Equity in AP CSP Participation Under a Districtwide Graduation Requirement: A 7-Year Analysis of Chicago Public Schools

Onur Ramazan, PhD[1]
Washington State University
Pullman, Washington, United States
Email: onur.ramazan@wsu.edu

Steven McGee, PhD
The Learning Partnership
Chicago, Illinois, United States
Email: mcgee@lponline.net

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[1] Onur Ramazan is currently a postdoctoral research fellow at The University of Hong Kong.

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Abstract

In 2016, Chicago Public Schools (CPS) implemented a computer science graduation requirement anchored by the Exploring Computer Science (ECS) course to create deliberate pipeline to Advanced Placement Computer Science Principles (AP CSP). The present study examined whether AP CSP enrollment demographics mirrored the demographics of schools that offered AP CSP over the first seven years (2016–2017 to 2022–2023). Using data on twelve demographic groups, we computed annual gaps (AP CSP schools% – AP CSP%) and tested for disparities with paired *t*-tests (Bonferroni corrected) and Cohen's *d*. Trend analyses employed Mann-Kendall tests and robust regression with sensitivity checks excluding the final year. White students were proportionally represented and African American students showed overrepresentation that did not survive correction. In contrast, Asian, Multi-Racial, Not Available, Limited English Proficiency and Special Education students were found the be significantly underrepresented after correction. Hispanic and Low-Income gaps were not statistically significant under the adjusted threshold. Only the Special Education gap showed a significant narrowing trend, but this result was not robust to the removal of the 2022-2023 school year. No other group exhibited systematic change. The findings indicate that the ECS-to-AP CSP pipeline has supported equitable participation for several groups, yet targeted and sustained efforts are needed for those where disparities remain robust. Implications for leveraging universal introductory courses to motivate broader advanced CS participation are discussed.

Keywords: Advanced Placement Computer Science Principles, Equity, Chicago Public Schools, Demographic Representation, Longitudinal Analysis

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1. Introduction

In 2016, Chicago Public Schools (CPS) became the first major school district in the United States to require all high school students to complete at least one year of computer science (CS) for graduation (McGee et al., 2022). The policy relied on the Exploring Computer Science (ECS) curriculum and professional development program as the foundational course, and it was preceded by years of capacity-building through the Taste of Computing project (Barrow et al., 2020; Johnson et al., 2022; McGee et al., 2022). After the requirement took effect, the number of CS teachers expanded rapidly and by 2020 nearly every high school offered at least one CS course. Participation rates across all demographic groups rose dramatically and by the second cohort subject to the policy the overall CS-taking population mirrored the district's racial/ethnic composition (Barrow et al., 2020; Johnson et al., 2022; McGee et al., 2022; Ramazan, 2024; Werner & Chen, 2025). These results demonstrated that a well-supported graduation mandate could produce broadly equitable participation in introductory CS.

Despite this overall success, emerging evidence points to enduring inequities in access to and participation in the advanced CS course Advanced Placement Computer Science Principles (AP CSP). By making ECS a graduation requirement, CPS created a structured pipeline. That is, every student is guaranteed at least one course in computer science that is explicitly designed to be inclusive and engaging. This universal exposure builds a broad and diverse foundation of interest and computational thinking skills which in turn feeds directly into AP CSP which is the advanced course that ECS was intended to precede (McGee et al., 2018; 2022). The ECS-to-AP CSP sequence thus functions as a deliberate on-ramp by using the graduation mandate to generate a pool of potential AP CSP enrollees that is more representative of the district's demographics than would be achieved by offering AP CSP as a standalone course (Childs et al., 2024, City of Chicago, Office of the Mayor, 2013; McGee et al., 2022). In schools that lack this feeder structure, AP CSP could simultaneously serve as both the entry point and the capstone which is a tension that can undermine its equity goals. Therefore, CPS's pipeline provides important infrastructure for sustaining representation in advanced computing (Boda & McGee, 2021; College Board, 2025; Redenbaugh, 2022).

Designed explicitly to broaden participation in computing, AP CSP serves as a critical pathway for students seeking college-level CS credit and further study in the field (Ganelin & Dee, 2025; Jeffrey, 2024; Kelleigh et al., 2025; Kolluri, 2018; McGee et al., 2022). Prior work within CPS has found that while all schools offer introductory ECS, not all offer AP CSP and among those that do, representation does not always match district demographics. Specifically, White and Asian students have been consistently overrepresented in AP CSP enrollment while African American, Hispanic/Latinx, low-income, English Learner and special education students have been underrepresented (Ramazan, 2024). However, these patterns may partly reflect how students sort into different advanced CS courses. In the same district, Boda and McGee (2021) found that Asian students were disproportionately concentrated in AP Computer Science A (AP CS A) which is the more programming-intensive alternative to AP CSP whereas African American and Hispanic students were underrepresented in that course. Consequently, Asian students' apparent underrepresentation in AP CSP could stem from their stronger enrollment in AP CS A while other groups' participation in AP CSP may be shaped by differential access to or awareness of the two distinct AP options. Such course-choice dynamics suggest that examining

AP CSP alone may not capture the full landscape of advanced CS participation. It is also important to recognize that the challenges of equitable AP CSP participation are compounded in schools where AP CSP is the first and only CS course offered. A national review of the literature documents that schools in this situation face a distinct set of obstacles which structural tension between the course's AP designation and its introductory-level design (College Board, 2025), teacher isolation and inadequate preparation (Hamlen Mansour et al., 2023; Cuny, 2012), the difficulty of recruiting students without a feeder course to build interest and identity (Mark et al., 2021), unintended policy barriers such as locally imposed prerequisites (McDaniel et al., 2024), program fragility due to single-teacher dependence (Zeringue et al., 2025) and inconsistent effects on the broader CS course landscape (Killen et al., 2019). These challenges are most severe in schools serving high proportions of African American, Hispanic, and economically disadvantaged students that are precisely the schools that equity-oriented policies most need to reach (Diaz et al., 2024). While CPS's model in which ECS serves as a near-universal introductory course addresses many of these challenges by design, the national literature suggests that for schools without such infrastructure, achieving representative AP CSP enrollment requires substantial external support in teacher professional development, implementation planning, and proactive student recruitment (Zeringue et al., 2025; Sax et al., 2020). These disparities raise the question of whether the graduation policy's gains in overall CS equity extend to advanced coursework.

1.1. The Present Study

The present study examines whether representation in AP CSP has grown more equitable over the first seven years of the CPS graduation requirement (2016–2017 to 2022–2023). Given that differential Access to AP CSP has led to demographic differences (Ramazan, 2024), we have limited our analysis to schools that offered AP CSP. Using AP CSP schools' data, we compare the demographic composition of AP CSP enrollment to that of the schools that offered AP CSP across twelve student demographic groups. Grounded in the Participation dimension of the CAPE framework (Fletcher & Warner, 2021), we analyze both the magnitude and the temporal trajectory of representation gaps. Thus, the present study has been guided by two main questions:

RQ1. To what extent do the percentages of each demographic group in AP CSP differ from the demographics of the AP CSP schools across the seven years?

RQ2. Have the representation gaps (AP CSP Schools% – AP CSP%) changed significantly over time, signaling a narrowing or widening of inequities?

2. Methods

2.1. Data

The data for the present study were obtained through a data-sharing agreement with Chicago Public Schools and comprised district-wide and school-level enrollment records for all high schools from the 2016–2017 through 2022–2023 academic years (seven school years in total). For each year, Chicago Public Schools provided aggregate demographic percentages for the schools that offered AP CSP (i.e., the proportion of students within each demographic category relative to AP CSP schools) and separately, the corresponding percentages for students enrolled in AP CSP courses.

2.2. Variables

The primary variables of interest were the percentages of students belonging to specific demographic groups within the AP CSP schools and within AP CSP course enrollment. Twelve demographic categories were examined which encompassed both race/ethnicity and program-status indicators. Race/ethnicity groups included White, African American, Asian, Asian/Pacific Islander, Native American/Alaskan, Hispanic, Multi-Racial, Hawaiian/Pacific Islander and a "Not Available" category for students whose race/ethnicity was not reported. Program-status indicators captured the percentage of students designated as Limited English Proficiency, students receiving special education services and students classified as Low Income (operationalized by eligibility for free or reduced-price lunch which is a common proxy for socioeconomic status; Harwell, 2018). All percentages were calculated by Chicago Public Schools as the number of students in a given category divided by the total number of students in the respective population (AP CSP schools or AP CSP enrollment). From these two sets of percentages, a difference score (Δ) was computed for each year as AP CSP schools% – AP CSP%, where a positive Δ indicates a higher proportion in the AP CSP schools than in the AP CSP course (i.e., underrepresentation in AP CSP) and a negative Δ indicates a higher proportion in AP CSP (overrepresentation).

2.3. Data Analytic Approach

All analyses were conducted in R (R Core Team, 2025). The analytic strategy followed four steps.

First, descriptive statistics (means and standard deviations) were calculated for each demographic group and source (AP CSP schools vs. AP CSP) across the seven years. Time-series line plots were generated to visually inspect trends in representation for all groups. Given the large differences in scale where some race/ethnicity groups accounted for more than 50% of the AP CSP schools while others fell below 1% the plots were split into two separate figures. Figure 1 displays race/ethnicity groups, ordered by their average AP CSP schools prevalence (largest to smallest), with free y-axis scales to highlight the substantial variation in magnitude across groups. Figure 2 presents the other characteristics (Limited English Proficiency, Special Education and Low Income) on their own panels.

Second, to assess whether the representation of each demographic group in AP CSP differed systematically from its AP CSP schools-wide proportion, we conducted paired-samples t-tests on the annual difference scores (Δ) for each group. Because twelve simultaneous tests were performed, a Bonferroni correction was applied to control the family-wise error rate. The adjusted significance threshold was set at $\alpha = .05 / 12 \approx .0042$. The t-test assumes normally distributed differences; given the small number of years ($N = 7$), we supplemented these with non-parametric Wilcoxon signed-rank tests. Effect sizes were quantified using Cohen's d for paired designs where $|d|$ values of 0.2, 0.5, and 0.8 correspond to small, medium and large effects, respectively (Cohen, 1988). For groups whose differences exhibited essentially zero variance (i.e., constant across years), parametric tests could not be computed and only descriptive means are reported.

Third, we examined whether the representation gap (Δ) changed systematically over the seven-year period using two complementary trend analyses. The non-parametric Mann-Kendall test (Kendall's τ) was employed to detect monotonic trends in the gap, providing a robust assessment free from distributional assumptions (Mann, 1945; Kendall, 1948). To quantify the magnitude of any trend, we applied robust linear regression (Huber-type M-estimation with KS2014 settings; Koller & Stahel, 2011) of Δ on school year by using ordinary least squares as a fallback when the robust estimator failed because of near-exact fits. The regression slope (β) represents the average annual change in the gap in percentage points; a positive slope indicates a widening gap (AP CSP schools% growing relative to AP CSP%) whereas a negative slope indicates narrowing.

Fourth, recognizing the sensitivity of trend estimates with only seven time points, we assessed the robustness of the Mann-Kendall and regression results by repeating all trend analyses after excluding the most recent school year (2022–2023). This sensitivity check allowed us to determine whether any apparent trend was driven disproportionately by the final year's data. All tests of trend employed a significance level of $\alpha = .05$. Yet, given the small number of years, the primary emphasis in interpretation was placed on effect sizes, confidence intervals and the stability of findings across analytic approaches.

3. Results

3.1. Descriptive Statistics

Table 1 presented the mean percentages of each demographic group in the CPS AP CSP schools and in AP CSP across the seven academic years from 2016–2017 to 2022–2023. White students' AP CSP schools average (17.9%) exceeded the AP CSP average (16.2%) while African American students were represented at 25.6% in AP CSP compared to 17.7% in the AP CSP schools. The largest AP CSP schools group was Hispanic (M = 52.7%, SD = 2.88), followed by White (M = 17.9%, SD = 0.97) and African American (M = 17.7%, SD = 3.73). Asian students constituted 8.37% of the AP CSP schools but only 6.46% of AP CSP enrollment. The remaining race/ethnicity categories each accounted for less than 2% of the AP CSP schools population and their small absolute sizes mean that year-to-year percentage fluctuations can be pronounced which is a point clearly visible in the separate time-series figures (Figure 1, race/ethnicity; Figure 2, other characteristics) which were sorted by AP CSP schools prevalence to emphasize scale differences across panels. Among non-race/ethnicity characteristics, Low Income students represented the largest group (AP CSP schools M = 77.6%, AP CSP M = 71.2%), while Limited English Proficiency (LEP) and Special Education students averaged 11.4% and 16.2% in the AP CSP schools respectively.

3.2. Paired Comparisons of AP CSP Schools and AP CSP Percentages

Paired samples t tests were conducted on the yearly difference Δ = AP CSP schools% – AP CSP% for all twelve demographic groups. A Bonferroni correction was applied to maintain the family wise error rate at $\alpha = 0.05$, yielding an adjusted significance threshold of $0.05 / 12 \approx 0.0042$. Effect sizes were estimated with Cohen's d for paired data and the Wilcoxon signed rank test provided a non parametric corroboration. Detailed outcomes are given in Table 2.

After correction, five groups demonstrated statistically significant differences. Multi Racial students were slightly underrepresented in AP CSP ($\Delta = 0.30$ percentage points, 95% CI [0.16, 0.43], $t(6) = 5.22$, $p = .0020$, $d = 1.27$) as were Asian students ($\Delta = 1.92$, 95% CI [1.13, 2.70], $t(6) = 5.95$, $p = .0010$, $d = 2.29$). The Not Available category showed a significant underrepresentation ($\Delta = 0.44$, 95% CI [0.28, 0.60], $t(6) = 6.79$, $p = .0005$, $d = 1.92$). Limited English Proficiency students were underrepresented by 2.05 points (95% CI [1.05, 3.05], $t(6) = 5.00$, $p = .0025$, $d = 0.68$) and Special Education students by 3.18 points (95% CI [1.60, 4.75], $t(6) = 4.94$, $p = .0026$, $d = 0.83$). The Wilcoxon test confirmed all these findings ($p \leq .0225$).

Without the Bonferroni correction, African American students ($\Delta = –7.83$, $t(6) = –3.96$, $p = .0074$, $d = –1.80$) and Hispanic students ($\Delta = 5.85$, $t(6) = 2.52$, $p = .0454$, $d = 1.07$) would have appeared significantly different but these results did not survive adjustment (Bonferroni $p = .089$ and .545, respectively). Low Income students who showed a raw p of .025 also failed to meet the corrected threshold (Bonferroni $p = .303$). The remaining groups which were White, Asian/Pacific Islander, Native American/Alaskan and Hawaiian/Pacific Islander yielded negligible and non significant mean differences (all $p > .17$). It is important to note that the very small AP CSP schools proportions of several subgroups (e.g., Asian/Pacific Islander, Native American/Alaskan) mean that even a minor absolute change in enrollment can produce a large relative percentage swing. Thus, non significant results for these groups should be interpreted cautiously.

3.3. Trend Analysis of the Disparity Gap

To determine whether the gap Δ = AP CSP schools% – AP CSP% changed systematically over the seven-year period, we applied two complementary methods: the non-parametric Mann-Kendall test for monotonic trend and robust linear regression (Huber-type M-estimation with KS2014 settings). Because the time series was short, we also examined the sensitivity of any trend to the most recent school year (2022-2023) by repeating all analyses after removing that year. Complete results are provided in Table 3.

Special Education was the only group for which the full data indicated a statistically significant trend. The underrepresentation gap (Δ positive) narrowed over time with a Mann-Kendall τ of –0.71 ($p = .036$) and a robust regression slope of –0.68 percentage points per year ($p = .021$). However, this result depended entirely on the 2022-2023 observation. When that year was excluded, the Mann-Kendall τ weakened to –0.60 ($p = .133$) and the slope became non-significant ($\beta = -0.58$, $p = .119$). Although the point estimates still pointed toward a decreasing gap, the evidence was no longer statistically reliable.

No other group exhibited a significant monotonic trend in either the full or reduced dataset. The gap for Asian students had a slope of 0.25 points per year ($p = .172$) and the Mann-Kendall τ was 0.43 ($p = .230$), neither approaching significance. Hispanic students showed a slope of 0.70 points per year ($p = .625$; $\tau = -0.05$, $p = 1.000$). The African American gap which was negative (overrepresentation in AP CSP) was essentially trendless ($\tau = -0.14$, $p = .764$; slope = –0.13, $p = .911$). Similarly, Low Income gaps showed no systematic change ($\tau = -0.14$, $p = .764$; slope = –1.15, $p = .345$) and the White gap was also stable ($\tau = 0.14$, $p = .764$; slope = 0.60, $p = .429$). The remaining groups which were Asian/Pacific Islander, Native American/Alaskan, Multi-Racial, Hawaiian/Pacific Islander, Not Available and Limited English Proficiency all yielded Mann-Kendall p-values above .23 and regression p-values above .15.

The sensitivity analysis highlighted the instability of slope estimates derived from only seven observations. When 2022-2023 was removed, several slopes reversed sign. For example, the Hispanic slope shifted from 0.70 to –0.97, the African American slope from –0.13 to 0.65 and the White slope from 0.60 to 0.04. In every case, p-values moved further from significance. These fluctuations stressed the caution that should be exercised when interpreting trend analyses with such a limited number of data points. A single year can substantially influence conclusions about the direction and significance of change.

4. Discussion

4.1. Summary of Findings

The present study examined demographic representation in AP CSP across the first seven years of CPS's computer science graduation requirement. Paired-samples t-tests with a Bonferroni correction (adjusted $\alpha = .0042$) compared district and AP CSP percentages for twelve groups and Mann-Kendall tests with robust regression assessed trends in disparity gaps including sensitivity checks that excluded the final school year.

The pattern of participation did not conform to a simple narrative of uniform advantage or disadvantage. White students' AP CSP enrollment was proportionate to their school-level representation. That is, the mean difference was small and non-significant. African American students exhibited an overrepresentation in AP CSP relative to their school-level share although this difference did not survive Bonferroni correction. In contrast, Asian, Multi-Racial and Not Available students were significantly underrepresented even after correction. Among non-race characteristics, Limited English Proficiency and Special Education students were significantly underrepresented whereas the underrepresentation of Low Income students was not statistically robust after adjustment. Hispanic students which is the largest district group showed a mean gap toward underrepresentation that did not reach the corrected significance level.

Trend analyses revealed a largely static landscape. Special Education was the only group with a significant monotonic trend in the full dataset which indicated a narrowing gap, but this result was not robust to the removal of the 2022-2023 school year. No other group exhibited significant trends and many slope estimates reversed sign when the final year was excluded.

4.2. Discussion of Findings

These results complicate the prevailing narrative that advanced CS coursework in CPS is broadly inequitable along demographic lines. The demographic inequity is largely driven by differences in Access to AP CSP. Prior evaluations of the district's graduation requirement documented that the ECS curriculum combined with robust teacher supports dramatically expanded access and brought the overall demographic composition of introductory CS enrollment into alignment with the district (Barrow et al., 2020; Johnson et al., 2022; McGee et al., 2022). The present findings suggest that at schools that offer AP CSP, this equity has extended at least partially to AP CSP. The structured pipeline that CPS built (City of Chicago, Office of the Mayor, 2013; Childs et al., 2024) appears to have created an on-ramp that not only democratized introductory CS but also helped maintain proportionate or even elevated participation for some groups in the advanced course. White students as often presumed to be overrepresented were proportionally represented and African American students showed a tendency toward overrepresentation consistent with finding that they were the most likely to enroll in any CS course once access was accounted for (Barrow et al., 2020). This pattern indicates that the graduation policy's effects on participation may be more durable than previously recognized which reached beyond introductory courses for at least some groups.

However, the significant underrepresentation of Asian students invites a more nuanced interpretation. Nationally, Asian students participate in AP coursework at high rates, yet in CPS they constitute a relatively small share of the overall student body. The gap may partly reflect that Asian students in CPS are disproportionately concentrated in AP CS A, the more programming-intensive alternative to AP CSP (Boda & McGee, 2021). As the ECS-to-AP CSP pipeline broadens the pool of CSP enrollees, the proportion of Asian students may naturally fall below their district percentage as not because they are excluded, but because some opt for a different advanced CS course. The stability of this gap across seven years suggests it is a persistent feature of enrollment patterns rather than an emerging problem, but it also points to the need to examine AP CS A and AP CSP participation jointly to understand the full landscape of advanced CS equity.

Multi-Racial and Not Available students were also significantly underrepresented. The Not Available category may signal that students whose demographic information is incomplete face barriers to advanced course-taking or that data quality issues obscure their participation which are both possibilities that warrant further investigation. The significant underrepresentation of Limited English Proficiency students aligns with well-documented linguistic barriers in advanced coursework (Kolluri, 2018) and is consistent with national findings that AP CSP's promise is often undermined by prerequisite and support gaps (McDaniel et al., 2024). The persistence of this gap with no significant trend over time indicates that access to AP CSP has not been sufficient to overcome language-related obstacles. Similarly, the significant underrepresentation of Special Education students points to enduring challenges that neurodiverse learners face in advanced CS settings, despite a fragile narrowing trend. Prior CPS research noted efforts to increase diversity in CS education (McGee et al., 2022) and the present data provide only suggestive evidence that these efforts may be beginning to affect AP CSP enrollment.

Hispanic students' representation deserves careful interpretation. With a mean gap of nearly six percentage points and a raw p-value of .045, one might have concluded that Hispanic students are significantly underrepresented. However, after Bonferroni correction, this difference was not statistically reliable and the lack of a significant trend further indicates that Hispanic participation has not deteriorated systematically over time. The sensitivity analysis revealed that the direction of the slope reversed when the final year was excluded which may caution against overinterpreting single-year fluctuations.

The general absence of significant trends is perhaps the most telling result. For nearly all groups, the disparity gap neither widened nor narrowed consistently. This stability suggests that the structural factors shaping AP CSP enrollment such as student choice have not shifted in ways that systematically alter relative representation. The CAPE framework (Fletcher & Warner, 2021) distinguishes Capacity, Access, Participation and Experience as interconnected equity dimensions. While earlier CPS research documented that Capacity and Access for AP CSP remain unevenly distributed with schools serving higher percentages of low-income, Hispanic and special education students less likely to offer the course (Ramazan, 2024; Ramazan & McGee, 2025), the present findings highlight that Participation itself presents persistent barriers even where the course is available. The literature on schools that lack a feeder course like ECS documents how teacher isolation (Hamlen Mansour et al., 2023; Cuny, 2012), recruitment difficulties (Mark et al., 2021) and program fragility (Zeringue et al., 2025) compound these participation challenges. CPS's pipeline model mitigates many of these issues by design which may help explain why some groups have achieved proportionate or better representation in schools where the course ids offered while the gaps that persist likely reflect deeper-seated mechanisms such as differential counseling, tracking or belongingness (Kolluri, 2018).

The fragility of the one detected trend which was Special Education is instructive. A single year's data (2022-2023) transformed an otherwise non-significant slope to a significant one. As Werner and Chen (2025) showed in their longitudinal analysis of CS course-taking patterns, multi-year data are essential to distinguish genuine trends from noise. The sensitivity of these results reinforces calls for sustained data collection and for caution when interpreting short time series (Sax et al., 2020; Killen et al., 2019).

5. Implications for Policy

The findings suggest that the CPS graduation requirement has supported equitable AP CSP participation for several groups and that the ECS-to-AP CSP pipeline provides important infrastructure that other districts might emulate (Childs et al., 2024; Redenbaugh, 2022). Policy attention could now shift to the specific groups for which significant underrepresentation persists after correction (i.e., Asian, Multi-Racial, Not Available, Limited English Proficiency and Special Education students). Unlike a blanket equity crisis, the problem is concentrated and therefore more amenable to nuanced actions.

For Asian students, at least in part, the underrepresentation likely reflects student sorting into AP CS A (Boda & McGee, 2021). Schools might consider advising practices that ensure students are aware of both AP CS options and can make informed choices without sacrificing the diversity of either course. For Limited English Proficiency students, language-support structures within AP CSP classrooms and bilingual counseling are essential. For Special Education students, the suggestive but fragile trend toward a narrowing gap indicates that inclusive practices might be having an effect, but at least another full cycle of data is needed. Schools should continue to expand co-teaching models, accommodations and scheduling flexibility. The significant underrepresentation of Multi-Racial students points to the need for disaggregated monitoring and outreach.

The lack of significant trends for most groups implies that systemic change would not occur spontaneously. As demonstrated, AP CSP enrollment is shaped by a complex interplay of school offerings, student preparation and information networks (Ganelin & Dee, 2025). Districts adopting similar graduation requirements should embed equity audits and longitudinal data monitoring from the outset with understanding that closing gaps may require years of sustained and targeted effort. The national literature makes clear that schools offering AP CSP without a preparatory course face compounded challenges in teacher preparation, student recruitment and program sustainability (Hamlen Mansour et al., 2023; McDaniel et al., 2024; Zeringue et al., 2025; Diaz et al., 2024). CPS's experience suggests that a universal introductory course like ECS can serve as a powerful equity lever, but it is not a panacea. Proactive support for the groups that remain significantly underrepresented is still required.

Furthermore, the present findings suggest the motivational advantage of a required introductory course. Research on AP CSP enrollment has shown that students from historically underrepresented groups often rely on external encouragement from counselors, teachers or even course placement policies to enter advanced CS, whereas students with prior positive CS experiences are more likely to self-select (Mark et al., 2021). A universal foundational course like ECS gives all students a structured opportunity to build interest, confidence and a sense of belonging in CS before they face the decision to enroll in an AP-level class. By making that first experience inclusive and low-stakes, districts can transform the advanced course choice from a high-barrier leap into a natural next step where they can motivate a broader and more diverse pool of students to continue. In districts that lack such a feeder course, AP CSP should simultaneously serve as both the recruitment vehicle and the advanced offering which is a dual role that makes it substantially harder to generate the intrinsic motivation that drives sustained participation (College Board, 2025; Zeringue et al., 2025). Therefore, embedding an introductory CS course as a standard component of the high school curriculum whether as a graduation requirement or as a strongly recommended prerequisite may be among the most effective policy levers for closing representation gaps in advanced computing.

6. Limitations and Future Directions

Several limitations should be acknowledged. First, the analysis relied on district-level aggregate percentages over only seven school years which constrained statistical power and precluded more sophisticated time-series models. The sensitivity analyses demonstrated that even the single significant trend was not robust to the removal of one year which emphasizes the fragility of estimates from such a short series. Non-significant trend results should not be interpreted as evidence of stability. Longer time frames may reveal patterns that are currently undetectable.

Second, the use of yearly cross-sectional percentages masks within-school and within-student variation and does not permit examination of individual-level determinants of AP CSP enrollment, such as prior academic achievement, teacher recommendations or student attitudes (Kelleigh et al., 2025). We could not determine whether the observed gaps reflect differential preparedness, scheduling constraints, opportunity hoarding or in the case of Asian students enrollment in alternative advanced courses like AP CS A (Boda & McGee, 2021).

Third, the Not Available category introduces uncertainty. Students with missing demographic data may be disproportionately from marginalized backgrounds and their significant underrepresentation could reflect both participation barriers and administrative data quality issues.

Future research should pursue student-level longitudinal data linked across middle school, high school and postsecondary records to permit the modeling of AP CSP enrollment predictors while controlling for prior achievement, course availability and school characteristics. Qualitative and mixed-methods studies are needed to illuminate the decision-making processes of students from the significantly underrepresented groups (Asian, Multi-Racial, LEP, Special Education) who do and do not enroll in AP CSP despite having access. Intersectional analyses that consider race/ethnicity, gender, socioeconomic status and disability status simultaneously would provide a more nuanced understanding of how multiple identities shape participation. Finally, extending the time series will be critical to ascertain whether the apparently static landscape truly reflects entrenched stability or merely insufficient statistical power to detect slow and cumulative change.

7. Conclusion

The present seven-year analysis of AP CSP participation in CPS reveals a more differentiated picture than broad claims of systemic inequity suggest. White students were proportionally represented and African American students showed a tendency toward overrepresentation. Significant underrepresentation was concentrated among Asian, Multi-Racial, Not Available, Limited English Proficiency and Special Education students. For the vast majority of groups, the participation gap remained stable over the study period with no systematic narrowing or widening. The only apparent trend which was a narrowing gap for Special Education students was not robust to the removal of a single year's data. These findings indicate that CPS's computer science graduation requirement and the ECS-to-AP CSP pipeline it created have supported equitable participation for several demographic groups, yet targeted and sustained efforts are still needed for those where disparities remain statistically robust. The CAPE framework's central insight that equity should be pursued at each dimension of the CS education ecosystem remains as relevant as ever. Capacity and access should be coupled with deliberate strategies to close the participation gaps that endure and the lessons from CPS's pipeline can inform national efforts to build truly inclusive advanced computing pathways.

References

Barrow, L., Freire, S., & de la Torre, M. (2020). *Trends in computer science education: Access, enrollment, and performance in CPS high schools.* University of Chicago Consortium on School Research. https://consortium.uchicago.edu/sites/default/files/2020-07/Trends%20in%20Computer%20Science%20Education-Jun2020-Consortium.pdf

Boda, P. A., & McGee, S. (2021). Broadening participation and success in AP CSA: Predictive modeling from three years of data. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (SIGCSE '21) (pp. 626–631). ACM. https://doi.org/10.1145/3408877.3432421

Childs, J., Zarch, R., Dunton, S., Madkins, T. C., Trautmann, K., Taylor, Z. W., Jacobson, M., Ozturk, S., & Ottenbreit-Leftwich, A. (2024). Advancing equity and access: Addressing the side effects of broadening participation in computer science K–12 education. *Review of Research in Education, 48*(1), 121-153. https://doi.org/10.3102/0091732x241286475

City of Chicago, Office of the Mayor. (2013, December 9). *Mayor Emanuel and CPS CEO Barbara Byrd-Bennett announce comprehensive K-12 computer science program for CPS students* [Press release]. https://www.chicago.gov/city/en/depts/mayor/press_room/press_releases/2013/december_2013/mayor-emanuel-and-cps-ceo-barbara-byrd-bennett-announce-comprehe.html

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203771587

College Board. (2025). *Bring AP Computer Science Principles to your school.* https://apcentral.collegeboard.org/courses/ap-computer-science-principles/bring-csp-to-your-school

Cuny, J. (2012). Transforming high school computing: A call to action. *ACM Inroads, 3*(2), 32–35. https://doi.org/10.1145/2189835.2189848

Diaz, L., Foster, T., & Barashango, S. C. (2024). Does the Advanced Placement Computer Science (CS) Principles course drive equitable and inclusive CS pedagogy, curriculum, and policy as a means to broaden participation in computing? In T. Pearson, M. Israel, & C. Strickland (Eds.), *Proceedings of the 2024 on RESPECT Annual Conference (RESPECT '24)* (pp. 158–162). Association for Computing Machinery. https://doi.org/10.1145/3653666.3656281

Fletcher, C. L., & Warner, J. R. (2021). CAPE: A framework for assessing equity throughout the computer science education ecosystem. *Communications of the ACM, 64*(2), 23–25. https://doi.org/10.1145/3442373

Ganelin, D., & Dee, T. S. (2025). New Advanced Placement course designed to broaden access promotes participation and demographic diversity in computer science education. *Proceedings of the National Academy of Sciences, 122*(15). https://doi.org/10.1073/pnas.2422298122

Hamlen Mansour, K., Jackson, D. K., Bievenue, L., Voight, A., & Sridhar, N. (2023). Understanding the impact of peer instruction in CS Principles teacher professional development. *ACM Transactions on Computing Education, 23*(2), Article 24, 1–21. https://doi.org/10.1145/3585077

Harwell, M. (2018). *Don't expect too much: The limited usefulness of common SES measures and a prescription for change* [Policy brief]. National Education Policy Center. http://nepc.colorado.edu/publication/SES

Jeffrey, W. (2024). *A computer science pipeline? Examining the link between high school coursework and bachelor's degree attainment* [Report]. The Learning Partnership, 1-12. https://doi.org/10.51420/Report.2024.8

Johnson, M., Wachen, J., & McGee, S. (2022). Building Strength in Chicago: Setting the Local and National Computer Science Agendas, Journal of Educational Leadership and Policy Studies, 6(2). https://go.southernct.edu/jelps/files/2022-fall-volume-6/4-Johnson.pdf

Kelleigh, W., Ramazan, O., & McGee, S. (2025). Using placement scores for AP CSP in Chicago Public Schools. In *Proceedings of the 2025 Conference on Research on Equitable and Sustained Participation in Engineering, Computing, and Technology,* 328-333, Newark, New Jersey, United States. https://doi.org/10.1145/3704637.3734787

Kendall, M. G. (1948). Rank correlation methods (4th ed.). Charles Griffin. https://psycnet.apa.org/record/1948-15040-000

Killen, H., Weintrop, D., & Garvin, M. (2019). AP Computer Science Principles' impact on the landscape of high school computer science using Maryland as a model. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education (SIGCSE '19)* (pp. 1060–1066). ACM. https://doi.org/10.1145/3287324.3287356

Koller, M., & Stahel, W. A. (2011). Sharpening Wald-type inference in robust regression for small samples. *Computational Statistics & Data Analysis, 55*(8), 2504–2515. https://doi.org/10.1016/j.csda.2011.02.014

Kolluri, S. (2018). Advanced Placement: The dual challenge of equal access and effectiveness. *Review of Educational Research, 88*(5), 671–711. https://doi.org/10.3102/0034654318787268

Mann, H. B. (1945). Nonparametric tests against trend. *Econometrica, 13*(3), 245–259. https://doi.org/10.2307/1907187

McDaniel, E. L., Christie, A., & Bourgeois, A. G. (2024). Unintentional barriers for AP Computer Science Principles: A course designed for every student. In *Proceedings of the 55th ACM Technical Symposium on Computer Science Education (SIGCSE '24, Vol. 2)* (pp. 1748–1749). ACM. https://doi.org/10.1145/3626253.3635499

McGee, S., Dettori, L., & Rasmussen, A. (2022). *Impact of the CPS computer science graduation policy on student access and outcomes* [Report]. The Learning Partnership. https://doi.org/10.51420/report.2022.4

McGee, S., McGee-Tekula, R., Duck, J., Dettori, L., Greenberg, R.I., Reed, D.F., Wilkerson, B., Yanek, D., & Rasmussen, A.M. (2018, April). Does Exploring Computer Science Increase Computer Science Enrollment? [Paper presentation] American Education Research Association, New York City. https://doi.org/10.51420/conf.2018.1

Mark, J., Zeringue, J. K., Klein, K., Mitchell, T., & Olivares, J. A. (2021). Why do students enroll in AP CSP? In *Proceedings of the 2021 Conference on Research in Equitable and Sustained Participation in Engineering, Computing, and Technology (RESPECT)*. IEEE. https://doi.org/10.1109/respect51740.2021.9620546

R Core Team. (2025). *R: A language and environment for statistical computing* [Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/

Ramazan, O. (2024). *Using the CAPE framework to report access and outcomes from AP CSP courses* [Report]. The Learning Partnership. https://doi.org/10.51420/Report.2024.7

Ramazan, O., & McGee, S. (2025). School-level predictors of offering AP CSP in Chicago Public Schools over time: A multilevel approach [Roundtable session]. American Educational Research Association, Denver, CO. https://doi.org/10.51420/Conf.2025.1

Redenbaugh, M. (2022, November 28). *The computing pipeline: A foundation for diversifying computer science*. UChicago Computer Science News. https://cs.uchicago.edu/news/the-computing-pipeline-a-foundation-for-diversifying-computer-science/

Sax, L. J., Newhouse, K. N. S., Goode, J., Skorodinsky, M., Nakajima, T. M., & Sendowski, M. (2020). Does AP CS Principles broaden participation in computing? An analysis of APCSA and APCSP participants. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education (SIGCSE '20)* (pp. 542–548). Association for Computing Machinery. https://doi.org/10.1145/3328778.3366826

Werner, S. M. & Chen, Y. (2025). *The State of Computer Science in Illinois High Schools Series: Part 5 - How does CS education vary by district across Illinois?* Chicago, IL: Illinois Workforce and Education Research Collaborative (IWERC), Discovery Partners Institute, University of Illinois. https://dpi.uillinois.edu/applied-research/iwerc/current-projects/cs-ed-research/

Zeringue, J. K., Kang, J. M., Spencer, D., Klein, K., & Mark, J. (2025). School implementation planning for equitable AP CSP. In J. A. Stone, T. T. Yuen, L. Shoop, S. A. Rebelsky, & J. Prather (Eds.), *Proceedings of the 56th ACM Technical Symposium on Computer Science Education V. 2* (SIGCSE TS 2025, pp. 1675–1676). Association for Computing Machinery. https://doi.org/10.1145/3641555.3705246

Tables and Figures

Table 1.
Means and standard deviations of demographic percentages by source across time.

Demographic Group	**Source**	**M**	**SD**
White	AP CSP Schools	17.9	0.97
White	AP CSP	16.2	3.23
African American	AP CSP Schools	17.7	3.73
African American	AP CSP	25.6	4.85
Asian/Pacific Islander	AP CSP Schools	0.02	0.01
Asian/Pacific Islander	AP CSP	0.05	0.11
Native American/Alaskan	AP CSP Schools	0.34	0.04
Native American/Alaskan	AP CSP	0.33	0.05
Hispanic	AP CSP Schools	52.7	2.88
Hispanic	AP CSP	46.9	6.59
Multi-Racial	AP CSP Schools	1.80	0.13
Multi-Racial	AP CSP	1.50	0.23
Asian	AP CSP Schools	8.37	0.51
Asian	AP CSP	6.46	0.97
Hawaiian/Pacific Islander	AP CSP Schools	0.28	0.09
Hawaiian/Pacific Islander	AP CSP	0.24	0.10
Not Available	AP CSP Schools	0.82	0.24
Not Available	AP CSP	0.39	0.21
Limited English Proficiency	AP CSP Schools	11.4	2.85
Limited English Proficiency	AP CSP	9.36	3.06
Special Education	AP CSP Schools	16.2	0.48
Special Education	AP CSP	13.1	2.12
Low Income	AP CSP Schools	77.6	7.02
Low Income	AP CSP	71.2	3.64

Note 1. n = 7 school years per group.
Note 2. Percentages do not sum to 100 because categories are not mutually exclusive (e.g., Limited English Proficiency, Low Income) and include a "Not Available" group.

Figure 1.

CPS AP CSP Schools vs AP CSP race/ethnicity demographic percentages over time.

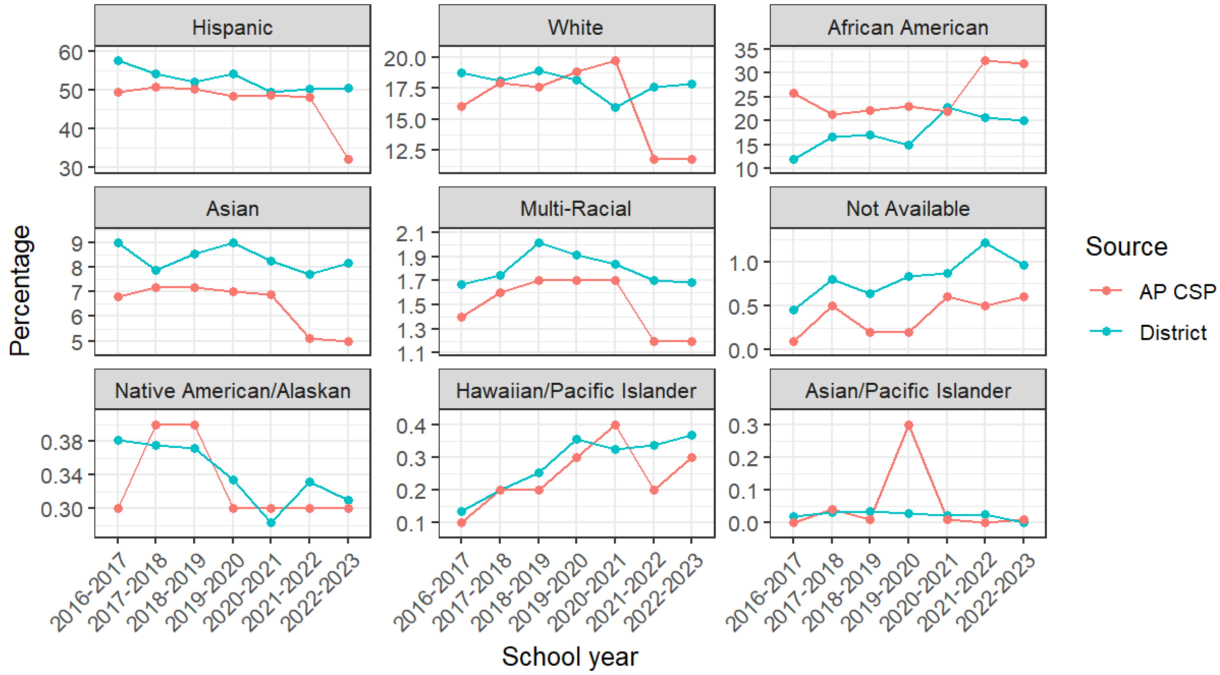

Figure 2.
CPS AP CSP Schools vs AP CSP non-race/ethnicity demographic percentages over time.

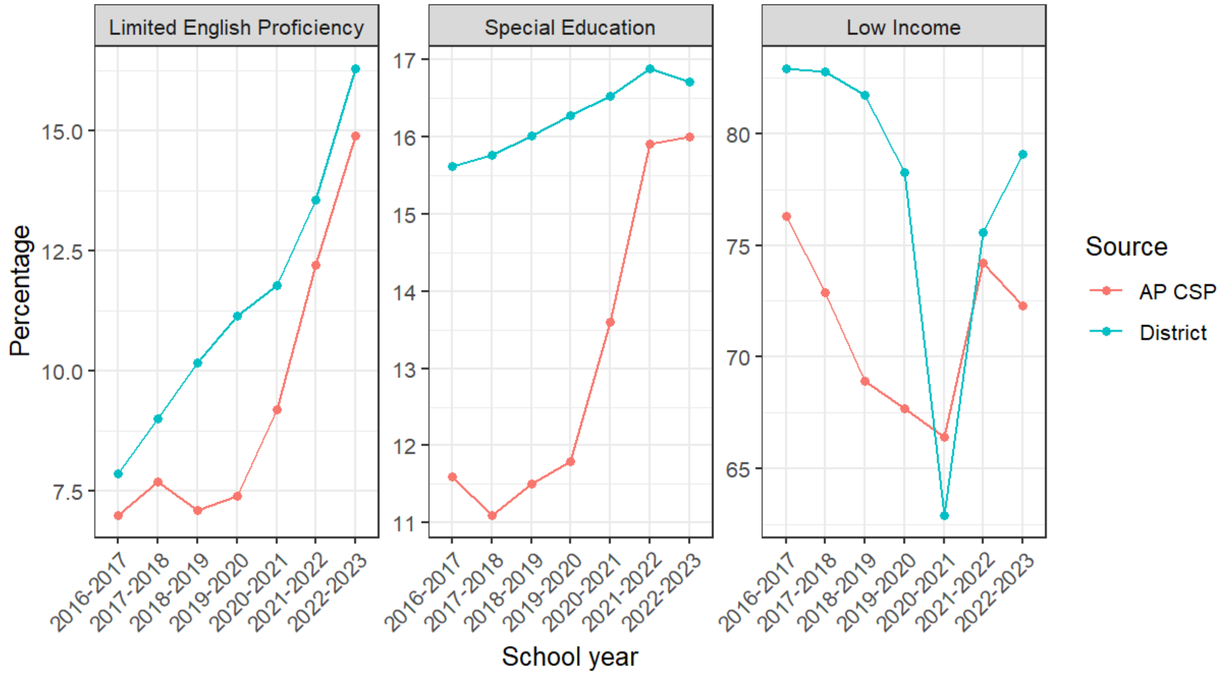

Table 2.
Paired comparisons of AP CSP schools and AP CSP percentages (Δ = District% – AP CSP%).

Group	Δ	95% CI	t(6)	p (raw)	Bonf. p	Sig. (Bonf.)	Cohen's *d*	Wilcoxon *p*
White	1.67	[–1.57, 4.91]	1.26	.2534	1.0000	No	0.721	.2719
African American	–7.83	[–12.67,–2.99]	–3.96	.0074	0.0894	No	–1.798	.0346
Asian/Pacific Islander	–0.03	[–0.13, 0.07]	–0.71	.5033	1.0000	No	–0.320	.5541
Native American/Alaskan	0.01	[–0.02, 0.05]	0.83	.4399	1.0000	No	0.280	.4469
Hispanic	5.85	[0.17, 11.53]	2.52	.0454	0.5447	No	1.069	.0225
Multi-Racial	0.30	[0.16, 0.43]	5.22	.0020	0.0236	**Yes**	1.270	.0225
Asian	1.92	[1.13, 2.70]	5.95	.0010	0.0121	**Yes**	2.285	.0225
Hawaiian/Pacific Islander	0.04	[–0.02, 0.10]	1.54	.1735	1.0000	No	0.409	.2719
Not Available	0.44	[0.28, 0.60]	6.79	.0005	0.0060	**Yes**	1.917	.0225
Limited English Proficiency	2.05	[1.05, 3.05]	5.00	.0025	0.0294	**Yes**	0.681	.0225
Special Education	3.18	[1.60, 4.75]	4.94	.0026	0.0312	**Yes**	0.829	.0225
Low Income	6.38	[1.11, 11.65]	2.96	.0252	0.3028	No	1.016	.0519

Note 1. Negative Δ indicates overrepresentation in AP CSP and positive Δ indicates underrepresentation.
Note 2. Bonferroni threshold = 0.0042.
Note 3. "Sig. (Bonf.)" marks differences that remain significant after correction.

Table 3.
Trend analysis of the disparity gap (Δ = AP CSP schools% – AP CSP%) – all years vs. excluding 2022-2023.

Group	Analysis	**n**	**MK τ**	**MK p**	**Slope (pts/yr)**	**SE**	**Slope p**
White	All years	7	0.143	.7639	0.601	0.698	.4288
	Excl. 2022-23	6	–0.200	.7071	0.037	0.995	.9725
African American	All years	7	–0.143	.7639	–0.133	1.133	.9114
	Excl. 2022-23	6	0.067	1.000	0.651	1.651	.7133
Asian/Pacific Islander	All years	7	–0.048	1.000	–0.001	0.003	.7551
	Excl. 2022-23	6	0.067	1.000	0.002	0.004	.6055
Native American/Alaskan	All years	7	–0.048	1.000	–0.003	0.009	.7622
	Excl. 2022-23	6	–0.067	1.000	–0.004	0.013	.7417
Hispanic	All years	7	–0.048	1.000	0.700	1.347	.6253
	Excl. 2022-23	6	–0.467	.2597	–0.966	0.622	.1956
Multi-Racial	All years	7	0.238	.5480	0.043	0.026	.1535
	Excl. 2022-23	6	0.067	1.000	0.030	0.038	.4795
Asian	All years	7	0.429	.2296	0.250	0.157	.1720
	Excl. 2022-23	6	0.200	.7071	0.136	0.202	.5379
Hawaiian/Pacific Islander	All years	7	0.429	.2296	0.010	0.013	.4952
	Excl. 2022-23	6	0.333	.4524	0.010	0.021	.6626
Not Available	All years	7	0.238	.5480	0.024	0.037	.5432
	Excl. 2022-23	6	0.333	.4524	0.058	0.042	.2420
Limited English Proficiency	All years	7	0.238	.5480	0.044	0.239	.8617
	Excl. 2022-23	6	0.333	.4524	0.199	0.325	.5727
Special Education	**All years**	**7**	**–0.714**	**.0355**	**–0.676**	**0.204**	**.0210**
	Excl. 2022-23	6	–0.600	.1329	–0.583	0.294	.1188
Low Income	All years	7	–0.143	.7639	–1.147	1.101	.3453
	Excl. 2022-23	6	–0.200	.7071	–1.958	1.469	.2534

Note 1. Positive τ/slope = gap increased (AP CSP schools% grew relative to AP CSP%) and negative = gap narrowed.
Note 2. All regression models used robust M-estimation (KS2014).
Note 3. Bold row indicates the only test reaching nominal significance ($p < .05$) with all years, but note the result is not robust to removal of 2022-2023.