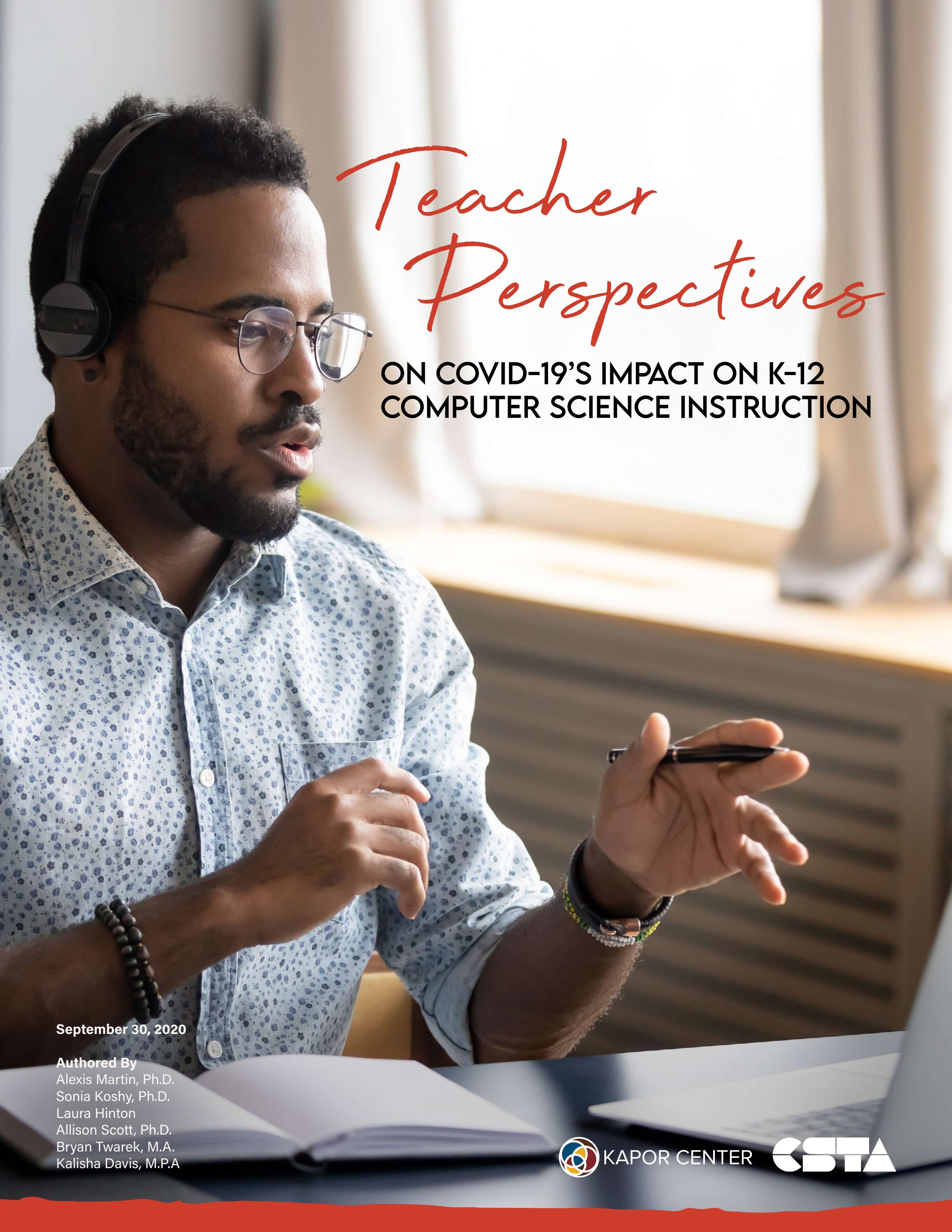

Teacher Perspectives

ON COVID-19'S IMPACT ON K-12 COMPUTER SCIENCE INSTRUCTION

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Summary

BACKGROUND

When the COVID-19 pandemic forced teachers nationwide to transition hastily to emergency distance learning environments, concerns about educational equity and access emerged. Previously alarming racial and socioeconomic inequalities in education were projected to increase, exacerbating gaps in opportunity and achievement. In K-12 computer science education specifically, disparities in access for Black, Latinx, Indigenous, and low-income students were of great concern without the additional challenges of virtual teaching and learning. The Kapor Center and the Computer Science Teachers Association surveyed nearly 3,700 K-12 computer science teachers, to understand how the transition to virtual learning has impacted K-12 computing education.

KEY FINDINGS

While only 18% of all teachers reported temporarily suspending computer science instruction, higher rates were reported for schools serving rural, low-income, and URM (Black, Latinx, Indigenous) students:

- **24%** of teachers in high-poverty schools had to suspend instruction (vs. **14%** in low-poverty schools).
- Teachers in rural schools had to suspend instruction at a rate over twice as high (**34%**) as those in urban schools (**17%**).
- **21%** of teachers at high-URM schools had to suspend instruction (vs. **17%** in low-URM schools).

42% of all teachers identified distance learning as a "major" challenge to instruction, with teachers of rural, low-income, and URM students more likely to face these challenges:

- **54%** of teachers at high-URM schools indicated distance learning is a major challenge (vs. **38%** in low-URM schools).
- **52%** of teachers in high-poverty schools indicated distance learning is a major challenge (vs. **36%** in low-poverty schools).
- **48%** of teachers in rural schools indicated distance learning is a major challenge (vs. **42%** in urban schools).

RECOMMENDATIONS

1. **Close the Digital Divide:** Build collaborations amongst school districts, public/private partners, and policymakers to distribute high-quality computers and expand access to high-speed internet connectivity.
2. **Invest In Teacher Professional Development & Support:** Provide teachers with professional development, learning communities, and technical support, to transition successfully to remote teaching.
3. **Prioritize Computer Science as a Core Course:** Institute computer science as a core academic discipline to ensure allocation of support and resources in line with other core subjects.
4. **Develop Monitoring & Accountability Systems for Virtual Computer Science Instruction:** Supplement existing systems of assessment with new systems more aligned to an online environment.

CONCLUSION

The disruption caused by emergency distance learning poses a risk to equitable computer science education for students of color, low-income students, and rural communities. In one of the wealthiest nations in the world, it is unconscionable that any students are not afforded access to the fundamental tools and support necessary for distance education. In order to continue to build a pipeline of future tech talent and provide economic opportunity to marginalized students and communities, districts must develop a comprehensive plan to support high-quality computer science instructional efforts in the current crisis and to ensure we emerge as a more equitable nation.

Introduction

The COVID-19 pandemic has upended every aspect of our lives, resulting in skyrocketing unemployment rates, an unprecedented death toll, and a new normal of distance education, work, communication, and entertainment. In many ways, COVID-19 is projected to have significant implications for decades to come. Yet, the impact of COVID-19 on the academic future of America's students, and thus the nation's future economy, may be among the most staggering.

Prior to the pandemic, educational advocates were raising alarms for decades about racial and socioeconomic inequality in education. School funding formulas benefit students in wealthier, less diverse neighborhoods, with higher per-pupil spending resulting in an estimated $23B funding gap between predominately white districts and predominately non-white districts. Low-income schools and schools serving racially diverse populations are significantly less likely to have access to rigorous STEM, computer science, and Advanced Placement coursework. Low-income, Black, Latinx, and Indigenous households and students living in rural areas are much less likely to have access to broadband internet and tech devices needed to connect in school and afterschool. All of these factors have created and perpetuated gaps in opportunity and academic outcomes.

After the onset of COVID-19, education systems, administrators, teachers, and students had to shift rapidly — almost overnight in some cases — into emergency virtual learning environments. Immediately, concerns about meeting students' needs around connectivity, access to technology devices, and reliable broadband emerged and have remained a significant educational equity issue, as one in three U.S. households earning below $30,000 lack high-speed connectivity. And yet, distance learning gaps extend far beyond the digital divide. Estimates indicate that Black, Latinx, Indigenous, and low-income students are at much higher risk of receiving no instruction at all, or lower-quality remote instruction, than their peers. The shift to virtual learning is therefore predicted to exacerbate achievement gaps by 15-20% and disproportionately impact low-income and Black, Latinx, and Indigenous students. Assuming a best-case scenario where K-12 students return to in-person instruction in January 2021, these students will have lost an estimated 9-12 months of learning.

In K-12 computer science education specifically, disparities in access for Black, Latinx, Indigenous, and low-income students were deeply challenging without the additional burden of emergency distance learning. Computer science education is critical for all students, providing computational thinking and computing skills needed across all fields of study and occupations. Taking computer science in high school is also a significant predictor of pursuing computing college and career pathways. Yet without a clearly articulated plan to disrupt racial and socioeconomic disparities in computing education, we risk widening equity gaps and having even fewer underrepresented students engaging in coursework critical to their future careers. While COVID-19 has presented many urgent and immediate challenges, we must also take action to ensure that we do not lose sight of the need to expand access to computer science and close equity gaps for all students, for the sake of their future.

To examine how COVID-19 and virtual learning are impacting computer science educators and classrooms, the Kapor Center and the Computer Science Teachers Association administered a nationwide survey to 3,693 K-12 computer science teachers from May-July 2020.[1, 2] In the sections to follow, this report will examine:

1. How has COVID-19 and virtual learning impacted K-12 computer science instruction especially in low-income schools, rural schools, and schools serving racially diverse populations?
2. What are the strategies K-12 computer science teachers have used to transition to virtual learning?
3. What are the specific recommendations to address equity in K-12 computer science education in the current context?

[1] A larger landscape report on computer science teachers nationwide will be released in winter 2020.

[2] See appendix 1 for survey methodology and teacher demographics.

[3] While this report focused on gaps of equity on underrepresented students of color, low-income students, and rural students, it is important to note that 30% of K-6 teachers indicated they had to suspend computer science instruction, while just 8% of 9th-12th grade teachers suspended instruction.

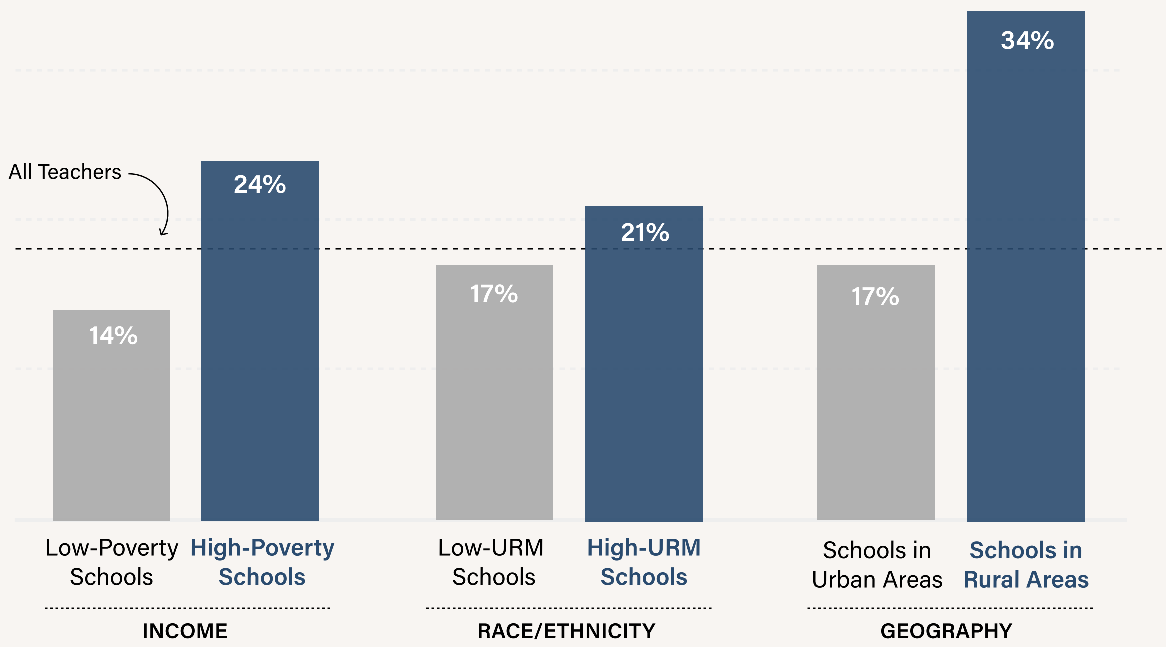
Challenges to K-12 Virtual Computer Science Instruction

While the majority of computer science teachers (82%) shifted their in-person computer science classes to a virtual setting, 18% of teachers reported temporarily suspending computer science instruction. Data revealed gaps in equity with respect to continuity of instruction.[3] Teachers serving high-poverty, rural, and/or high-URM schools (schools attended predominantly by Black, Latinx, and Indigenous students) were more likely to suspend computer science courses in response to the shift to distance learning (Figure 1).

In high-poverty schools, 24% of teachers had to suspend computer science instruction, while only 14% of teachers in low-poverty schools had to suspend instruction. Similarly, teachers in rural schools suspended instruction at a rate over twice as high (34%) as those in urban schools (17%). At high-URM schools, 21% of teachers stated they had to suspend computer science instruction, yet only 17% of teachers at low-URM schools had to do so.

Figure 1. Suspension of Instruction, by Student Body Demographics

By percent of teachers who indicated they suspended computer science instruction due to COVID



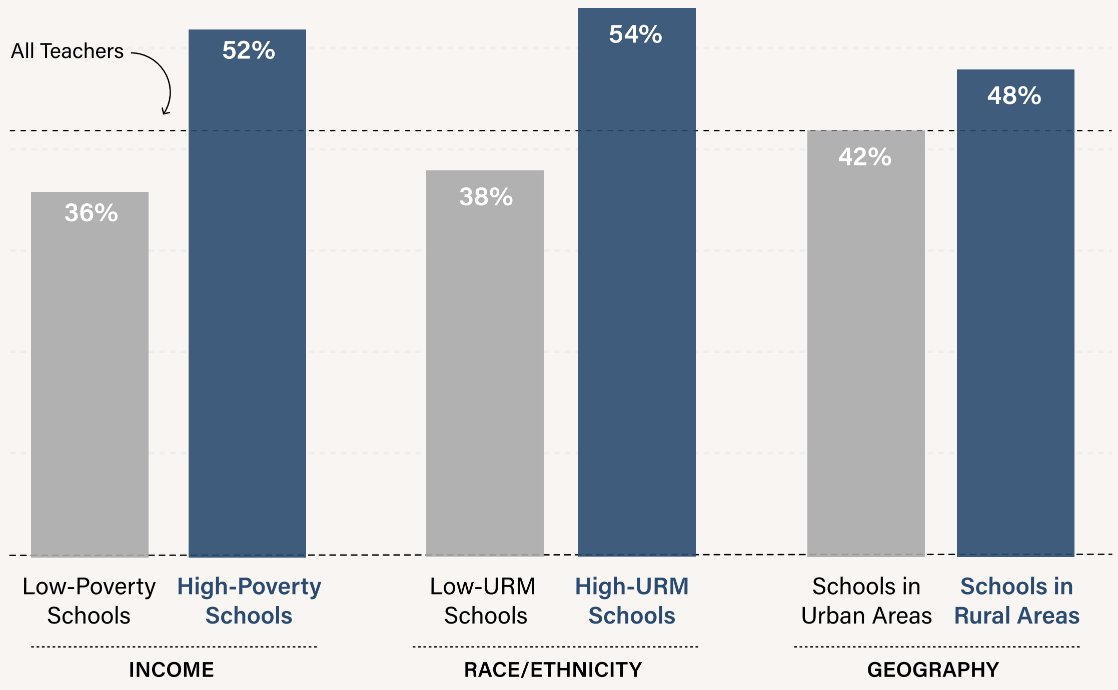
Definitions: High-poverty schools have >75% students eligible for Free/Reduced Price Lunch (FRPL), low-poverty schools have <26% students eligible for FRPL; High-URM schools have >75% underrepresented students of color (Black, Latinx, Native American, Pacific Islander); Low-URM schools have <26% underrepresented students of color.

Anecdotally, several teachers cited district mandates about the de-prioritization of computer science during this time of distance learning, in favor of teaching only "core" classes. Others described computer science being deemed as a "non-essential subject area" or "taking a back seat to the basics." Additionally, a portion of computer science teachers had courses cancelled due to students' lack of computing devices at home and/or access to high-speed internet connectivity.

When asked to rank how challenging distance learning was to instruction, 42% of computer science teachers identified distance learning as posing a "major" challenge (Figure 2). Once again, there were differences in socioeconomic status and race/ethnicity. In high-URM schools, 54% of teachers indicated that distance learning due to COVID-19 presents a major challenge, while this was only true of 38% of teachers in low-URM schools. Fifty-two percent of teachers in high-poverty schools indicated that distance learning due to COVID-19 is a major challenge, while among low-poverty schools, only 36% of teachers responded in this manner. Among teachers in rural schools, 48% indicated that distance learning due to COVID-19 is a major challenge, while only 42% of teachers in urban schools ranked it as such.

Figure 2. Distance Learning as Major Challenge, by Student Body Demographics

By percent of teachers who identified distance learning as a major challenge due to COVID



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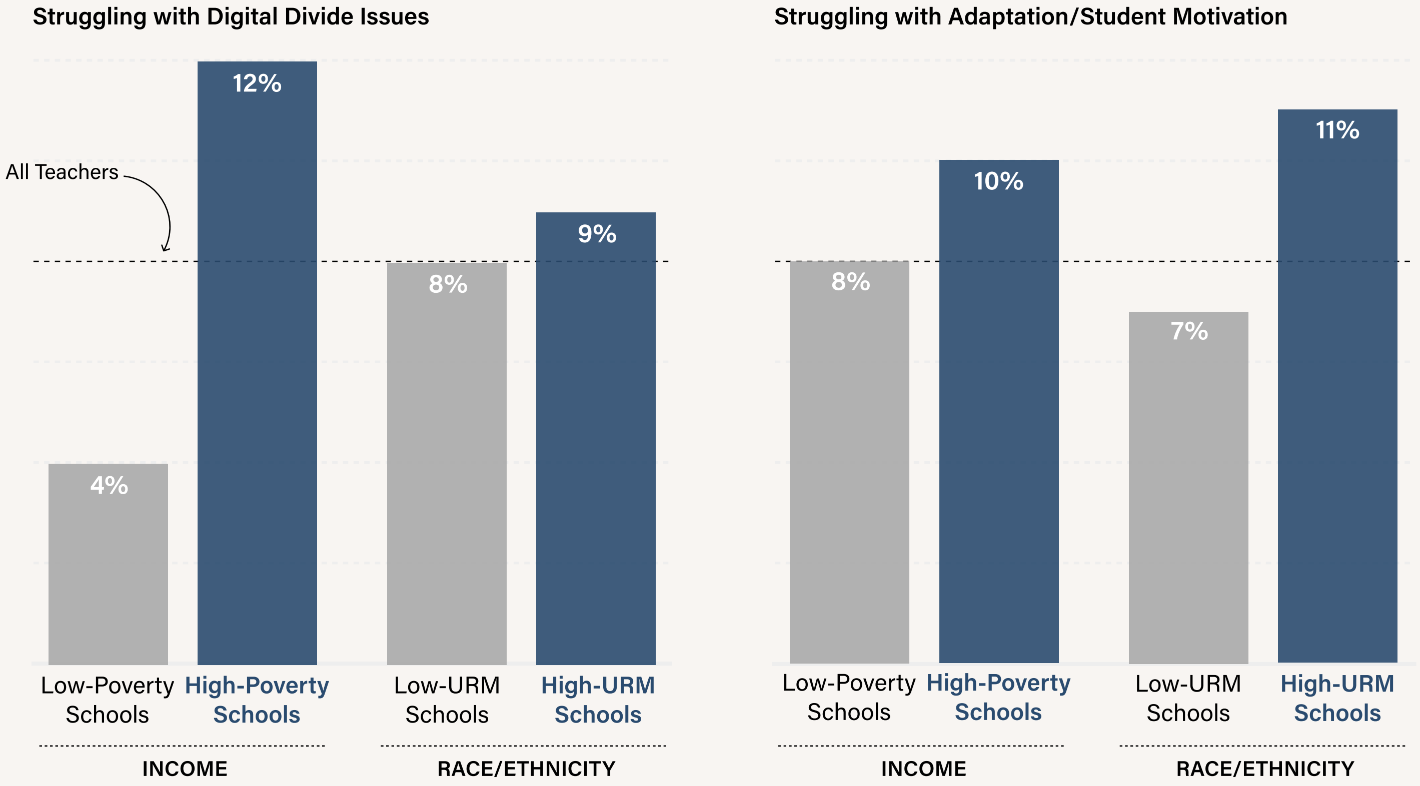
Among the challenges identified by teachers to distance learning, the most prevalent ones that arose in qualitative responses were related to engaging students in virtual instruction and challenges due to the digital divide.[4] Teachers described challenges with how to adapt their teaching while keeping students engaged. One teacher reported, "Some of my students are expected to help take care of siblings and do not have the same time dedicated to working on school work they had before." Teachers also described their students' digital divide issues. As summarized by one educator, "All of my work has gone to hard copy and printed packet availability, as 50%+ of my students do not have internet or device access."

Disparities again emerged when examining these responses broken down by student populations (Figure 3). Teachers in high-poverty schools mentioned struggling with student digital divide issues at a rate three times higher than their counterparts in low-poverty schools. Additionally, while 11% of teachers in high-URM schools reported struggling with curriculum adaptations, just 7% of teachers in low-URM schools described that as a challenge.

Figure 3. Challenges to Distance Learning, by Student Body Demographics

By percent of teachers who identified each challenge



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[4] While teachers were not explicitly asked about their challenges to distance learning, these themes emerged in response to an open-ended question about adaptations to distance learning; thus, these challenges are not meant to be a comprehensive review.

Virtual K-12 Computer Science Instructional Practices

Computer science teachers were asked to share ways in which they have deployed instruction and adapted curriculum to meet the needs of students in a virtual environment. Responses were categorized into two major themes, aligned with best practices in teaching and learning, that provide helpful insights for teachers and administrators:[5]

- **Revised Learning Goals and Objectives:** Teachers reported a need to shift and reprioritize their expectations of students' learning goals, including a narrowing of curricular goals and decreasing the pace of the course to develop feelings of success and confidence. Teachers also focused more on project-based learning, aiming to encourage student engagement, and gave students choices around what specific content they wanted to focus on learning. Finally, some teachers created asynchronous learning opportunities, allowing students to work at their own pace and giving opportunities for students and families to determine the best timing and location for student learning.
- **Used Technology Tools to Provide Differentiated Learning Opportunities:** Teachers described utilizing remote meeting and learning management systems and platforms (e.g., Zoom, Google Classroom, Teams) to create differentiated classroom experiences for their students and to provide opportunities for synchronous and asynchronous instruction, peer-to-peer learning and pair programming, multimodal activities, project-based learning, and fostering community building among students. Teachers also indicated that they switched their curriculum to utilize online/browser-based curricular supports (e.g., CodeHS, Code.org, Tynker). Teachers also incorporated instructional videos to meet the needs of students, including recording screencasts for students to watch, creating videos of themselves explaining concepts and providing a "quasi-presence of the teacher," and utilizing videos from other websites to promote student learning (e.g., Youtube, Udemy). Instructional videos also provided the opportunity to incorporate student participation strategies into the videos (e.g., using a code word within a video that students needed to report back to the teacher) and to tailor instruction and provide support for specific students.

While these practices demonstrate examples of ways that computer science teachers have adapted their instruction, there is still a lot we don't know about the efficacy of teaching and learning computer science in virtual environments during the COVID-19 pandemic, and how remote computing instruction is impacting student learning.

[5] Additionally, a smaller number of teachers indicated that they have not had to adapt their curriculum because they were already teaching an online course.

Summary and Recommendations

These data collected from computer science educators across the country illustrate how the shift to virtual learning in computer science has already exacerbated disparities for low-income and rural communities as well as students of color due to COVID-19. Even prior to the current educational crisis, those in under-resourced communities were severely underrepresented in computer science. The data demonstrate these students are even more disproportionately impacted by the discontinuation of computer science instruction, they are less likely to have access to computing devices and high-speed internet, and their teachers were more likely to face significant challenges in delivering virtual instruction.

Understanding the experiences of computer science teachers in these unprecedented times is only the first step. As teachers move into this academic year, we must urgently address the challenges to instruction to counter the widening disparities in computer science. As such, the Kapor Center and the Computer Science Teachers Association put forth the following key recommendations:

Recommendation #1:

Close the Digital Divide

"Policymakers need to bring the entirety of the United States high-speed broadband. Lack of broadband is a major disadvantage. Broadband access is not a luxury but a necessity to function in the modern 21st century."

-High school teacher

The digital divide has been a longstanding concern and has come to the forefront during the COVID-19 crisis, greatly impacting the most marginalized student populations (i.e., high-URM, high poverty, and rural communities). While some schools do provide devices to students (often Chromebooks or iPads), frequently they are not sufficient to provide computing power needed for computer science activities and applications. Even when devices are provided, teachers overwhelmingly report a widespread lack of access to high-speed internet in students' homes. Districts must urgently find effective new ways to distribute high-quality computers, and local, state, and national policy is needed to expand access to universal high-speed internet connectivity, especially in areas that are most disconnected (low-income, rural, families of color).

Recommendation #2:

Invest In Teacher Professional Development & Support

"Teaching computer science in a distance format has been challenging on a variety of fronts, so I would like to learn more strategies for engaging students remotely."

-High school teacher

With many teachers shifting to distance learning for the first time, teachers will need professional development, learning communities, and technical support to ensure a successful transition. Yet, teachers in schools serving the most vulnerable populations are the least likely to have access to the necessary supports. Furthermore, teachers are overwhelmed and overburdened, so creating time and space for them to participate in professional development by reducing other obligations (e.g., release days) make it far more possible for full engagement.

Recommendation #3:

Prioritize Computer Science as a Core Course

"If students start computer science early and continue with computer science education for multiple years, they will potentially have opportunities to exit poverty."

-Elementary school teacher

Providing equitable access to quality computer science courses, even in the midst of the pandemic, must be a priority to build critical skills for the workforce of the future while ensuring long-term economic opportunity. While the technology industry holds tremendous economic opportunities, Black, Latinx, and Indigenous professionals are severely underrepresented in computer science fields, collectively representing just 15% of the computing workforce nationwide. This severe underrepresentation affects low-income communities of color that already have lower overall incomes and higher unemployment levels, disparities which have been worsened by COVID-19. School districts, states, and administrators must deem computer science a "core" academic discipline, rather than an elective, trained and certified teachers (a role separate from school tech support). The prioritization will make it more likely that sufficient resources and support are allocated to this discipline in line with other core subjects and students' needs.

Recommendation #4:

Develop Monitoring & Accountability Systems for Virtual Computer Science Instruction

"I would like to see more accountability from city to district to school level in addressing the needs and supporting educators with practical implementation plans."

-Middle school teacher

Data from this teacher survey have shown the variety of ways teachers have adapted to distance learning, yet questions remain about student engagement, achievement, and outcomes. Additionally, evidence from this survey of teachers reveal wildly divergent ways in which districts, schools, and teachers are providing computer science instruction. Managing the shift to virtual learning will require consistent messaging, strong monitoring of both instructional quality, and student learning outcomes. This requires moving beyond existing assessment tools, towards the creation of new systems more aligned to pedagogy and assessment of learning within online environments.

CONCLUSION

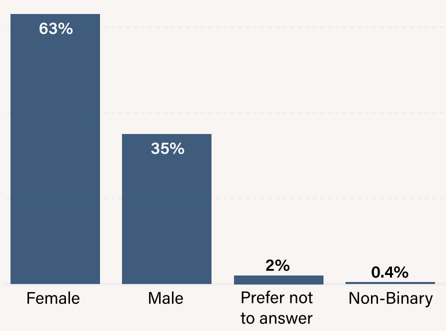
The disruption caused by emergency distance learning poses a risk to equitable computer science education for students of color, low-income students, and rural communities. In one of the wealthiest nations in the world, it is unconscionable that any students are not afforded access to the fundamental tools and support necessary for distance education. In order to continue to build a pipeline of future tech talent, provide economic opportunity to marginalized students and communities, and create a skilled and well-informed citizenry, districts must develop a comprehensive plan to support high-quality computer science instructional efforts in the current crisis and to ensure we emerge as a more equitable nation.

APPENDIX 1: *Survey & Participants*

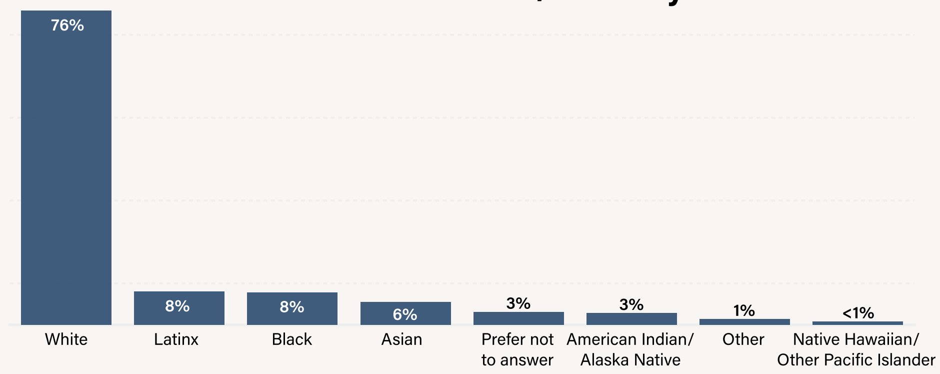
The 63-item teacher survey contained seven sections: Teacher Demographics; School Demographics; Satisfaction with Computer Science Teaching; Instructional Practice; Satisfaction with Curriculum; Perceptions of Incorporating Culturally Relevant Pedagogy; and Professional Development. For the purposes of this report, nine items on teacher/school demographics, instructional support, and teaching challenges were analyzed.

The online survey was distributed May through July 2020. The Computer Science Teachers Association and the Kapor Center recruited K-12 computer science teachers nationwide through multiple channels including member and partner emails, blog posts, targeted social media, and newsletters. A total of 3,693 K-12 computer science teachers participated, from all 50 states.

Teacher Gender



Teacher Race/Ethnicity

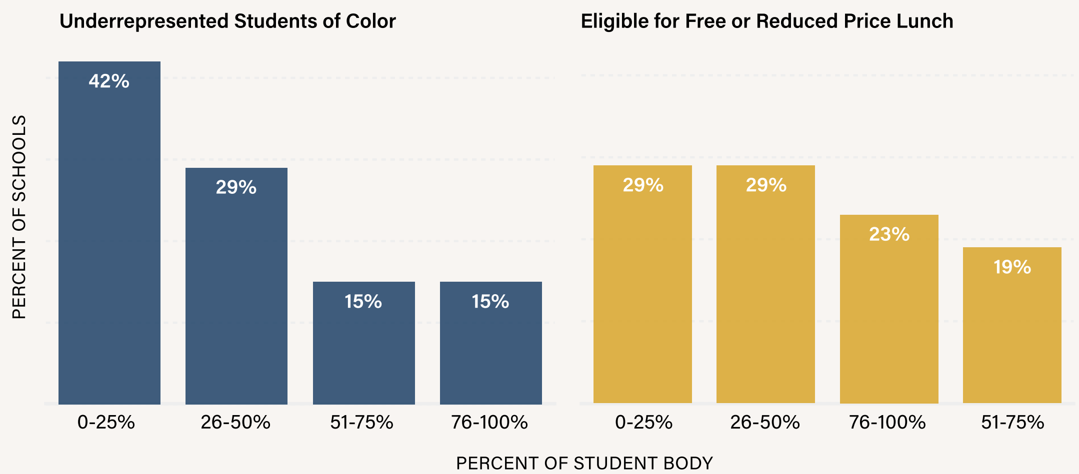


*Multiple options allowed, does not sum to 100%

Courses Taught

Standalone computer science course (PreK-8)	**26%**
Integrated computer science course (PreK-8)	22%
Advanced Placement Computer Science A	**20%**
Advanced Placement Computer Science Principles	24%
Intro-level high school computer science course (e.g., Exploring Computer Science, Intro to Computer Science)	**34%**
Specialized computing course (e.g., Robotics, Game Design)	22%
Other	**17%**

School Demographics



APPENDIX 2: Definitions

- **Definition of "Digital Divide":** The Digital Divide refers to disparities in access to computing devices, high-speed connectivity, and technological experiences.
- **Definition of Computing and Computer Science:** 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." 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." The terms computing and computer science are used interchangeably throughout this report.
- **Definition of "Underrepresentation" and "Underrepresented Students:"** The term "underrepresented" is used to describe student populations from racial/ethnic or gender groups which are traditionally underrepresented in computing education, degree completion, and the tech workforce, relative to their percentage of the U.S. population, specifically Black, Latinx, Native American/Alaskan Native/Native Hawaiian, and Pacific Islander. Underrepresentation varies across computing contexts and stages and in this report, we focus on underrepresentation in K-12 computer science education.
- **Definition of "High-URM" and "Low-URM" Schools:** The categories used in this report include "Low-URM" schools (0-25% of the school's student population is Black, Latinx, Native American/Alaskan Native/Native Hawaiian, and Pacific Islander) and "High-URM" schools (76-100% of the student population is Black, Latinx, Native American/Alaskan Native/Native Hawaiian, and Pacific Islander).
- **Classification of Urban vs. Rural:** Counties with less than 50% of the population living in rural areas are classified as urban; counties with greater than 50% living in rural areas are classified as rural (Census, 2010).
- **Definition of "High-Poverty" and "Low-Poverty" Schools:** The socioeconomic demographics of schools are determined by the percentage of the school's student population who qualify for Free/Reduced-Priced Lunch (FRPL; through federally-determined poverty guidelines) from the National School Lunch Program. "Low-poverty" was defined as 0-25% FRPL and "high-poverty" was defined as 76-100% FRPL, consistent with the National Center for Education Statistics.

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