CULTURALLY RESPONSIVE-SUSTAINING CS EDUCATION:
A FRAMEWORK

KAPOR CENTER

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BACKGROUND

Computer Science as a Foundational Literacy

As technological innovation and advancement continues to impact all industries and sectors of the economy, influencing every aspect of our lives including how we work, learn, and communicate, computational literacy is critical for all students. Equitable access to computer science education is a national and critical priority. Prioritizing equitable access to computer science will help to address racial and economic disparities in the tech sector; drive creativity, innovation, and problem-solving; prepare a diverse tech workforce to meet the future needs of our economy; and ensure students develop core computing literacies while understanding social, cultural, and political impacts of technology.

Inequality in Computer Science Education

Despite the increased significance of computer science education, computational thinking, and computing literacy across all fields and occupations, access to computer science education is unequally distributed by race, gender, socioeconomic status, and geography. Just 47% of high schools in the U.S. offer computer science courses. Black, Latinx, and Native American students and those in schools serving low income communities are significantly less likely to have access to CS courses in their schools. Moreover, while Black, Latinx, and Native American students comprise 43% of U.S. K-12 enrollment, they represent just 23% of students taking AP CS courses. Girls also face similar disparities, with only 29% of girls taking AP CS courses despite representing a greater percentage of the K-12 population. Additionally, Black, Latinx, Native American and Pacific Islander students, low-income students, students with disabilities, and girls face additional barriers that impede their opportunity to participate in CS coursework. These barriers range from stereotypes about computing, lack of understanding of the discipline of computer science, to lower expectations for success, lack of inclusion and belonging in CS classroom environments, and lack of engaging and culturally relevant curriculum. Inequality in computer science education is situated within a context of significant historical inequality across societal institutions broadly, and in education specifically. Disparities in school funding and access to resources, such as broadband and technology devices, qualified and certified teachers, and rigorous STEM and computer science courses, limit students' opportunities for educational success. More broadly, a history of systemic racism and inequality negatively impacts outcomes in education, employment, housing, income, wealth, health, and life expectancies of communities of color.

Toward an Equitable Future for Computer Science Education

While much of the focus of broadening participation in computer science efforts has centered around increasing access to courses, access alone is insufficient and significant disparities remain. We believe that a multi-pronged approach centering racial justice is required to ensure meaningful participation, success, and matriculation in computer science education for students from all demographic backgrounds to close racial, gender, and socioeconomic equity gaps. This approach must address foundational educational disparities, create equitable policies at the federal, state and local levels, and invest deeply in the development of teachers, pedagogical practices, and curriculum that reflect and sustain students' cultures, experiences, and interests. Yet, we know from our survey of 3,700 CS teachers that less than 60% of CS teachers felt equipped to utilize culturally relevant pedagogical practices, believed existing curricular resources were culturally relevant, or felt confident incorporating critical discussions of computing's role in society and driving inequality. Toward that end, this empirically and theoretically-driven framework articulates an approach for designing and implementing equitable and culturally responsive pedagogical practices within computer science classrooms.

A FRAMEWORK FOR CULTURALLY RESPONSIVE-SUSTAINING CS EDUCATION:

Recognizing the need for a research-driven framework to design and implement equitable and culturally responsive-sustaining pedagogy within computer science classrooms, we have developed the **Culturally Responsive-Sustaining CS Framework** for K-12 computer science education. The **Culturally Responsive-Sustaining CS Framework** builds upon decades of theory and research on culturally relevant and responsive pedagogy across disciplines and was developed in partnership with researchers, practitioners, teachers, students, and other education advocates. The framework is intended to guide teacher preparation and professional development, curriculum development, and policies for developing a robust pipeline of CS teachers that will ultimately ensure greater adoption of culturally sustaining practices within computer science classrooms, close equity gaps in computer science, and improve the outcomes of marginalized students in computer science education. It is our intention that this framework will help to move the needle on equity in computer science education. We anticipate that the framework and its utilization will continue to evolve and be refined over time.

The process for developing, refining, and reviewing the framework was completed over a period of several months during 2020 and 2021. The project team reviewed relevant literature and co-created a draft framework with members of the National Advisory Board (which consisted of nine dynamic thought leaders with expertise in racial equity, social justice, community building, and CS education). The framework draft was then reviewed and edited by the National Advisory Board, the National Student Leadership Team (comprised of nine high school students representing nine communities in seven states); CSTA Equity Fellows, K12 computer science teachers, national experts in equity, inclusive and culturally responsive K-12 teaching; and other leaders and scholars within the national K12 computer science education community.

There are two elements to this framework:

01

A **shared definition** of culturally responsive-sustaining computer science classroom pedagogy

02

Articulated **core components** for implementing culturally responsive-sustaining computer science pedagogy

Definition: Culturally Responsive-Sustaining CS Pedagogy

Culturally responsive-sustaining computer science pedagogy is situated within a context of racial, socioeconomic, and gender inequality in computer science education. It articulates a strategy to move beyond increasing access to computer science courses and ensure all students have the opportunity to be inspired and engaged in computing education, develop critical computational skills, and have equitable opportunities to pursue computing careers and contribute to technological innovation. **Culturally responsive-sustaining computer science pedagogy ensures that students' interests, identities, and cultures are embraced and validated, students develop knowledge of computing content and its utility in the world, strong CS identities are developed, and students engage in larger socio-political critiques about technology's purpose, potential and impact.** Culturally sustaining computer science pedagogy includes: the teacher's instructional practice, the curriculum, resources, and activities used in the classroom, as well as the instructional design practices utilized by the teacher. Culturally responsive-sustaining computer science instruction is necessary but not sufficient to achieve equity in computer science education. It must be implemented alongside broader solutions to dismantle racism and inequity in education, employment, health, and the environment, all of which disproportionately negatively impact marginalized communities.

Six Core Components:

The Six Core Components of the framework serve as guidance for any educators seeking to create culturally sustaining, equitable, and inclusive K-12 computer science classrooms. The core components are complemented by additional details about ways that these components can be enacted. It is our goal that a range of K-12 educators, including teachers, instructional coaches, administrators, and curriculum providers utilize these six core components to directly inform their instructional practices, curriculum development, and approaches to implementing equitable K-12 computer science education.

01 Acknowledge Racism in CS and Enact Anti-Racist Practices

02 Create Inclusive and Equitable Classroom Cultures

03 Pedagogy and Curriculum are Rigorous, Relevant, and Encourage Sociopolitical Critiques

04 Student Voice, Agency, and Self-Determination are Prioritized in CS Classrooms

05 Family and Community Cultural Assets are Incorporated into CS Classrooms

06 Diverse Professionals and Role Models Provide Exposure to a Range of CS/Tech Careers

CORE COMPONENT	COURSE OF ACTION
01 The role of racism and white supremacy and its manifestation in computer science education is understood and acknowledged. Anti-racist practices and the decentering of whiteness are enacted within computer science courses and classrooms.	Educators explore their own identities (racial, gender, cultural, ethnic, linguistic, religious, socioeconomic, etc.) and positions of privilege and power/oppression
	Educators demonstrate awareness of white supremacy and racism in education, computing, and CS classrooms as well as commit to ongoing learning to understand systemic racism as a part of their committment to anti-racist and trauma informed pedagogy
	Educators actively use language to call out racism and decenter whiteness in CS courses
	Educators explicitly teach and engage in anti-racist/anti-bias and trauma-informed practices in CS
02 Inclusive and equitable classroom cultures are co-created to cultivate meaningful learning experiences for students and ensure belonging for students from all backgrounds. Individual and collective identity exploration are utilized as tools to create inclusive classrooms, ensure belonging for all students, and ensure equity.	Educators actively and intentionally confront and dispel stereotypes and biases about the abilities and skills of students from groups marginalized in CS
	Educators actively explore, understand, and reflect upon their own identities, positionality, power, and privilege, how these constructs reside/operate within society and computer science
	Educators honor and affirm students' intersecting identities within curriculum, instructional practices, and classroom culture and support students' navigation of CS and society at large
	Educators intentionally recruit students with disabilities, Black, Native American, Latinx students, girls, and non-binary students into CS courses
	Educators help students explore their identities to develop CS projects that reflect their passions and interests
	Educators deliberately establish an accessible classroom community that recognizes, respects, and includes the voices, ideas, needs, and perspectives of all students by engagement in consistent class check-ins, advisory, and student feedback sessions

CORE COMPONENT

COURSE OF ACTION

03 **Pedagogy and curriculum is rigorous — aligned to K-12 CS standards and high expectations are set for all students; relevant — is authentic to students' experiences, interests, and cultures; and examines current and historical socio-political contexts within which CS is situated.**

Educators ensure curriculum is high-quality, rigorous, challenging, and aligned to state and national standards

Educators support students in learning about the history of their respective communities, honor their ethnicities and cultures, and incorporate their cultures, interests, and passions into the learning process

Educators actively seek out vetted resources and regular opportunities to learn about the current and historical cultures of their students

Educators utilize pedagogy and curriculum which equips students to critically examine technology and interrogate its role in society, as well as its ethical, political, and societal implications

04 **Student voice, student agency, and self-determination are valued, encouraged, and incorporated during the CS learning process. Student ideas and input are actively solicited from students to co-create classroom instruction.**

Educators incorporate student voices and perspectives throughout the curriculum and classroom experience, engaging them as cultural experts

Educators engage students as emerging experts to lead activities, support peer-to-peer teaching and learning, and encourage ongoing feedback

Educators honor and respect the diverse ways that students process and learn information, striving to be mindful and inclusive in their engagement

CORE COMPONENT

COURSE OF ACTION

05 **Families and communities — and their cultures and assets — are incorporated into the design of CS curriculum, classrooms, and learning opportunities. Families and community members are intentionally sought out and included in the construction of CS classroom learning and activities.**

Educators value and consult with families and community members and incorporate their perspectives into CS

Educators partner with community-based organizations to build interest in CS among students and families and encourage the learning of CS inside and outside of the classroom

Educators encourage and invite families and communities to engage in learning CS for their own knowledge, growth, as well as to support student learning
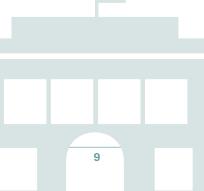
Educators align CS content and instruction with in-school and out-of-school experiences, cultures, and perspectives

06 **A diverse variety of experts are incorporated into the classroom (including researchers, community members, entrepreneurs, tech leaders) to intentionally expose students to a variety of computing professionals and careers. Specific efforts are taken to identify role models from diverse identities, backgrounds, careers, and trajectories.**

Educators expose students to a range of computing and technology-related careers, programs, and opportunities that are aligned to student interests

Educators actively build relationships with members of the local and national tech community who can lend their knowledge and expertise to the classroom experience

Educators actively seek out and recruit diverse guests and experts representing underrepresented or marginalized groups in computing

Educators leverage a variety of tech tools to introduce students to industry professionals and career pathways into their classroom, especially when in-person opportunities are a challenge

ABOUT US

The Equitable CS Initiative. The Equitable CS Initiative is a multi-year endeavor designed to create equitable computer science education experiences for children and youth in grades K-12. We will achieve this through intentional and collaborative efforts that dismantle racism and bias, center CS learning on student assets, culture and experience, and elevate the value that families and communities bring to the learning process. There are six different elements in this project: (1) *A shared definition* of culturally sustaining computer science classroom pedagogy, (2) An articulated *core practices* for implementing culturally sustaining computer science pedagogy, (3) An articulated *set of competencies* for students in the computer science classroom, (4) A series of *rubrics/scorecards* to examine whether culturally sustaining instruction is being implemented at the classroom, school, and system level, (5) A set of *modules* providing a comprehensive examination of each core practice of the framework, and (6) A virtual *professional learning community* for teachers to share, learn, and grow while implementing this framework. This initiative is guided by an Advisory Board of CS education experts, a student leadership team, and is informed by and builds upon empirical and theoretical research literature. Ultimately, we aim to ensure CS educators are equipped with resources and strategies needed to create and develop engagement, identity, and persistence in computing pathways for Black, Latinx, Indigenous, girl, and gender non-binary students, to ensure they have equitable opportunities to pursue computing pathways in K-12, college and career.

KAPOR CENTER

The Kapor Center aims to enhance diversity and inclusion in the technology and entrepreneurship ecosystem through increasing access to CS and STEM education, advancing diversity and inclusion in tech companies, and investing in community organizations, diverse entrepreneurs, and gap-closing social ventures. The Equitable CS Initiative is one of our key initiatives and part of a broader focus on equity in computer science education.

APPENDIX 1. KEY TERMS

Culturally Relevant Pedagogy: Culturally relevant pedagogy includes three core principles: (1) academic achievement, (2) cultural competence, and (3) critical consciousness. Culturally relevant teaching must develop students academically, demonstrate a willingness to nurture and support cultural competence, and support the development of a sociopolitical or critical consciousness (Ladson-Billings, 1995)

Culturally Responsive Pedagogy: Culturally responsive pedagogy is defined as a framework for teaching that uses cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant and effective for them (Gay, 2010). Culturally responsive pedagogy is enacted in instructional techniques, instructional materials, student-teacher relationships, classroom climate, and self-awareness to improve learning for students.

Culturally Sustaining Pedagogy: Culturally sustaining pedagogy builds upon culturally relevant and responsive pedagogy and seeks to perpetuate and foster linguistic, literate, and cultural pluralism (i.e., preserves the unique cultural identities and histories of all students) as part of the democratic project of schooling and sustains the cultural practices of communities of color (Paris and Alim, 2017)

Culturally Responsive Computing: Culturally responsive computing, whose roots are based in culturally responsive teaching is defined as, "a strategy constructed to engage culturally and linguistically diverse youth, concerned with empowerment, transformation, validation, comprehension, multidimensionality and emancipation." CRC proposes five tenets: (1) All students are capable of digital innovation, (2) The learning context supports transformational use of technology, (3) Learning about one's self along various intersecting sociocultural lines allows for technical innovation, (4) Technology should be a vehicle by which students reflect and demonstrate understanding of their intersectional identities, (5) Barometers for technological success should consider who creates, for whom, and to what ends rather than who endures socially and culturally irrelevant curriculum (Scott, Sheridan, and Clark, 2015)

Culturally Responsive-Sustaining Computer Science Pedagogy ensures that students' interests, identities, and cultures are embraced and validated, students develop knowledge of computing content and its utility in the world, strong CS identities are developed, student, family, and community voices and experiences are validated, and students engage in larger socio-political critiques about technology's purpose, potential and impact. This definition builds upon culturally relevant, responsive, and sustaining pedagogy and culturally responsive computing (CRC) to articulate a clear framework for equitable computer science instruction.

Computer Science: Computer science is defined by the Association for Computing Machinery as the "study of computers and algorithmic processes, including their principles, their hardware and software designs, their implementation, and their impact on society." Computing is a broad term defined by the Association for Computing Machinery as "any goal-oriented activity requiring, benefiting from, or creating computers... including five sub-disciplines of computer science, computer engineering, information systems, information technology and software engineering." The terms computing, computer science, and the abbreviation "CS" are used interchangeably throughout this framework.

APPENDIX 2. REFERENCES

Computer Science Education Frameworks:
- K-12 Computer Science Framework
- CSTA Standards for CS Teaching
- CS for CA: CS Equity Guide
- Code.org Nine Policy Ideas to Make CS Fundamental in K-12
- The Teacher Accessibility, Equity & Content (TEC) Rubric for Evaluating Computing Curricula
- CS Visions: Diverse Visions of CS Education in Practice

Culturally Relevant and Responsive Frameworks and Rubrics:
- Culturally Responsive-Sustaining Education Framework (New York State Department of Education)
- Culturally Responsive Curriculum Scorecard (NYU/Steinhardt)

Culturally Relevant/Responsive/Sustaining Research and Theory
- Toward a Theory of Culturally Relevant Pedagogy (Ladson-Billings, 1995)
- Culturally Responsive Teaching: Theory, Research, and Practice (Gay, 2000)
- Culturally Responsive Teaching and the Brain (Hammond, 2014)
- Culturally Sustaining Pedagogy : A Needed Change in Stance, Terminology, and Practice (Paris, 2012)
- Culturally Sustaining Pedagogy: A Critical Framework for Centering Communities (Alim, Paris & Wong, 2020)
- Cultivating Genius: An Equity Framework for Culturally and Historically Responsive Literacy (Muhammad, 2020)
- Guide to Racial Justice & Abolitionist Social and Emotional Learning (Abolitionist Teaching Network)
- We Want To Do More Than Survive: Abolitionist Teaching and the Pursuit of Educational Freedom (Love, 2020)
- Cultural Revitalizing Pedagogies: Critical Culturally Sustaining/Revitalizing Pedagogy and Indigenous Education Sovereignty, (McCarty & Lee, 2014)
- But That's Just Good Teaching! The Case for Culturally Relevant Pedagogy (Ladson-Billings, 2009)
- Culturally Responsive Teaching as an Ethics and Care Based Approach to Urban Education (Shevalier & McKenzie, 2012)
- Educating All Students: Creating Culturally Responsive Teachers, Classrooms, and Schools (Brown, 2014)
- Operationalizing Culturally Relevant Pedagogy: A Synthesis of Classroom-Based Research (Morrison et al., 2008)

Culturally Relevant/Responsive/Sustaining CS/STEM Education
- Culturally Responsive Computing: A Theory Revisited (Scott, et al., 2015)
- Culturally Relevant CS Pedagogy: From Theory to Practice (Madkins et al., 2020)
- Culturally Responsive Computing As A Brokerage: Toward Asset Building With Education-Based Social Movement (Lachney, 2016)
- Toward Culturally Responsive Computing Education (Eglash et al., 2013)
- Animal tlatoque: Attracting Middle School students to Computing Through Culturally-Relevant Themes (Franklin et al., 2011)
- Attracting Native Americans to Computing (Varma, 2009)
- Bridging the Diversity Gap in Computer Science with a Course on Open Source Software (Weng & Murphy, 2018)
- Assuming Brilliance: A decriminalizing approach to education African American and Latino boys in elementary school STEM settings (Basile & Lopez, 2018)
- Creating Access and Opportunity: Preparing African-American male students for STEM trajectories PreK-12 (Wright et al.,2016)
- Computational Thinking for All: Pedagogical Approaches to Embedding 21st Century Problem Solving in K-12 Classrooms (Yadav, 2016)
- Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes (Cheryan et al., 2015)
- Democratizing computer science knowledge: transforming the face of computer science through public high school education (Ryoo et al., 2012)
- Increasing Diversity in K-12 Computer Science: Strategies from the Field (Goode, 2008)
- This is What Diversity Looks Like: Making CS Curriculum Culturally Relevant for Spanish-speaking Communities (Miranda et al., 2019)

Equity, Inclusivity and Racism in Schools and CS/STEM

- Ambient Belonging: How Stereotypical Cues Impact Gender Participation in Computer Science (Cheryan et al., 2009)
- Avoiding Racial Equity Detours (Gorski, 2019)
- An Ecological Model of STEM Education: Operationalizing STEM for all (Basham et al., 2010)
- Guide to Inclusive Computer Science Education (Microsoft, 2019)
- Eliminating Racism in the Classroom (Morgan, 2021)
- Embedding and Sustaining Inclusive Practices in STEM (McPherson et al., 2019)
- Exploring Intersectionality in Education: The Intersection of Gender, Race, Disability, and Class (Petersen, 2006)
- Good Teaching? An Examination of Culturally Relevant Pedagogy as an Equity Practice (Schmeichel, 2012)
- Humanizing Pedagogy: Beliefs and Practices on the Teaching of Latino Children (Huerta, 2011)
- Inclusive STEM High School Design: 10 Critical Components (Peters-Burton et al., 2014)
- Influencing Middle School Girls to Study Computer Science Through Educational Computer Games (Stewart-Gardiner, 2013)
- Schools as Racial Spaces: Understanding and Resisting Structural Racism (Blaisdell, 2016)
- Take Space, Make Space: How Students Use Computer Science to Disrupt and Resist Marginalization in Schools (Ryoo et al, 2020)
- The Computer Science Teacher Landscape: Results of a Nationwide Teacher Survey (Koshy et al, 2021)
- Understanding STEM Education and Supporting Students Through Universal Design for Learning (Basham & Marino, 2013)
- Weaving Cultural Relevance and Achievement Motivation into Inclusive Classroom Cultures (Kumar et al., 2018)

Ethical and Sociopolitical Considerations in CS

- Ethics, Identity, and Political Vision: Toward a Justice-Centered Approach to Equity in Computer Science Education (Vakil, 2018)
- Embedded EthiCS: Integrating Ethics Broadly Across Computer Science Education (Groscz et al., 2018)
- It's About Power: A Call to Rethink and Equity in Computing Education (Vakil & Higgs, 2019)
- Culturally Situated Design Tools: Ethnocomputing from Field Site to Classroom (Eglash et al., 2006)
- Exploring Politicized Trust in a Racially Diverse Computer Science Classroom (Vakil & Mckinney de Royston, 2019)
- Let's Teach Computer Science Majors to be Good Citizens. The Whole World Depends on It. (Núñez et al., 2021)
- Race After Technology: Abolitionist Tools for the New Jim Code (Benjamin, 2020)
- Algorithms of Oppression: How Search Engines Reinforce Racism(Noble, 2018)

Developing Student Voice, Agency, and Identity in the Classroom and Computing:

- Connecting Computer Science Education to Students' Passions: A Critical Step Toward Supporting Equity in CS Education (Ryoo et al, 2019)
- A threat in the air. How stereotypes shape intellectual identity and performance (Steele, 1997)
- Leveraging Technology: How Black girls enact critical digital literacies for social change (Garcia et al, 2020)
- A qualitative investigation of factors promoting the retention and persistence of students of color in STEM (Palmer et al., 2011)
- Willing, Able and Unwanted: High School Girls' Potential Selves in Computing (Kelly et al., 2013)

Community Perspectives and Funds of Knowledge

- Leveraging Local Resources and Contexts for Inclusive CS Classrooms: Reflections from Experienced High School Teachers Implementing E-Textiles (Shaw et al, 2020)
- Elaborating Funds of Knowledge: Community-Oriented Practices in International Context (Moll, 2019)
- Parent Involvement, African American Mothers, and the Politics of Education Care (Cooper, 2009)
- Prevention through Collaboration: Family Engagement With Rural Schools and Families Living in Poverty (Blitz et al., 2018)
- Funds of Knowledge for Teaching: Using a Qualitative Approach to Connect Homes and Classrooms (Moll et al., 2005)
- Funds of Knowledge and Discourse and Hybrid Space (Barton, 2008)

Project-Based Pedagogy & Curriculum

- Project-Based Teaching Practices for K-12 (PBLWorks)
- Attitudes towards STEM in a project-based learning environment (Tseng et al., 2013)
- How STEM Project-Based Learning affects high, middle, and low achievers differently: The impact of student factors on achievement (Han et al., 2014)
- Learning-Goals-Driven Design Model: Developing Curriculum Materials that Align with National Standards and Incorporate Project-Based Pedagogy (Krajcik et al., 2008)
- Middle School Students' Self-Efficacy, Attitudes, and Achievement in a Computer-Enhanced Problem-Based Learning Environment (Liu et al., 2006)
- Project-Based Learning: A Primer (Solomon, 2003)
- Using Problem-Based Learning Software with At-Risk Students (Samsonov et al., 2006)

APPENDIX 3. ADDITIONAL RESOURCES

- AccessCSforAll
- Addressing Race and Trauma in the Classroom
- Common Sense Media Digital Citizenship Curriculum and Lessons
- CSforAll
- ComputerScience.org
- Computer Science Education Week
- Culture in the Classroom — PD Resource for Teachers, Teaching Tolerance
- Digital Learning Day Activities and Resources
- Discovering My Identity: Lesson Plan
- Embedded EthiCS
- Nepris
- REAL-CS Initiative
- RoadTripNation
- Tool Kit: Identity Development
- Universal Design for Learning