neatly and regularly onto the racial and ethnic realities of our schools." District and school leaders' comments emphasized that the economic debt is impacting CS course access, specifically rural, low-socioeconomic, and lower tracked students. Orchid County (State-1) and Rose School Division (State-2) leaders confirmed that APCS courses are only offered at schools with robust STEM/computing academies that require student applications. For example, Mr. Beck admitted that CS course access is happening strongly "in pockets," namely opt-in specialized academies that are overwhelmingly male (Mr. Beck said diversity is increasing, but it is hard to confirm since the STEM Center's demographics are not publicly available). Dr. Parker, the Assistant Superintendent of Peony County, stated that rural students do not have access to CS, affirming that there is some sort of economic disparity between low-wealth rural schools and high-wealth schools in metropolitan areas. When comparing Sunflower County with Orchid County and Peony County, Sunflower's majority White students have greater access to APCS courses than Orchid County's and Peony County's majority students of color. These trends suggest that CS is inequitably mapped by race and/or wealth across the State-1 cases.

Funding disparities for CS in State-2 are even more striking; Both Dr. Karmen and Mr. Rey from Lily School Division (State-2) referenced data that shows gaps in CS course access by student race and family income-level. Additionally, Mr. Vere, Assistant Principal at Union High in Rose School Division, critiqued the inequities in the STEM Center's enrollment process, citing the influence of elite resources (internships, previous exposure to CS) and supportive role models. Across the State-2 cases, there is a clear division between who can learn CS (White and wealthy students) and who can't (low-wealth, students of color).

The Historical Debt

The historical debt refers to the history of the education system and its continuous exclusion of BLNA students from meaningful and high-quality educational opportunities. The school districts maintain the historical debt through how they define and classify CS. State-2 leaders expressed confusion around classifying CS under CTE and/or math and presented unclear definitions of CS. Associating CS with college-bound math students is dangerous because it promotes the narrative that CS is for a distinct student demographic; State-2 central office leaders were more likely than State-1 leaders to maintain stereotypical definitions of CS that suggest CS is only for “advanced” or “elite” students. In each of the State-2 cases, there was at least one high school principal who critiqued how CS was being presented to students and how existing pathways to enroll in APCSA are exclusionary and restrictive. For example, Dr. Hollis, a high school principal in Lily School Division, felt that leaders are not preparing students, especially Black students, to succeed in APCS courses. Mrs. Rae’s comments (Table 7) about her colleagues grouping CS into categories rather than seeing it as a cross-disciplinary subject also shows how State-2 leaders are still considering stereotypical perceptions of CS.

Across all of the interviews, APCS students were described as having parents who exposed them to computing early on, students interested in the subject, high performing students, students with strong math abilities, and typically students enrolled in prestigious STEM academies. These descriptions reaffirm stereotypes within the computing community that computer science is only for “nerdy” students who like math and perpetuate historical misconceptions of CS. However, although State-1 leaders also described limited diversity in APCS courses, there was a stronger commitment to eliminate barriers to elective APCS courses such as removing math prerequisites and hiring CS advocates who oversee CS. However, Dr. Rowan’s comments about CTE and who has the right to learn CS shows that historical perceptions of CS education prevail in Orchid County. He felt that in addition to the APCS courses, Orchid County could be making CS more accessible to students by showing that CS is not just an elective course but something that is used across all careers and disciplines. Dr. Riley from Peony County also referenced the culture of the CS community and the need to show students of all cultural backgrounds and races that they belong in CS.

The Sociopolitical Debt

The sociopolitical debt interrogates *who* holds decision-making power in society. I observed the sociopolitical debt through the central office leaders disconnect in what they *think* is happening in CS classrooms and what the principals describe *is* happening. Therefore, the sociopolitical debt was most evident when leaders described student experiences in CS.

At the district level, leaders typically placed the responsibility on students to enroll in CS courses. At the high school level, principals referred to factors like limited marking of CS courses to students and families, fragmented PK-12 CS course pathways, and limited coherence in central office commitment to CS education all impact student enrollment. As observed in Peony County (State-1), Rose School Division (State-2), and Marigold School Division (State-2), central office leaders are making decisions around high school CS from disconnected and isolated viewpoints. These power structures suggest that those who work directly with students (principals) are rarely heard and rarely contribute to division-level policymaking.

Unequal power in decision-making was also observed within central office positions. First, the mainly White and male leadership, with the exception of Orchid County (State-1), did not match the diversity of students in their local contexts. Therefore, we have evidence of the sociopolitical debt where leaders who do not understand the experiences of Black, Hispanic/Latino/a/x, and Native American/Alaskan Native students are making decisions about how these students should experience high school CS education. This is extremely concerning when leaders, like Mr. Ripley from Sunflower County (State-1) do not see diverse students and teachers as the solution to solving racial disparities in the CS education community (Table 7). Mr. Ripley's opinions do matter, because according to the Assistant Superintendent of Sunflower County, Mr. Ripley has the freedom to act as he chooses. It is also interesting that Sunflower County's Mr. Ripley, who is a White man with stereotypical experiences in CS, holds more decision-making power in his county than Mrs. Rae, a woman, and Mr. Beck, a member of the LGBTQ+ community.

In addition to making decisions that directly impact students of color, some of the central office leaders in charge of determing course requirements for APCS courses expressed knowing very little about the students who enroll in those courses. Dr. Emerson (Marigold School Division: Assistant Superintendent) directly stated that she could not describe student demographics in high school CS courses. Dr. Emerson's limited awareness is concerning since she holds the power to personally design policies that impact who can and cannot enroll in high school CS courses. Mrs. Rae, who works under Dr. Emerson, expressed that her passion to change high school CS course access was weakened by central office leaders' limited awareness of CS and their subsequent limited support for the subject.

Discussion

This study aimed to understand how district and school leadership in two states on the East Coast are attending to the levels of the CAPE framework: creating *capacity* for, *access* to, *participation* in, and positive student *experiences* in high school APCS courses while simultaneously mitigating the educational debt that BLNA students accrue. Findings indicate that there was a clear overlap between the educational debt and the CAPE framework, with the leaders' comments on capacity for, access to, participation in, and student experience in CS mapping directly onto specific aspects of the educational debt. Moreover, all four aspects of

Ladson-Billings’ (2006) educational debt theory are sustained across each case and manifest in similar, but sometimes, different ways.

A consistent theme across the central office leader interviews was that from their perspectives, the CAPE framework is flipped: they will only create capacity and access for CS education if students express an interest (enroll/participate) in CS. By associating student interest with capacity to establish CS education pipelines, central office leaders make APCS course access, and subsequent student enrollment, a *personal* responsibility rather than a *social* or *collective* responsibility (the moral debt). The central office leaders believed that without student interest, there is no need to shift resources away from other competing priorities like standardized testing, student course scheduling, and state expectations for academic achievement outcomes. The process of focusing on student achievement measures rather than the skills they need to succeed in a technologically oriented society reproduces social inequities by ensuring the wealthy and elite remain in positions of power (Au, 2022). In other words, their descriptions of student enrollment in APCSA takes the attention away the system and maintains race-neutral policy that fails to attend to the needs of BLNA students (Ladson-Billings, 2006). Therefore, it is critical that central office and school leadership have access to professional development opportunities that support them in understanding how CS fits into existing school structures and developing policies and practices that focus on school system structures rather than individual students.

The contrast between leaders' involvement with CS in State-1 compared to State-2 also emphasizes the importance of policy coherence between state, district, and school leaders and establishing capacity for CS education. Cohen and colleagues (2018) argue that effective educational reform depends on the ability of school systems to develop “coherent, system-wide instructional programs or coherent educational infrastructure to support such programs," or in other words, the *capacity* to implement reform (p. 205). In State-1, Orchid County and Sunflower County had consistent coherence between the central office and schools, which led to clear expectations around CS education. However, in State-2, Mr. Beck (Rose School Division) and Mrs. Rae (Marigold School Division) expressed frustration towards the limited infrastructure at the state and county levels to enact their instructional goals for high school CS education. Without this coherence, CS advocates like Mr. Beck, Mrs. Rae and State-2 high school principals were unable to translate their support for CS into practice; they found it difficult in their positions to dismantle historical perceptions of CS and funding inequities associated with APCS course distribution. Future research and policy should consider ways to support leaders at the central office and school level to develop comprehensive plans for CS education that align with the unique needs of each school system.

This study also highlights the power behind how PK-12 leaders market CS courses to high school students and the need to address historical perceptions of CS (the historical debt). Take Orchid County as an example: Dr. Quinn said the "science" part of "computer science" alludes to math and makes students afraid of CS, while Dr. Elliot said students were enrolling in APCSP because they marketed CS as a lucrative and successful career field. Across all of the cases, the APCS student was described as college-bound with strong math skills, reinforcing stereotypes of what a computer scientist may look like. Meanwhile, other principals like Dr. Hollis in Lily School Division referred to her observations of students succeeding in APCS courses and suggested that school leaders advertise APCS as an alternative math course for students who struggle with traditional algebra. Whatever the message, the principals' comments suggest that student perceptions of and experiences in CS are powerful recruitment tools to drive student enrollment in CS. Their comments align with existing research that shows how student voice positively impacts educational reform efforts (Charteris & Smardon, 2019; Dolan et al., 2015; Mitra, 2012). Most importantly, school district leaders should take care in how they promote CS to students and be conscious of the stereotypical perceptions that CS as a subject may bring. Future research that aligns with the CAPE framework may want to consider a top-down approach to CS course expansion by working with students to inform CS expansion efforts. Their input could help create sustainable capacity for, access to, and participation in CS.

Ample research shows an inequitable relationship between student access to and enrollment in APCS courses and schools serving high-wealth, White, and Asian students (Kapor Center, 2022; Parker & Hendrickson, 2022). The cases in this study are no exception and reemphasize that the economic debt is alive and well. APCSA course access and enrollment across Peony County (State-1) and Lily School Division (State-2) varies by race and socioeconomic status, with low-wealth, rural, and BLNA students having little to no access to APCS courses. Moreover, across all the cases, student enrollment in and funding for APCSA is associated with enrollment in/access to STEM academies, student math abilities, and prior exposure to CS either in elementary and middle school or support from parents/guardians. BLNA student enrollment also depends on mainly a disconnected White and male leadership that is making CS course decisions without truly understanding BLNA student experiences in CS (the sociopolitical debt). The relationship between the economic debt and the sociopolitical debt perpetuate structural inequities associated with CS course expansion by ensuring that funding for CS goes towards specialized academies, high schools with high access to technology, or schools with students and parents who have the power to advocate for APCS course offerings.

Limitations

Although this study shows how school system leaders from two different U.S. states think about and approach CS education in their local contexts, it is important to highlight a key limitation of the study: participant recruitment. The leaders' busy schedules or the county/division-specific external research application processes made it difficult to collect enough interview data to develop comprehensive cases. This limitation is especially evident with Marigold School Division (State-2), which had the least central office representation compared to the other cases. The limited interview data for central office leaders impacted my ability to identify rival explanations or conditions within the Marigold case specifically (Yin, 2009); rival conditions are additional hypotheses that can influence the outcome, or results, of a multiple-case analysis. If I had been able to interview the CTE lead in Marigold, I would have been able to corroborate Mr. Beck's comments about CS like I had done in the other cases. However, I only had Mr. Beck's viewpoint at the central office, which may not tell the whole story of CS in Marigold School Division.

In addition to participant recruitment, it is possible that by altering my research applications to exclude words like equity and race might have impacted the data collection process. For example, had I not edited the applications and continued to submit them as-is in State-2, it would have been interesting to see which school districts approved of the research and which didn't. However, by altering the research applications, I may have recruited school districts that would not have initially participated in the research and that provide strikingly different perspectives than the school districts that approved the more "controversial" research applications.

Conclusion

This study is a reminder that as CS continues to expand across the U.S., growth does not equate to equity. Regardless of if PK-12 leaders are a part of a thriving CS education ecosystem, they still face systemic barriers that limit student access to, enrollment in, and experiences in CS courses across racial and socioeconomic lines. The State-2 are a reminder of the importance of establishing capacity for CS education but also coherence between state, district, and school actors. Without this coherence, historical (mis)perceptions of CS can persist and create a harmful and exclusionary narrative that APCS courses are only for college-bound, elite, math-focused students.

This study also emphasizes a need for explicit definitions of equity when evaluating CS education reform using the CAPE framework. In this case, Ladson-Billings' educational debt theory allowed for a deeper analysis into the ways that school system leaders recognize and renegotiate their capacity for, student access to, participation in, and experiences in secondary CS courses. As the State-1 cases revealed, establishing capacity and access is an ongoing process that can be driven by, positive or negatively, student enrollment in and experiences in APCS courses. Harmful narratives that connect CS expansion with personal factors (student interest and achievement gaps) can diminish leadership's attention towards CS and conflict with equity goals. This study provides an opportunity for stakeholders to develop professional learning opportunities and cohesive CS education policies that encourage district and school leaders to shift the narrative around CS course expansion from a personal to a collective and social movement.

Chapter 5: PK-12 District and High School Leaders for Equitable Computer Science Education: Challenges and Opportunities

Executive Summary

Access to computer science (CS) education is growing across the U.S., with 57.5% of public high schools now offering a foundational CS class. Despite expressing support for CS, district and public high school leaders are divided in their perceptions of how CS is expanding in their local contexts. High school principals serving mainly Black, Hispanic/Latino/a/x, and Native American/Alaskan Native students, rural students, and students on the National School Lunch Program feel that their mainly White and male central office leaders could do more to address disparities in CS education in their schools. This brief:

- provides a national overview of U.S. district and school leadership's beliefs and perceptions of CS education,
- describes how district and school leaders are expanding CS in their local contexts (using two East Coast states as examples),
- reports how district and school leaders describe existing barriers in CS education for Black, Hispanic/Latino/a/x, and Native American/Alaskan Native students,
- recommends federal, state, and local education policies that can ensure the equitable expansion of CS education to *all* students.

Introduction

Technology permeates the modern world and drives societal innovation, from post-pandemic virtual education to important medical discoveries. How individuals choose to construct, use and consume this technology also directly impacts the world around them (Benjamin, 2022; Johnson & Wetmore, 2021). The intricate relationship between technology and society emphasizes the need for comprehensive PK-12 computer science (CS) education in U.S. public schools that prepares all students for a technologically driven world.

Recognizing the need for robust PK-12 CS education, stakeholders have invested in various national initiatives that aim to expand CS education to students across the U.S. (Code.org, 2023; CS for All, 2023; National Science Foundation, 2022). However, these efforts are exposing how CS course expansion fits into, and even exacerbates, existing racial, socioeconomic, and geographic disparities in U.S. PK-12 public schools. For example, Black, Hispanic/Latino/a/x, and Native American/Alaskan Native students, rural students, and students who qualify for the National School Lunch Program are less likely to attend a U.S. public high school that offers a CS course due to multiple factors such as limited school funding and resources for CS education and disparities in access to technologies associated with CS (Kapor Center, 2022). Even when CS is offered in a U.S. public high school, mainly White, Asian, and male students enroll in these courses (Kapor Center, 2022). Facing this reality, CS education researchers and stakeholders are committed to identifying the root causes of these inequities and creating policies and practices that dismantle harmful cultural and systemic structures within U.S. PK-12 CS education.

Recent studies have shown that central office and school-based leaders hold important decision-making power that can either uphold or dismantle disparities in CS education in their local contexts (Parker, 2022; Santo et al., 2020). Yet CS education reform focuses extensively on students, teachers, and curricula without considering the role that district and school leadership have in reform implementation. In a public PK-12 education system where the majority of superintendents are White men (89% White and 73% male) and PK-12 public school principals are White (77% White) begs a deeper analysis into the ways school district leaders are influencing CS course expansion in their respective areas. This brief synthesizes:

1) key results from two studies—
   a. statistical analysis of Google and Gallup (2020) data of U.S. PK-12 superintendent and
   b. high school principal beliefs and perceptions of CS education,
2) a case study analysis of six school districts,
   a. three in a Mid-Atlantic state and
   b. three in a Southern state.

The purpose of the brief is to shed light on how school leaders are approaching CS education in their local contexts. Federal, state, and local-level policies are also recommended.

Defining Support for CS Education: National Perspectives

In 2020, before the COVID-19 pandemic, 1479 U.S. PK-12 superintendents and 539 high school principals expressed relatively high levels of support for CS education in a national Google and Gallup (2020) survey. Google and Gallup's authors stated in their report titled, *Current Perspectives and Continuing Challenges in Computer Science Education in U.S. K-12 Schools*, that the majority of superintendents (75%) and principals (73%) say that offering computer science courses is just as important as offering subjects like English, math, history and science. Multiple regression analyses of this data revealed that the regions of the U.S. where superintendents and high school principals work, the average income level of their students, and the number of students they oversee (student enrollment) do not significantly predict their support for CS education. Exploratory factor analysis also showed that both groups of leaders hold similar definitions of what it looks like for U.S. PK-12 school leaders to personally support CS education in their local contexts (Figure 1).

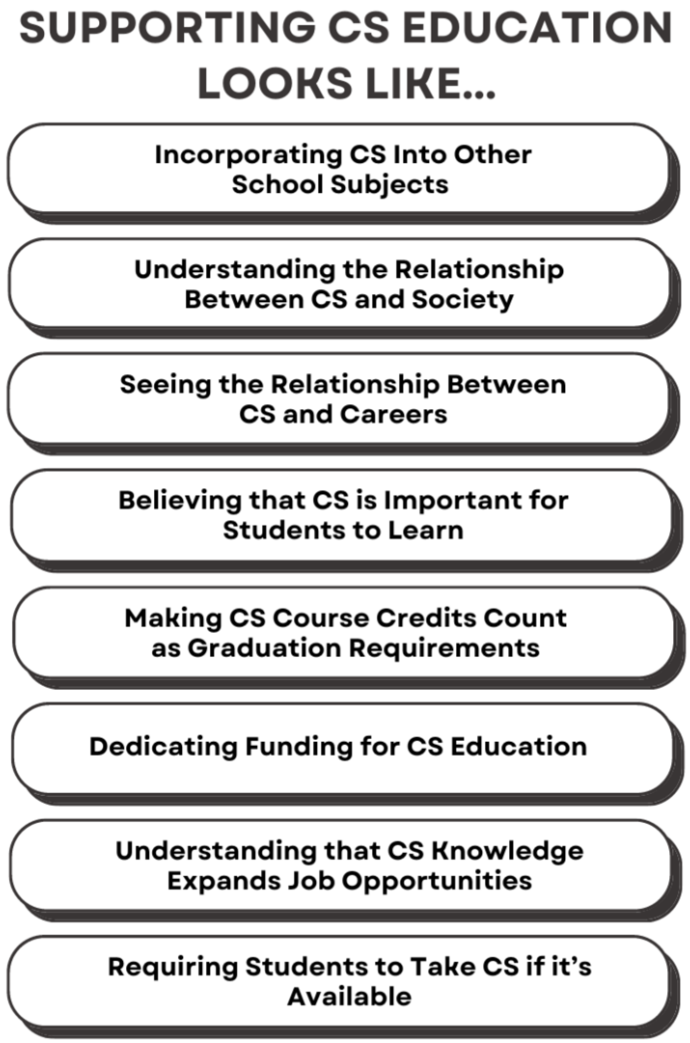


Figure 1. Exploratory Factor Analysis Results of Google and Gallup (2020) Survey Items that Revealed How U.S. PK-12 Superintendents and High School Principals Define Support for CS Education at a Leadership Level.

Disconnected Opinions: How Perceptions of Support Impact CS Education Reform

In the quantitative study, despite expressing high levels of support for CS education, multiple regression analyses of the Google and Gallup survey data revealed that PK-12 school district leadership in highly populated and high-wealth areas perceive greater stakeholder support for CS education than leaders who work in low-wealth and rural areas (Figure 2). These findings suggest that U.S. superintendents and high school principals who oversee larger student bodies and students from high-wealth backgrounds are more likely to perceive cohesive support for CS education from stakeholders like school board officials, parents/guardians, teachers, students, and central office staff. However, why do U.S. PK-12 superintendents and public high school principals who serve majority low-wealth students and/or rural students hold lower perceptions of stakeholder commitment to CS education in their communities? These perceptions can have direct negative consequences on low-wealth students and students in rural areas in terms of their access to CS learning opportunities. Additionally, these findings reinforce perceptions that CS education can only be expanded to wealthy students in high-tech, city-like areas.

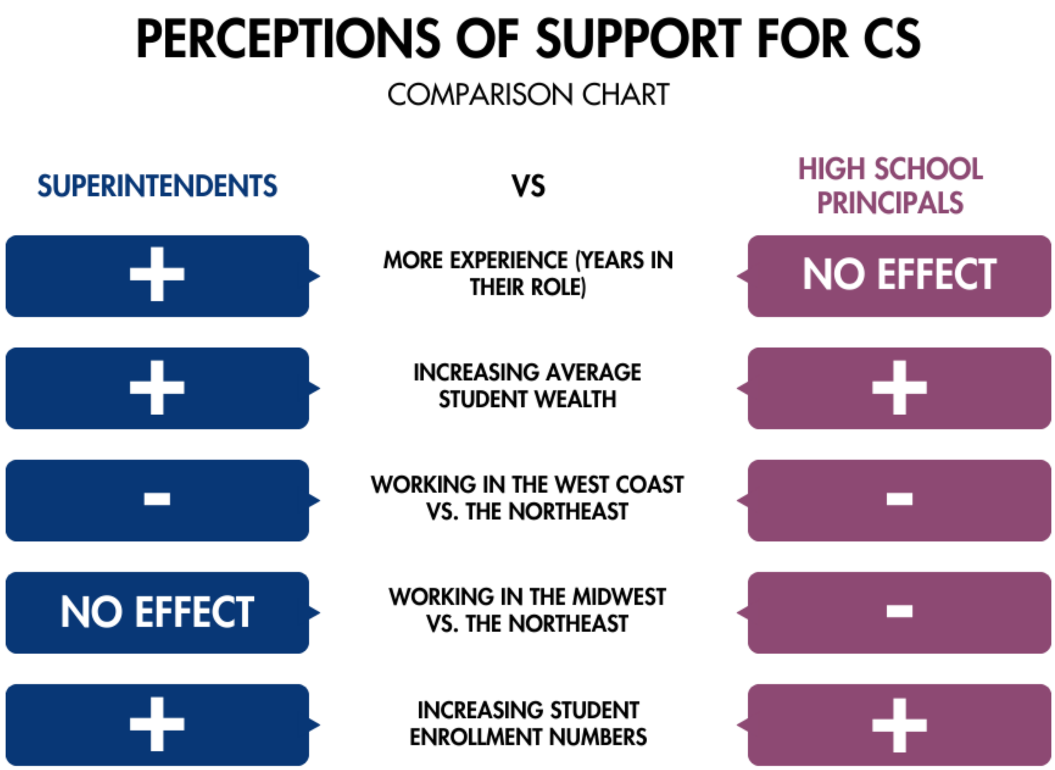


Figure 2. Factors that positively or negatively impact U.S. superintendent and high school principal perceptions of stakeholder support for CS education in their local contexts.

In addition to perceived fragmented support for CS education across socioeconomic and local geographic lines, perceptions vary regionally as well. U.S. PK-12 superintendents and high school principals in the Western part of the U.S. perceive lower stakeholder support for CS education than leaders in the Northeast. Google and Gallup classifications of states that fall into the different regions of the U.S. are provided in Table 1.

Region	
Northeast	New York, New Jersey, Pennsylvania, Connecticut, Massachusetts, New Hampshire, Vermont, Maine
Midwest	Illinois, Minnesota, Wisconsin, Michigan, Iowa, Indiana, Ohio, North Dakota, South Dakota, Nebraska, Kansas, Missouri
South	Maryland, Virginia, Washington D.C., Oklahoma, Texas, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Florida, North Carolina, South Carolina, Tennessee, Kentucky
West	California, Oregon, Washington, Montana, Idaho, Nevada, Wyoming, Colorado, Utah, Arizona, New Mexico, Alaska

Table 1. Google & Gallup's grouping of U.S. states by region.

Defining Support for CS Education: Local Perspectives

According to interview results with thirty central office leaders and high school principals from each state, both groups of leaders were aware of disparities in student enrollment in Advanced Placement CS courses in their respective school districts (Figure 3). They described Advanced Placement CS students as generally having strong math abilities, an invested interest in CS, and prior exposure to CS. Except for one school district that serves mainly Black students, leaders from the other five school districts described Advanced Placement CS students as being overwhelmingly White and male. Their descriptions align with the current demographics of students enrolling in Advanced Placement CS courses across the county (Code.org, 2023).

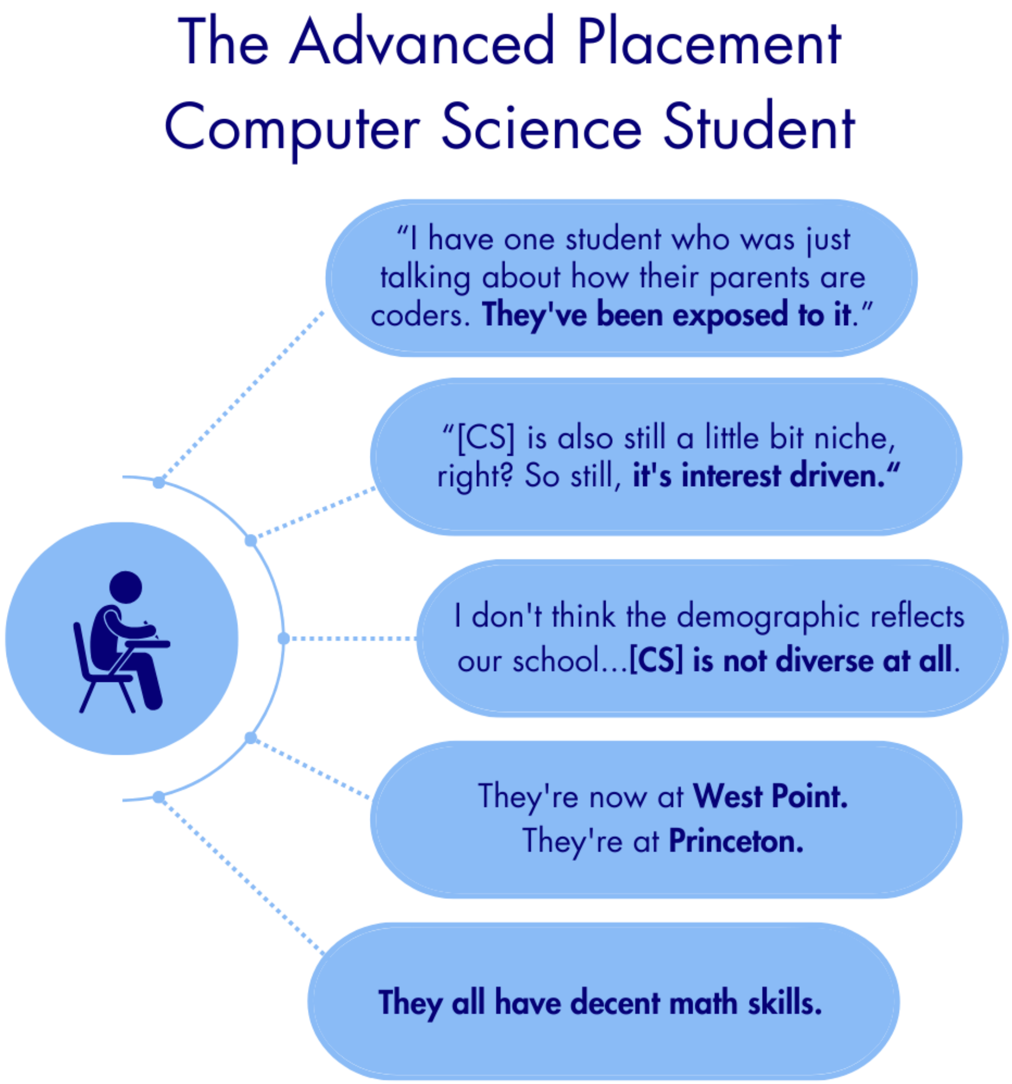


Figure 3. Central office leaders and high school principal descriptions of students who enroll in AP CS courses.

Both central office leaders and high school principals described the need for state and local leaders to take actionable steps to expand CS to all students (Figures 5-6). They specifically expressed frustration with how CS education is being handled at the state and local levels. Without intentional coordination between stakeholders and a shared commitment to expand CS education, the leaders believe that CS will remain an elusive field to most students.

Figure 4. Central Office Leadership Testimonials on Ways other Central Office Leaders and State Leaders Can Support the Expansion of CS Education.

Figure 5. High School Principal Testimonials on What They Believe Central Office Leaders Can Do to Support the Equitable Expansion of CS Education.

Despite the leaders expressing avid support for CS education, decision-making power typically fell into the hands of central office leaders who were either removed from CS classrooms or were unaware of their personal biases around CS education (Figure 7). Only in some cases did central office leaders provide examples where they used their power to address disparities. The central office leaders' comments reveal fragmented support for CS education in their local contexts. Additionally, like the quantitative data, the interviews confirmed that leaders of larger school districts had more positive perceptions of stakeholder support for CS education that leaders in smaller, more medium-sized school districts.

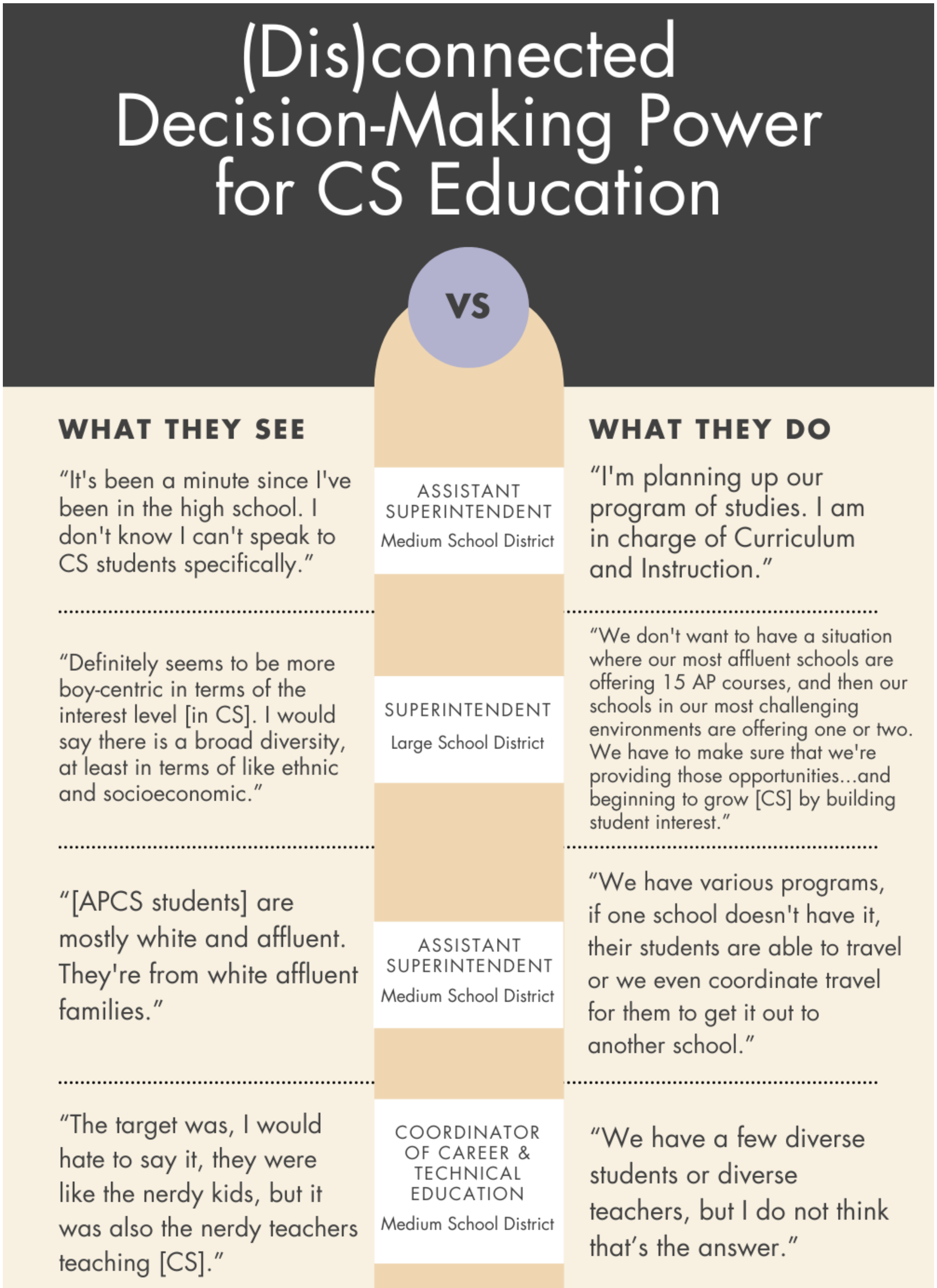


Figure 6. Central Office Leaders' Awareness of Disparities in Their School Districts Versus the Actions They Take to Address Those Disparities.

Policy Recommendations

Bringing high-quality CS education learning opportunities to *all* students requires dramatic policies that break repetitive cycles of inequity within the U.S. public PK-12 education system. Dr. Gloria Ladson-Billings (2006) provides examples of what a dramatic but *impactful* policy can look like:

> imagine that an examination of the achievement performance of children of color provoked an immediate reassignment of the nation's best teachers to the schools serving the most needy students. Imagine that those same students were guaranteed places in state and regional colleges and universities. Imagine that within one generation we lift those students out of poverty. (p. 7)

Referring to Dr. Ladson-Billings' examples, federal, state, and local leaders can break down racial, socioeconomic, and geographic disparities in U.S. public high schools by adopting the following policies:

Develop federal CS education mandates that require U.S. states to create comprehensive plans for PK-12 CS education.

With the growth of standardized testing in the U.S., state departments of education now hold extensive power in local school funding and policymaking (Vinovskis, 2019). The most recent Code.org report (2023) on the state of CS education in the U.S. revealed that only 30 U.S. states have state plans in place for CS education. Within these 30 states, nine (30%) do not require high schools to teach CS. Although central office and high school principals believe that CS is important for students to learn, their states either don't have the structures in place to enact CS education or they are unsure how to translate their support into actionable reform. U.S. states must develop concrete plans for CS education that emphasize unified support for CS education. By doing so, school district leaders will feel secure in their state's commitment to fund CS education and allocate resources to develop robust CS education pipelines in each school district.

If mathematics and reading are mandated subjects in the U.S. because of their relevance to student success in society, why can't CS take on the same level of importance?

Allocate federal and state funding for central office and high school leadership professional development for CS education.

The CS education community is committed to establishing teacher education and professional development pipelines to sustain a CS teacher workforce in the U.S. (Code.org, 2023). Despite the critical role that teachers play in both expanding CS education in local school systems and ensuring students have positive experiences in CS, too little attention is given to the leaders in charge of funding and organizing CS teacher development. Central office leaders and high school principals also need professional support to implement CS education initiatives (Santo et al., 2020). In addition to allocating funds for CS teacher professional development, states should devote funds to central office and school administration professional development to help district and school leadership develop comprehensive plans and coherent support for CS education.

Develop state-specific CS course sequences for PK-8 education that prepare all students for elective Advanced Placement CS.

Despite efforts to expand CS education at the elementary and middle school levels, there remains a disconnect between K-8 and high school CS education. More specifically, students from high-wealth backgrounds or who attend schools with fewer students on the National School Lunch Program are more likely to be exposed to K-8 CS education (Code.org, 2023; Kapor Center, 2022). These disparities at the K-8 level leave low-wealth students unprepared to enroll in CS courses in their first year of high school, a time that central office leaders and high school principals believe predicts whether a student enrolls in APCSA. In addition to developing coherent PK-12 CS education standards that align elementary, middle, and high school CS learning experiences, states should consider creating K-8 CS course sequences that *all* students are required to take. By doing so, every student will have the opportunity to explore CS prior to starting high school and have the necessary skills to pursue higher-level, elective CS courses like APCSA.

Create a state-level longitudinal data system to track student enrollment in middle and high school CS courses.

Some states, like Maryland, (MLDS) track high school student enrollment in CS across the state as well as whether these students later pursue a computing-related degree (Maryland Longitudinal Data System, n.d.). In addition to Maryland, 78% of U.S. states have state-wide longitudinal systems in place (Education Commission of the States, n.d.). However, they do not necessarily track student enrollment in CS education. States should hire a state-level CS advocate to collect data on middle and high school student enrollment in CS. This data could be critical in identifying patterns in disparities in access to CS education in local school districts, determining which school systems are successful in designing middle to high school pathways for students to enroll in APCS courses, and developing robust state plans for PK-12 CS education.

Distribute district funds to hire a CS advocate for each school district.

In addition to having advocates at the state level, districts can benefit from having distinct-level advocates for CS. Similar to instructional leads for mathematics, reading, and science, school districts should hire an instructional lead who focuses explicitly on CS. Career and Technical Education (CTE) can serve as CS advocates, but they must also oversee CTE-specific competing priorities. By hiring a central office instructional lead for CS education and allowing these leaders to have their own staff/division, can alleviate the pressures that current

CTE coordinators feel with having to balance their responsibilities in overseeing PK-12 CS education *and* CTE.

Conclusion

CS education research and policy must focus on school district leaders and school leaders. While the majority of U.S. PK-12 superintendents and high school principals express support for CS education, CS education advocates feel that their district leaders are stuck: central office leaders want to expand CS education but do not necessarily know how to. This policy brief emphasizes the need for federal and state-level leaders to design policy that clarifies the role of CS education in public PK-12 education, especially at the high school level. Without clear guidance from these levels, district and school leaders must navigate fragmented beliefs, processes, and structures as they try to bring CS education to their students. Federal and state-level policy plays a critical role in ensuring that CS education reaches all students, not just the wealthy and White elite.

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