Report

CS4All:
Examining Equity in Computer Science Access and Participation in NYC Schools

By Cheri Fancsali

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Executive Summary

New York City is one of several large school districts around the country that are actively working to promote “computer science for all” students. Launched in 2015, NYC’s CS4All initiative aims to ensure that all public school students learn computer science—especially female, Black, and Latinx students, who are starkly underrepresented in CS education and careers. The initiative is attempting to provide meaningful CS experiences that develop computational thinking, problem-solving, creativity, and critical thinking skills to every student, at least once in each grade band (K-2, 3-5, 6-8, 9-12). As part of the Research Alliance’s ongoing evaluation of CS4All, we have been examining progress toward the initiative’s goals, including the extent to which schools are reaching all of their students with CS (i.e., saturation), as well as the extent to which participation is equitable for girls and Black and Latinx students. Our current analysis looks at the experiences of three cohorts of NYC students.

Key Findings

• Overall, from 2018-2019 to 2020-2021, the district made important progress toward the initiative’s goals. By 2020-2021, most schools in NYC (91%) were offering CS (up from 76% in 2019); 17 percent of schools were achieving the initiative’s participation and equity goals (an increase of 5 percentage points). In total, 44 percent of schools were either achieving these goals or had at least improved on measures of participation and equity during this time period.

• Most of the improvement occurred between 2018-2019 and 2019-2020. Less improvement was seen between 2019-2020 and 2020-2021, which is likely related to the onset of the COVID-19 pandemic and the move to remote instruction.

• Despite positive trends, even in 2020-2021, fully half of schools were reaching only a small portion of their student enrollment with CS (i.e., less than 10 percent), indicating that the district still has a considerable way to go toward meeting the initiative’s goals.

• Schools that made greater improvements were more likely to have multiple teachers participate in CS4All professional development (PD) and to have an administrator or teacher participate in the CS4All leadership PD, suggesting these experiences may have helped facilitate implementation.

• Schools that made greater improvement also enrolled lower percentages of Black and Latinx students on average, pointing to persistent inequities in CS access and participation not only within schools, but also across schools.

• In general, elementary schools were more successful in reaching the initiative’s goals than middle or high schools. High schools lagged behind elementary and
middle schools in terms of achieving CS4All’s goals, with only 4 percent doing so, but middle schools were the most likely to have not offered CS at all, with 21 percent still not having done so by 2021. The relative success of elementary schools is probably related to the fact that, at this level, CS is often integrated into classes that all students take. The CS content at the elementary level may also be easier to grasp for teachers who are new to CS, compared with the more advanced content typically offered in middle and high school courses.

Recommendations

These findings point to several recommendations, which are informing the NYC DOE’s strategies for the current and upcoming school years.

- **Target recruitment efforts and support to schools making the least progress toward the initiative’s goals.** Despite promising improvement and progress toward reaching the initiative’s goals over the last three years, there remains a substantial portion of schools that have yet to offer CS, or are only offering it to a small percentage of their enrollment. Further, progress toward CS4All’s goals intersects with preexisting inequalities along lines of race/ethnicity, with schools that are more successful serving lower proportions of Black and Latinx students. Addressing these inequities will require shifting the allocation of limited resources to target those schools and districts that are the furthest behind.

- **Support strategies must be differentiated for schools at different stages of progress and in different contexts.** Our findings point to substantial differences in progress by grade band. Because the way CS is implemented (e.g., integrated vs. stand alone), as well as the content covered, is very different for elementary, middle, and high schools, the challenges and factors related to school success are also different—suggesting a need for more targeted support strategies. The lagging progress of high schools, in particular, suggests the need to consider a new set of strategies and approaches to help those schools reach all their students. Similarly, schools at different stages of progress need different types of support. Schools not offering CS, not making progress, or regressing in their progress likely face different contextual factors and implementation challenges—requiring different solutions—than schools that have been more successful in implementing CS to date.

- **Continue to support and build on CS4All leadership PD.** Our findings suggest schools benefit from leadership PD that facilitates the development of a schoolwide CS vision as well as schoolwide activities and events that increase awareness and engagement around CS. The NYCDOE should continue to invest in and build on these strategies, and encourage both administrators and teachers to participate in leadership PD.

- **Continue to encourage multiple teachers from each school to participate in the CS4All PD.** Our findings, and ample prior research, suggest that school reform initiatives are more successful when multiple teachers participate, allowing the development of communities of practice that foster collaboration and support and mitigate challenges due to teacher turnover. The NYCDOE should continue to encourage groups of at least two or three teachers from each school to participate
in PD, and facilitate collaboration and the development of communities of practice within and across schools.

The NYCDOE has acted on these recommendations in their programming and support efforts, as well as strategic planning for the current school year (2022-2023). This includes using school-level findings to identify schools and districts to target for recruitment and additional support; reserving space in PD sessions for schools making the least progress and with at least 65 percent Black/Latinx student enrollment and/or a high proportion of students in economic need; providing additional support through coaching visits; and developing progressive PD experiences (e.g., introductory, intermediate, advanced) for teachers and school leaders to address different needs.

**Next Steps**

Future work conducted as part of our evaluation will include in-depth interviews and observations to deepen our understanding of the factors that promote or prevent schools’ progress toward CS4All’s goals, as well as possible solutions. Further, understanding the importance of moving beyond a numerical assessment of equity—which focuses only on whether students achieve parity in terms of access and participation in CS instruction—we are also beginning to collect data on the extent to which students are meaningfully engaged in CS instruction through culturally responsive-sustaining educational practices. In addition, our evaluation is looking at short and longer-term outcomes for students taking CS. This includes CS-related attitudes, perceptions, and achievement; continued interest and engagement in CS course-taking; and post-secondary enrollment and attainment. Future analyses in these areas are crucial to evaluating equity in CS education, and will be used to guide program improvement and ultimately gauge the success of the CS4All initiative.
Introduction

Since 2015, the New York City Department of Education has been engaged in an effort to bring computer science (CS) education to all students in the district. Through the CS4All initiative, the NYCDOE strives to provide meaningful CS experiences that develop students’ computational thinking, problem-solving, creativity, and critical thinking skills.

The initiative is driven by intersecting economic, educational, and equity imperatives. On the economic front, CS4All is motivated by the need to fill computing-related jobs that are growing at an exponential rate. The educational imperative stems from increasing recognition that computational thinking is applicable and useful across disciplines and nearly every profession, as well as in everyday life. Fueling the equity imperative is the desire to increase access and participation for those who have historically been left out of CS education and careers and to empower students to use CS to confront unjust systems and solve problems. As noted by Christy Crawford, the NYCDOE’s Director of Culturally Responsive-Sustaining Education for CS4All:

“Kids don’t just have to be consumers of technology...Students [build] their sociopolitical consciousness by using their classroom knowledge to identify and help solve real-world problems.”

As part of the Research Alliance’s ongoing evaluation of CS4All, we have been examining progress toward the initiative’s goals, with a particular focus on equity in CS in NYC schools. Our assessment of equity is guided by the CAPE framework, which identifies four interactive and progressive components: Capacity, Access, Participation, and Experience. Depicted as a pyramid (see Figure 1 on the next page), the CAPE framework takes into account the necessary antecedents to equitable CS. This starts with a foundation of capacity (level 1) to offer CS education. Teachers must have the skill, confidence, and materials needed to provide high-quality CS instruction as a necessary precondition for schools offering and students having access to CS education (level 2). Access, in turn, is necessary for students to participate (level 3). Finally, participation is required, but not sufficient for students to have equity in terms of their CS experiences and ultimately, outcomes (e.g., development of computing competencies, continued participation in CS coursework in K-12 and post-secondary education, etc.). The CAPE framework is helpful in that it explores equity not only in terms of the desired end result (e.g., equal participation in CS), but also in terms of the necessary elements of a larger system that supports equity.

While our evaluation of CS4All is investigating all four levels of the CAPE framework, this report focuses on the middle of the pyramid, assessing equity in terms of access and participation. (Prior and ongoing work explore issues related to capacity and experience and will be the focus of future publications.)
In this report, we have sought to answer the following research questions:

- To what extent are schools meeting the CS4All initiative’s goal of providing all students with meaningful CS experiences in each grade band (K-2, 3-5, 6-8 and 9-12)?
- To what extent is participation in CS equitable in terms of gender and race/ethnicity?
- What conditions and factors are supporting schools’ progress toward the initiative’s goals?

Our analyses and findings draw on several sources of data, including:

- Student CS course-taking records from the 2016-2017 through 2020-2021 school years;
- CS4All professional development (PD) participation records; and
- Surveys of 363 school leaders and CS lead teachers completed in 2021.6

In the next section, we describe how we calculated progress ratings for schools. In section three, we present findings from the analyses of progress ratings, as well as survey data that help explain the patterns we see across schools and over time. The final section summarizes implications and recommendations drawn from these findings.
CS4All Progress Rating Methodology

The NYCDOE’s CS4All initiative aims to provide every student in the district with a meaningful CS learning experience at each grade band (K-2, 3-5, 6-8, and 9-12). The initiative has an explicit focus on girls, Black students, and Latinx students, who are underrepresented in CS education and careers. Meaningful CS learning experiences are defined as units of CS instruction that last at least 11 hours and are integrated into another course, or semester- or year-long stand-alone CS courses. As part of the initiative, the NYCDOE provides CS curricula and PD for both integrated units and stand-alone courses, for elementary, middle, and high school students.

To assess schools’ progress toward the initiative’s goals, we calculated a saturation measure based on the percent of students in each school who had at least one CS experience in their respective grade band. We also calculated an equity measure by looking at the gender and race/ethnicity of students who took CS. Using the saturation and equity measures, we then calculated an overall progress rating for each school and grade band in community school districts 1 through 32, and the district as a whole. These ratings are described briefly below and in more depth in Appendix A.

**Saturation** is the percentage of students in the school who had at least one unit of CS instruction, or a stand-alone CS course, by the final year of their respective grade band (i.e., 2nd, 5th, 8th, or 12th grade). Based on this percentage, we assigned each school a saturation rating (Not Offering, Beginning, Progressing, Approaching, Achieving), as shown in Table 1 on the next page.

The **Equity** rating takes into account the extent to which student participation in CS is equitable for Black and Latinx students and girls, using three different metrics:

- **Participation Rate** is the rate at which students of a particular group (e.g., Black, Latinx, girls) took at least one CS course or unit by the final year of the grade band.
- **Composition Index** is the percentage of CS takers belonging to a subgroup (e.g., Black students, girls), compared with the percentage of students in that subgroup across the school’s entire grade band.
- **Relative Participation Ratio** is the likelihood or “odds” that a particular group takes at least one CS course in the grade band, relative to other groups.

These measures were influenced by Fergus’ work exploring disproportionality in special education (2016) and are similar to those used by Warner et al. (2021) in CS education. They are in alignment with and build on measures used by the district’s AP4All initiative team to assess equity in Advanced Placement course taking. We selected these three metrics because they allow us to look at proportionality through different lenses: within groups, in comparison to the larger school race/ethnicity and gender composition, and relative to other groups. By looking at equity through these different lenses, we can assess progress in a more nuanced way. For example, looking across these three metrics allows us to determine if one group’s participation is coming at the expense of another.
Table 1: Saturation, Equity, and Overall Progress Rating Definitions

<table>
<thead>
<tr>
<th>Rating</th>
<th>Saturation: The percent of students in the school who have had at least one CS course by the last grade in the grade band.</th>
<th>Equity: The extent to which there is equity in female, Black and Latinx student participation in CS.</th>
<th>Overall Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Beginning</td>
<td>1-29 percent</td>
<td>At least 1 subgroup did not meet the equity threshold for any of the 3 metrics.³³</td>
<td>Average score of 1 or 1.5</td>
</tr>
<tr>
<td>2 - Progressing</td>
<td>30-59 percent</td>
<td>All 3 subgroups met the threshold for 1 of the 3 metrics.</td>
<td>Average score of 2 or 2.5</td>
</tr>
<tr>
<td>3- Approaching</td>
<td>60-89 percent</td>
<td>All 3 subgroups met the threshold for 2 out of the 3 metrics.</td>
<td>Average score of 3 or 3.5</td>
</tr>
<tr>
<td>4- Achieving</td>
<td>90 percent +</td>
<td>All 3 subgroups met the threshold for all 3 metrics.</td>
<td>Average score of 4</td>
</tr>
</tbody>
</table>

To assign an overall equity rating, we calculated the participation rate, composition index, and relative participation ratio separately for girls and Black and Latinx students. We then assigned each grade band within a school a rating by looking at the number of measures that met our threshold for equitable participation (i.e., no more than a 10 percentage point difference in subgroup participation and a relative participation ratio between .9 and 1.1) for each subgroup.

To calculate an **Overall Progress** rating that takes into account both saturation and equity, we averaged the numerical values attached to each rating category (Not Offering = 0 to Achieving = 4) for saturation and equity. For example, school grade bands that had Beginning ratings for both saturation and equity (averaging 1), or a mix of Beginning and Progressing (averaging 1.5) were rated as Beginning in overall progress.

In the next section, we summarize findings from our analysis of the saturation, equity, and overall progress ratings for three cohorts of students: students in the terminal year of their grade band in 2018-2019, 2019-2020, and 2020-2021. We first present three-year trend findings for the district as a whole, to assess progress toward the initiative’s goals over time. Then, we explore changes in progress ratings between the first and third year of data to see the extent to which individual schools improved, maintained, or slid backwards in their progress, as well as factors related to those changes. Finally, given differences in how elementary, middle, and high schools implement CS, as well as their progress ratings, we provide results by grade band for the most recent cohort of students (i.e., 2020-2021).
Findings

Progress Toward the Initiative’s Goals: Three-Year Trends

In 2018-2019, the first year we were able to calculate progress toward the initiative’s goals, we found that the majority of NYC schools were in the early stages of implementing CS4All. As shown on the left side of Figure 2 below, almost one fourth of schools (24%) were Not Offering CS to their students, and 41 percent were just Beginning to meet the initiative’s goals. A little more than a third of schools (36%) were rated as Progressing or higher.

Since the 2018-2019 school year, we have seen an increase in the proportion of schools making progress toward the initiative’s goals. By 2020-2021, most schools in NYC were offering CS (91%, up from 76%). However, only 21 percent were at the Approaching or Achieving level, indicating the district still has a way to go toward reaching the initiative’s goals. Over the three-year period, we saw the largest increases in the proportion of Beginning schools (up 8 percentage points) and Achieving schools (up 5 percentage points), while the proportion of Progressing schools increased only slightly (up 2 percentage points).

Most of the growth occurred between the first and second year (2018-2019 and 2019-2020). While it is difficult to know exactly why this is the case, it is likely that disruptions...
caused by the COVID pandemic help explain slower growth between the second and third year (2019-2020 and 2020-2021). As one school’s CS lead reported:

“Due to COVID and staff changes, we were not able to expand our program as we originally planned. However, we hope to in the next school year.”

Similarly, another school lead told us:

“This year has been very difficult due to the constant changing tide from remote to blended and school closures due to COVID.”

Future research will provide more information about the factors related to schools’ progress (or lack thereof) over time.

Looking at equity and saturation ratings separately (see Figures 3 and 4 below), we found generally parallel improvement on the two measures, with similar proportions of schools at each of the rating categories. This suggests that as schools increased the proportion of students who participated in CS, they did so in a way that did not lead to increased disproportionality by gender and race/ethnicity. The notable exceptions were that schools were much more likely to have a Progressing rating in equity (49% Progressing in equity vs. 13% Progressing in saturation in 2020-2021) and a Beginning rating in saturation (51% Beginning in saturation vs. 14% in equity).
Further, while we found that only 19 percent of schools had an Achieving equity rating (which takes into consideration three different measures of equity), participation rates for students in the three focal subgroups (girls, Black and Latinx students) were similar to their peers (boys, non-Black, and non-Latinx students). For example, the percentage of girls participating in CS—out of all girls—was similar to the percentage of boys participating in CS in 88 percent of schools. Similarly, the percentage of Black and Latinx students participating in CS was similar to the percentage of non-Black and non-Latinx students participating in CS in 82 and 83 percent of schools, respectively. These patterns were consistent across grade bands, except at the high school level, where 68 percent of schools had equitable participation rates for girls, 67 percent had equitable participation rates for Black students, and 69 percent had equitable participation rates for Latinx students.

In addition to looking at equity in participation rates (i.e., are students from each subgroup taking CS at equal rates?), it is useful to look at the demographic composition of CS course takers in comparison to the overall demographic composition of the school. Exploring equity in terms of a school’s composition is particularly important in NYC, where many schools are made up predominantly of Black and Latinx students. For instance, we might find Black and non-Black students participating at similar rates (e.g., 3% of Black students and 6% of non-Black students participate in CS)—but the demographic composition of CS students is not similar to the demographic composition of the school’s grade band overall.
(e.g., 33% of all students in the grade band are Black, but only 20% of CS students in the grade band are Black). When we looked at CS course taking through this lens, we found fewer schools with a demographic composition of CS course takers that was similar to their overall demographic composition (in terms of race/ethnicity and gender) than schools with equitable participation rates. Specifically, 63 percent of schools had an equitable composition index for girls; 73 percent of schools had an equitable composition index for Black students, and 65 percent of schools had an equitable composition index for Latinx students.

**Changes in Progress Ratings: Did Individual Schools Improve, Maintain, or Backslide?**

Looking at overall progress from 2018-2019 to 2020-2021, we calculated the percentage of schools that showed improvement, stayed the same, or declined in ratings. As shown in Table 2, more than a third of schools (36%) improved by at least one level (e.g., from Beginning to Progressing). Nearly half (47%) stayed at the same level over the three-year period (8 percent accomplished an Achieving rating in the first year and stayed there). At the same time, 17 percent of schools saw their rating decline: 14 percent declined at least one level and almost 3 percent stopped offering CS altogether.

<table>
<thead>
<tr>
<th>Percent of Schools (N=1498)</th>
<th>Regressed</th>
<th>Stayed the Same</th>
<th>Improved</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Stopped Offering CS</td>
<td>Regressed in ratings but still offering CS</td>
<td>Never offered CS</td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>-----------</td>
</tr>
<tr>
<td>2.9%</td>
<td>14.1%</td>
<td>5.6%</td>
<td>33.4%</td>
</tr>
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</table>

Source: Research Alliance calculations based on STARS data provided by the NYCDOE.

Table 3 on the next page shows the specific changes by each rating level. For example, among the 608 schools that had a Beginning rating in 2019, a majority of them (65%) still had a Beginning rating in 2021. Another 20 percent improved one level to Progressing, 3 percent improved two levels to Approaching, and 8 percent improved three levels to Achieving. Five percent were no longer offering CS by the 2020-2021 school year. It is noteworthy that among schools not offering CS in 2018-2019, a majority (76%) began offering CS by 2020-2021. Further, over two thirds (68%) of schools that were Achieving in 2018-2019 were able to maintain that rating in 2020-2021.
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<tbody>
<tr>
<td>Not Offering (N=347)</td>
<td>24.2% (0)*</td>
<td>57.9% (+1)</td>
<td>12.7% (+2)</td>
<td>1.5% (+3)</td>
<td>3.7% (+4)</td>
</tr>
<tr>
<td>Beginning (N=608)</td>
<td>5.1% (-1)</td>
<td>64.6% (0)</td>
<td>20.1% (+1)</td>
<td>2.5% (+2)</td>
<td>7.7% (+3)</td>
</tr>
<tr>
<td>Progressing (N=292)</td>
<td>2.7% (-2)</td>
<td>37.7% (-1)</td>
<td>34.2% (0)</td>
<td>8.2% (+1)</td>
<td>17.1% (+2)</td>
</tr>
<tr>
<td>Approaching (N=72)</td>
<td>5.6% (-3)</td>
<td>23.6% (-2)</td>
<td>36.1% (-1)</td>
<td>11.1% (0)</td>
<td>23.6% (+1)</td>
</tr>
<tr>
<td>Achieving (N=179)</td>
<td>0% (-4)</td>
<td>5.2% (-3)</td>
<td>16.2% (-2)</td>
<td>11.2% (-1)</td>
<td>67.6% (0)</td>
</tr>
</tbody>
</table>

Source: Research Alliance calculations based on STARS data provided by the NYCDOE.
Note: * Numbers in parentheses indicate the number of levels of improvement or decline. Total N=1498.

**Progress Ratings by School’s Racial/Ethnic Composition**

When we compared the racial/ethnic composition of schools with different progress ratings, we found notable disparities. Schools that received an Achieving rating in 2020-2021 had an average Black or Latinx student enrollment of 55 percent, versus 80 percent for schools that were not offering CS. We also looked at changes in ratings over the three-year period and found a similar pattern (see Figure 5 on the next page). Schools no longer offering CS served the highest percentages of Black and Latinx students on average (83%), followed by schools that never offered CS (80%). Schools that maintained an Achieving rating served the fewest Black and Latinx students on average (50%). These findings point to troubling inequities across schools, and suggest the need to offer more targeted support for schools that are struggling to implement CS. It’s important to note that the racial inequities seen here mirror other inequities between schools that offer CS and those that do not. For example, our previous report on CS4All showed that schools not offering CS generally served higher-needs students, including English language learners, students with disabilities, low-income students, and students who were not proficient in math or English language arts. Thus, these schools may face a number of challenges and competing priorities that make it harder to successfully implement CS.
To explore factors that might be related to a school’s improvement or decline in ratings, we looked at the relationship between rating changes and participation in CS4All PD offerings for both teachers and school leaders. Since 2016, the NYCDOE has provided PD to over 3,000 teachers on a wide range of K-12 CS curricula. These teacher PD experiences range from 25 hours for foundational and integrated unit curriculum to 100 hours or more for more advanced curriculum, and are intended to prepare teachers to implement the curriculum in their classroom. As shown in Figure 6 on the next page, schools that maintained an Achieving rating or made substantial improvement between 2018-2019 and 2020-2021 were more likely to have sent two or more teachers to the CS4All curriculum PD. This was also true across grade bands. By having more than one teacher who participated in the CS4All curriculum PD, teachers may have had more opportunities to collaborate, share resources, support one another, and foster a stronger CS culture across the building, and schools may have been in a better position to weather teacher turnover and continue offering CS.

In addition to the curriculum PD, the NYCDOE implemented two types of CS4All leadership PD beginning in 2018: one for CS teacher leaders, and another for school administrators. The leadership PD was developed as part of a larger strategic effort to move beyond building individual teacher capacity toward providing more support for the whole school. Both types of leadership PD were designed to help school leaders (both teachers and administrators) develop plans to grow and sustain CS programming, including a schoolwide vision for CS and strategies to promote a positive culture and community involvement in CS.
Figure 6: Change in School’s Overall Progress Rating by Number of Teachers Who Participated in CS4All Curriculum Professional Development

Similar to the findings about the curriculum PD, we found that schools that never offered or stopped offering CS between 2018-2019 and 2020-2021 were less likely to have attended any type of CS4All leadership training (see Figure 7 on the next page). Conversely, schools that maintained their Achieving rating or showed some improvement over that period were more likely to attend either or both types of leadership PD. These findings suggest that these PD experiences may have supported schools in their efforts to achieve the initiative’s goals. However, it’s notable that 29 percent of schools that regressed in their ratings also participated in CS4All leadership PD, indicating that some schools require supports in addition to PD, or perhaps different types of PD, to maintain and continue making progress toward CS4All. That being said, it is also worth noting that the last several years have been among the most challenging for school leaders, with the multiple detrimental effects of the pandemic hitting higher-need students the hardest.

The call for differentiated types of support and PD was highlighted in several open-ended responses to our survey of administrators and CS lead teachers. For example, respondents made the following recommendations for improving school support for CS implementation:

“Continue to provide Professional Development for multiple levels of understanding of CS.”

“I think it would be prudent to help schools identify where they are on an adoption spectrum and then provide meaningful supports on how to move along the spectrum.”

“Differentiated levels for training such as introductory, intermediate and advanced classes.”

“Differentiated level training based on comfort with technology. “

“More individualized school support.”
Findings from our 2021 survey of CS teacher and administrator leads also revealed specific factors that supported progress toward the initiative goals. For instance, schools that made more progress were more likely to have CS-related implementation plans (including specific plans for increasing the participation of girls, Black students, and Latinx students) and school-wide CS vision statements, and to host CS-related events. These were strategies and components covered in and supported by the CS4All leadership PD. In open-ended survey responses, administrators and CS leads reported that school-wide CS activities and events—such as CS Education Week, hackathons, coding clubs, and student showcases—were instrumental in building awareness and engagement in CS across the school community. For example, when asked how participation in community engagement activities (such as Hour of Code) influenced the CS culture in their school, CS lead survey respondents noted:

“Since the CS team distributed the [CS Ed Week/Hour of Code] activities to every grade, we noticed increased interest and participation from both the teachers and students. Teachers who had not engaged in CS activities before presented the activities to their class and gave students opportunities in the classroom to engage.” - CS lead in an elementary school

“Offering exposure to activities (e.g., Hackleague, Coding Club, CS and Tech Expo Student showcase) have improved students' understanding of CS, engagement and interest. We have also exposed many more students to CS in our afterschool activities, events and CS Ed week.” - CS lead in a high school
**Progress Ratings by Grade Band**

Given the initiative’s emphasis on providing meaningful CS experiences at each grade band, and differences in how CS is implemented and accessed by students at the elementary, middle, and high school levels, it is important to explore differences in progress by grade band. This section looks at progress ratings by grade band in 2020-2021, the most recent year available. In reviewing these findings, it is useful to remember the structural differences in how CS is offered across grade bands. At the elementary level, CS is typically offered as units integrated into other subject areas that last 16 to 20 hours. At the middle and high school levels, CS is more frequently implemented as semester- or year-long stand-alone courses that students elect to take.

**Overall Progress Ratings by Grade Band**

Similar to previous years, elementary schools were more likely than middle and high schools to achieve the initiative’s goals. As shown in Figure 8, 23 percent of K-2 and 29 percent of 3-5 schools achieved the initiative’s saturation and equity goals, compared with 17 percent of middle schools and only 4 percent of high schools. This figure also highlights that middle schools were the least likely to offer any CS at all, with 21 percent not having done so by 2021.

![Figure 8: Overall Progress Ratings by Grade Band, 2020-2021 School Year](image)

Source: Research Alliance calculations based on STARS data provided by the NYCDOE.
Equity Ratings by Grade Band

As with the overall progress ratings, there were some differences in equity of participation by grade band. As shown in Figure 9, elementary schools were more likely to have equitable participation of girls and Black and Latinx students than middle or high schools. Specifically, 25 percent of schools serving students in grades K-2 and 30 percent of schools serving students in grades 3-5 achieved equity versus 18 percent of middle and only 6 percent of high schools.

Figure 9: Equity Rating by Grade Band, 2020-2021 School Year

Source: Research Alliance calculations based on STARS data provided by the NYCDOE.
Saturation Ratings by Grade Band

In terms of saturation, we also found that high schools trailed elementary and middle schools in their progress toward achieving the initiative’s goals (see Figure 10). Whereas 27 percent of schools serving students in grades K-2 and 33 percent of schools serving students in grades 3-5 achieved saturation, only 19 percent of middle school and 6 percent of high schools were doing so. Further, schools at all grade bands were more likely to be rated at the Beginning level in saturation than in equity.

Figure 10: Saturation Ratings by Grade Band, 2020-2021 School Year

Source: Research Alliance calculations based on STARS data provided by the NYCDOE.

Figure 11 on the next page presents another way of looking at CS saturation across the district. In this figure, each dot represents a school. It shows that in 2020-2021, fully half of all schools were reaching less than 10 percent of their enrollment with CS. The remaining 50 percent of schools are fairly evenly distributed along the scale, with a small cluster of schools at the top, indicating 100 percent saturation. This figure vividly illustrates that schools fall across the spectrum in terms of the proportion of students they are reaching with CS.
Looking at the distribution of schools’ saturation rates by grade band, as shown in Figure 12 on the next page, we also see different patterns for elementary, middle, and high schools. In particular, this figure shows that high schools—despite being less likely reach an Achieving rating—were more likely to have a saturation rate above 10 percent (i.e., more than 10% of their student enrollment had at least one CS experience in the grade band), compared with middle and elementary schools. Furthermore, the saturation rates for high schools were more evenly distributed and less bifurcated than for middle and elementary schools, where schools tended to cluster at the top of the distribution—providing CS to a very high percentage of their students—or at the bottom of the distribution—providing CS to few or none of their students.

Our analyses of equity, saturation, and overall progress ratings by grade band show that elementary grades generally have been more successful in reaching the initiative’s goals. This is likely related to the fact that at these grade levels, CS is typically integrated into other core subjects, which all students are required to take, and in short units (16-20 hours), taking less time overall. In contrast, middle and high school students have more choice and can opt in or out of CS courses. This autonomy in course selection increases at the same time that student interest in STEM subjects (including computer science) tends to wane (Potvin & Hasni, 2014). Further, middle and especially high schools offer more advanced CS options (such as AP CS), which may have real or perceived prerequisite requirements—limiting opportunities for students with little or no prior CS exposure.
For example, guidance counselors, teachers, and students themselves may make assumptions about what prior coursework or academic achievement is needed to be prepared to take AP CS courses.

In addition, elementary schools may find it easier to offer CS instruction because the content is generally at a more entry level that does not require teachers to have advanced CS knowledge or skills. Thus many more elementary teachers may be in a position to provide CS instruction. In contrast, middle and high schools may have only one teacher who is adequately prepared to teach the CS curriculum at that level, limiting the number of CS courses the school can offer. Finally, when looking at differences by grade band, it is important to remember that high school courses typically last for a semester or a full year, and therefore provide a more substantial dosage of CS instruction than elementary-level units that may last 20 hours or less.

Figure 12: Percent of Enrollment Taking CS at Least Once at Every NYC School by Grade Band, 2020-2021 School Year

Source: Research Alliance calculations based on STARS data provided by the NYCDOE.
Summary and Recommendations

Our analyses of CS course-taking data for three cohorts of students allowed us to create several measures of progress toward the CS4All initiative’s goal of providing all students with at least one CS experience at each grade level. The measures take into account the extent to which schools are reaching all of their enrolled students with CS (i.e., saturation), and the extent to which participation is equitable for girls and Black and Latinx students. Key findings include the following:

- Overall, from 2018-2019 to 2020-2021, we saw progress toward the initiative’s goals. There was a decrease in the proportion of schools that were not offering CS, and an increase in the proportion that achieved the initiative’s goals. Most of the improvement occurred between 2018-2019 and 2019-2020. Less improvement was seen between 2019-2020 and 2020-2021, which is likely related to the onset of the COVID-19 pandemic and the move to remote instruction during this time period.

- Despite the positive trend over time, in 2020-2021, the 6th year of the initiative, about half of the schools were not offering CS or were reaching only a small portion of their student enrollment.

- Looking at equity and saturation ratings separately, we found generally parallel improvement on the two measures, with similar proportions of schools at each of the rating categories. This suggests that as schools increased the proportion of students who participated in CS, they did so in a way that did not lead to increased disproportionality by gender and race/ethnicity.

- By 2020-2021, 44 percent of schools were achieving initiative goals or had at least improved their progress rating over the three-year period. Another third of schools (33%) stayed at a Beginning, Progressing, or Approaching rating, and 17 percent regressed in their rating; 6 percent never offered CS.

- Schools that made greater improvement in their progress were more likely to have multiple teachers participate in the CS4All PD and to have an administrator or teacher participate in the CS4All leadership PD, suggesting these experiences may have helped support schools by allowing opportunities for teacher learning and professional communities and may have mitigated the negative effects of teacher turnover among those who participated in CS4All PD.

- Schools that made greater improvement in their progress enrolled lower percentages of Black and Latinx students on average, pointing to inequities in CS access and participation not only within schools, but also across schools. Black and Latinx students were less likely to attend schools where all students have at least one CS experience, and more likely to attend schools that have never offered CS or stopped offering CS by 2020-2021.

- In general, elementary schools were more successful in reaching the initiative’s goals than middle or high schools. Greater success at the elementary level may be a result of integrating CS into courses that all students are required to take. Additionally, elementary schools may be more successful because at that level CS typically involves more foundational content that is less likely to be dependent on a teacher with highly specialized training. Conversely, middle and high schools may
struggle to reach a larger portion of their students because CS courses at those levels tend to be more advanced and thus require teachers with more advanced knowledge and skills. Further, more advanced CS courses may not be as appealing, or may be perceived as inaccessible to students with little or no prior CS experience.

These findings point to several recommendations:

- **Target recruitment efforts and support to schools making the least progress toward the initiative’s goals.** Despite promising improvement and progress toward reaching the initiative’s goals over the last three years, our findings show that a substantial portion of schools have yet to offer CS, or are only serving a small percentage of their enrollment. Further, the fact that schools that have made more progress serve fewer Black and Latinx students on average indicates inequities both within and across schools. Addressing these inequities requires shifting the allocation of limited resources to target those schools most in need of assistance. Using school-level data on progress ratings will help the NYCDOE address this by pinpointing and prioritizing schools and districts that are the furthest behind.

- **Differentiate support strategies by grade band and type of CS offered.** The CS4All initiative was designed with the premise that there is no “one size fits all,” rather, schools are encouraged to implement CS instruction in a way that aligns best to their community’s needs and educational vision. Building on this, the NYCDOE’s recruitment and support efforts cannot be “one size fits all.” Our findings point to substantial differences by grade bands and type of CS instruction that require differentiated support.

Factors related to school success are different for elementary schools versus middle and high schools. For example, elementary schools may need more support in figuring out how to best integrate CS into subject-area courses, such as English language arts, science or mathematics, in ways that help students learn interdisciplinary computational thinking skills, or how to find time within busy core course-pacing schedules to integrate CS. Middle and high schools may need more support in building teacher capacity to offer CS coursework, increasing the breadth of offerings to include more foundational courses for students with no prior CS experience, programming CS courses so that more students can fit it into their schedule, and attracting students to those courses.

Supports should also be differentiated by the type of CS schools are offering (i.e., integrated into other courses or as a stand-alone course), student needs (e.g., schools serving larger proportions of lower-achieving students), and the extent of progress made toward initiative goals. In particular, schools not offering CS, not making progress, or regressing in their progress likely face different contextual factors and implementation challenges—requiring different solutions—than schools that have been more successful engaging in and implementing CS. It may be that schools that have yet to offer CS have competing demands that are preventing them from taking on a new initiative, or that the leadership and staff do not see the value of CS education. Schools that are already offering CS to all of their students might need support to ensure the sustainability of their programming, and to make
certain that instruction is high-quality, affirming, and empowering—particularly for students who have been historically marginalized in CS.

In keeping with these insights, Ron Summers, the CS4All Executive Director, has said:

“Our approach is around the idea that one size does not fit all. We focus on the [CS instruction] options that we can provide a school or community school district so they can figure out what is right for the students and community that they serve.”  

- **Continue to support and build on CS4All leadership PD.** Our findings point to strategies that schools seem to be benefitting from, including leadership PD that facilitates the development of a schoolwide CS vision and activities and events that increase awareness and engagement around CS. This is likely because teachers, by themselves, are not able to change policies such as course scheduling and enrollment criteria; administrators need to play a role in these kinds of changes. The leadership PD may help build buy-in for policies that facilitate CS implementation, and may offer leaders a place to develop and share effective strategies. The NYCDOE should continue to support and build on these efforts, and encourage both administrators and teachers to participate in leadership PD. Given the possibility that the leaders who volunteered to participate in this PD might have already made headway implementing CS and have fewer barriers to offering CS (e.g., fewer competing demands, more resources, greater buy-in from teachers and district leaders), it will be important to recruit schools that are struggling the most for future PD sessions and consider offering PD that is differentiated by levels (e.g., more or less advanced sessions for leaders at different stages of engagement).

- **Continue to encourage multiple teachers from each school to participate in the CS4All PD.** Finally, these results suggest that schools benefit from having more than one teacher participate in CS4All PD. Possible reasons for this are that it mitigates the effects of teacher turnover, allows for collaboration where teachers can support each other and share resources, and provides more opportunities for the school to offer additional CS courses and therefore reach more students. The advantages of a community of practice that allows for teachers engaged in school improvement efforts to collaborate and support each other is well supported by prior research.

The NYCDOE has already acted on several of these recommendations in their programming and support efforts as well as strategic planning for the current school year (2022-2023). Specifically, they used school-level progress rating findings to identify schools and districts to target for recruitment and additional support. Given limited capacity to serve all schools in a year, the district dedicated at least 50 percent of the available PD spots for schools that are not yet offering CS or received a Beginning progress rating; schools with at least 65 percent Black/Latinx student enrollment and/or with an economic need index of at least 60 percent are prioritized. Additionally, no more than 25 percent of the available spots are for schools that received a Progressing or Approaching rating. The district is also providing extra support through coaching visits, and developing differentiated supports. For example, they are offering progressive PD experiences (e.g., introductory, intermediate,
advanced) for teachers and school leaders at different stages of implementation, adding PD on introductory and intermediate level curricula at the high school level, and revising PD agendas and support to focus on specific implementation barriers identified through the evaluation (such as scheduling challenges for high schools, or competing demands related to preparing for required standardized tests). Finally, the NYCDOE is exploring how it might expand CS course offerings at the high school level to address a wider range of student interests and needs.

**Future Directions**

Future research for this mixed-methods evaluation will include in-depth interviews and observations to deepen our understanding of the factors that promote or prevent schools’ progress toward CS4All’s goals, as well as possible solutions. In particular, we plan to explore barriers and facilitators for schools at different stages of progress, especially those schools that have yet to begin offering CS. Further, CS for All movements across the country—including NYC’s CS4All—are increasingly attending to the fact that expanding access and participation is not sufficient, on its own, to address deep-seated inequities and structural racism that produces gaps in CS opportunities and outcomes. Thus, it is important that such initiatives move beyond an assessment of “numerical representation” of equity, which focuses only on whether students achieve parity in terms of access and participation, to include a broader vision of equity and social justice in CS education.

Toward this end, our evaluation is beginning to focus on understanding and measuring the implementation and outcomes of culturally responsive-sustaining education (CR-SE) practices that aim to affirm students’ cultural identities, elevate historically marginalized voices, empower students as agents of social change, and support their engagement, learning, growth, and achievement in CS. We are also looking at short-term (e.g., CS-related attitudes, perceptions, and achievement) and longer-term outcomes (e.g., continued interest and engagement in CS course-taking and post-secondary enrollment and attainment) for students who take CS. Exploring the outcomes of CS education can offer timely evidence to inform the NYCDOE’s Career Pathways initiative, for example, by identifying CS competencies and experiences that are important for students’ post-secondary and labor market success. These will be important research areas to pursue to guide program improvement and ultimately gauge the success of the initiative.
Endnotes


4 Quoted in Mirakhur, Fancsali & Hill (2021).


6 See Appendix B for a description of the survey sample, administration procedures, and response rates.

7 In 2018-19, we had only three years of CS course-taking records, so we calculated the percent of students who took CS in high school as the percent of 12th grade students who took CS in their 10th, 11th or 12th grade year.

8 The three metrics are participation rate, composition index, and relative participation ratio.

9 Additionally, some of the improvement between 2018-2019 and 2019-2020 may be related to the fact that we had only three years of data upon which to base our 2018-2019 ratings for the high school grade band. For 2018-2019, progress toward the initiative’s goals at the high school grade band was determined by looking at CS participation in the 10th through 12th grades, and may have resulted in lower ratings for schools that provided CS predominantly in the 9th grade.

10 The three measures that comprise the equity rating are participation rate, composition index, and relative participation ratio. See the appendix for a detailed description of each of these measures.

11 Quoted in Mirakhur, Fancsali & Hill (2021).


13 The economic need index is a measure of the socioeconomic status of the school population, based on the percent of students in temporary housing, eligible for HRA, and eligible for free lunch.


17 In 2018-19, we had only three years of CS course-taking records, so we calculated the percent of students who took CS in high schools as the percent of 12th grade students who took CS in their 10th, 11th or 12th grade year.

References


Appendix

A. Analytic Approach for Progress Ratings

We calculated progress ratings for all schools and grade bands in community school districts 1 through 32. Schools and grade bands with fewer than nine students were excluded from our analyses. We included three school-year cohorts (2018-2019, 2019-2020, 2020-2021) of students in our analyses. Each cohort comprised students in the terminal grade for each grade band (i.e., 2nd, 5th, 8th, or 12th grade) in October of 2018, 2019, or 2020. For the 2018-2019 cohort, only three years of data were available. Therefore, participation in CS at the high school grade band was defined as taking at least one CS course between 10th and 12th grade for that cohort. Students were counted in the progress rating for the school they attended in October of the terminal grade for the grade band. Students may have attended different schools in years prior to the terminal grade for the grade band.

Participation in CS was defined as taking at least one CS course (integrated or stand-alone) in the three-year grade band for elementary/middle grades and the four-year grade band for high school (with the exception of the 2018-2019 high school cohort, which used a three-year period, as noted above). We used the NYCDOE’s Student Transcript and Academic Reporting System (STARS) data to determine which students had taken a CS course by the end of each grade band. Although NYCDOE defines a “meaningful unit of CS” as including at least 11 hours of CS instruction, we included any course that was recorded in the STARS system as a CS course. We calculated three types of ratings: Saturation, Equity, and Overall Progress. Details on how we calculated each are provided below.

Saturation

Saturation is the percentage of students in the school who had at least one unit of CS instruction, or a stand-alone CS course, by the final year of their respective grade band (i.e., 2nd, 5th, 8th, or 12th grade). Based on this percentage, we assigned each school and grade band a saturation rating (Not offering, Beginning, Progressing, Approaching, Achieving), as shown in Table 1 below.

Equity

This rating takes into account the extent to which student participation in CS is equitable for Black and Latinx students and girls. Three metrics were used to assess equity in CS participation: the participation rate, the composition rate, and the relative participation ratio.

1. Participation Rate is the rate at which students of a particular group (e.g., Black, Latinx, girls) took at least one CS course or unit by the final year of the grade band.

   \[
   \text{Participation Rate} = \frac{\# \text{ students in a population taking CS (e.g., Black, Latinx, girls) who took CS at a given school}}{\text{total number of Black students in the population (e.g., total number of Black students in the grade band in the school)}}
   \]

   Participation rates for subgroups are considered equitable if there is no more than a 10 percentage-point difference between the participation rate of students in the subgroup of interest and the participation rate of students not in that subgroup (e.g., if 30% of Black students and 35% non-Black students—i.e., Latinx, Asian, and White students...
2. **Composition Index** is the percentage of the subgroup of students (e.g., Black students, girls) who take at least one CS course by the final year of a grade band, compared with the percentage of students in that subgroup across the school’s entire grade band. In other words, it compares the demographic composition of CS students in a grade band to the demographic composition of the grade band as a whole.

\[
\text{Subgroup } \% = \frac{\text{(# of students in a population in the school grade band)}}{\text{(total # of students in the school grade band)}}
\]

\[
\text{Subgroup } \% \text{ of CS population} = \frac{\text{( # of students in a population taking CS in school grade band)}}{\text{(total # of students taking CS in school grade band)}}
\]

Composition is considered equitable if there is no more than a 10 percentage-point difference between the subgroup participation rate and the school composition of that subgroup (e.g., if 30% of CS students are Black, and 35% of the school enrollment is Black, the groups are considered equitable in composition index because there is not more than a 10 percentage-point difference between the groups.)

3. **Relative Participation Ratio** is the likelihood that a particular group takes at least one CS course in the grade band, relative to other groups. It is calculated by dividing the subgroup participation rate by the participation rate of all the students not in that subgroup (e.g., participation rate of Black students / participation rate of non-Black students).

\[
\text{Participation rate of a population} / \text{Participation rate of all students not in that population}
\]

Relative ratios between .9 and 1.1 are considered equitable.

We selected these three metrics because they allow us to look at proportionality through different lenses: within groups, in comparison to the larger school race/ethnicity and gender composition, and relative to other groups. By looking at equity through these different lenses, we can assess progress in a more nuanced way. For example, looking across these three metrics allows us to determine if one group’s participation is coming at the expense of another.

To assign an overall equity rating, we calculated the participation rate, composition index, and relative participation ratio separately for girls and Black and Latinx students. We assigned each grade band within a school an equity rating by looking at the number of measures that met our threshold for equitable participation (i.e., no more than a 10 percentage point difference in subgroup participation and a relative participation ratio between .9 and 1.1) in each subgroup. Schools with no subgroups (Black, Latinx, or girls) meeting the equity threshold for all three measures were rated as Beginning. Schools with girls and Black and Latinx students meeting the equity threshold for at least one of the three measures were rated as Progressing. Schools with girls and Black and Latinx students meeting the equity threshold for at least two of the three measures were rated Approaching. Schools that met the equity threshold for girls and Black and Latinx students in all three measures were rated as Achieving. (See table below.)
Equity Rating | Definition
--- | ---
0 - Not Offering CS | No students took CS
1- Beginning | At least 1 subgroup (Black, Latinx, girls) did not meet the equity threshold for any of the 3 metrics*
2- Progressing | All 3 subgroups met the threshold for 1 of the 3 metrics
3- Approaching | All 3 subgroups met the threshold for 2 out of the 3 metrics
4- Achieving | All 3 subgroups met the threshold for all 3 metrics

*Equity is assessed using 3 metrics: Participation rate, composition index, and relative participation ratio.

Overall Progress

To calculate an overall progress rating that takes into account both saturation and equity, we averaged the numerical values attached to each rating category (not offering = 0 to achieving = 4) for saturation and equity. For example, school grade bands that had Beginning ratings for both saturation and equity (averaging 1), or a mix of Beginning and Progressing (averaging 1.5) were rated as Beginning in overall progress. Those with Progressing ratings for both saturation and equity (averaging 2), or a mix of Progressing and Approaching (averaging 2.5) were rated as Progressing. Those with Approaching ratings for both saturation and equity (averaging 3), or a mix of Approaching and Achieving were rated as Approaching (averaging 3.5). And those with Achieving ratings for both saturation and equity were rated as Achieving overall (averaging 4). (See table below.)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Saturation: The percent of students in the school who have had at least one CS course by the last grade in the grade band.</th>
<th>Equity: The extent to which there is equity in female, Black and Latinx student participation in CS.</th>
<th>Overall Progress</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Beginning</td>
<td>1-29 percent</td>
<td>At least 1 subgroup did not meet the equity threshold for any of the 3 metrics*</td>
<td>Average score of 1 or 1.5</td>
</tr>
<tr>
<td>2 - Progressing</td>
<td>30-59 percent</td>
<td>All 3 subgroups met the threshold for 1 of the 3 metrics</td>
<td>Average score of 2 or 2.5</td>
</tr>
<tr>
<td>3- Approaching</td>
<td>60-89 percent</td>
<td>All 3 subgroups met the threshold for 2 out of the 3 metrics</td>
<td>Average score of 3 or 3.5</td>
</tr>
<tr>
<td>4- Achieving</td>
<td>90 percent +</td>
<td>All 3 subgroups met the threshold for all 3 metrics</td>
<td>Average score of 4</td>
</tr>
</tbody>
</table>
B. CS Lead Survey Administration and Sample

We administered the CS lead survey online through Qualtrics between April and July 2021. The sample included all schools with at least one teacher who participated in any type of CS4All sponsored PD between 2016 and 2021 (n=676). For each school, we emailed a link to the online survey to the “CS lead” teacher, defined as a teacher who participated in any of the CS4All leadership PD. If a school had multiple CS leads, we asked them to either work together or to designate one lead to complete the survey. If no one from the school participated in the CS leadership PD, we asked the school principal or administrator who had the most knowledge about the school’s CS instruction and programming to complete the survey. Out of 676 schools in our sample, 363 responded, yielding a response rate of 54 percent. Response rates varied by school level, with a 53 percent response rate from elementary schools, a 22 percent response rate from middle schools, and a 24 percent response rate from high schools.
The Research Alliance conducts rigorous studies on topics that matter to the City’s public schools. We strive to advance equity and excellence in education by providing nonpartisan evidence about policies and practices that promote students’ development and academic success.