Examining Capacity and Equity in Computer Science in Chicago Public Schools: A Longitudinal Study

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1. Introduction

In 2016, Chicago Public Schools (CPS) implemented a groundbreaking policy requiring all high school students to complete one year of computer science coursework to graduate (McGee et al., 2018). This initiative aimed to expand access to computer science education and prepare students for the growing demands of the digital economy. A key component of this effort was the inclusion of Advanced Placement Computer Science Principles (AP CSP) courses which provide students with college-level instruction and the opportunity to earn college credit. However, the availability of these courses heavily depends on the presence of qualified AP CSP teachers as schools without certified instructors are unable to offer the program (e.g., Fletcher & Warner, 2021). The CAPE (Capacity, Access, Participation and Experience) framework highlights the importance of teacher capacity as a foundational element for ensuring equitable access to advanced computer science education (Fletcher, 2021; Fletcher & Warner, 2021).

The present study investigates the factors associated with the likelihood of schools having at least one AP CSP-certified teacher in CPS from 2016 to 2023 school years. The analysis focuses on demographic as well as structural and institutional factors that are related to teacher availability, such as school size, student demographics and socioeconomic indicators (e.g., Bryk et al., 2010; Ramazan, 2024). Prior research has shown that schools with larger enrollments and higher proportions of White and Asian students are more likely to offer AP CSP courses while those serving predominantly Hispanic or Latinx, low-income or special education students often face barriers in securing qualified instructors. Therefore, the present study aimed to identify systemic inequities and inform policies that can expand teacher capacity in underserved schools by examining these trends over time. The findings are hoped to contribute to discussions about educational equity and the role of institutional support in fostering inclusive access to advanced computer science coursework.

2. Methods

Data Background. The primary data source for this study was derived from 106 high schools within the Chicago Public Schools (CPS) district, spanning seven academic years from

2016–2017 to 2022–2023. The dataset encompassed comprehensive school-level information, including demographic composition (e.g., racial/ethnic breakdown, socioeconomic status and special education enrollment), institutional quality metrics (e.g., Five Essentials survey scores) and teacher qualifications (e.g., ECS certification). These variables were selected to align with the CAPE framework which systematically examines Capacity, Access, Participation and Experience in CS educational settings (Fletcher & Warner, 2021).

Data Analysis. To analyze the likelihood of schools having at least one AP CSP-certified teacher over time, a multilevel binary logistic regression was employed. This approach accounted for the hierarchical structure of the data where schools were nested within school years and allowed for the examination of both fixed and random effects (Snijders & Bosker, 2011). Predictor variables were grand-mean centered to ensure interpretability of the intercept which is a recommended practice for multilevel models to avoid conflating within- and between-group effects (Enders & Tofighi, 2007). The analysis was conducted using Jamovi v2.5, which is an R-based statistical software which facilitated robust handling of hierarchical data structures and model fit evaluation through log-likelihood and deviance metrics (Jamovi Project, 2024). The methodological rigor of this approach provided a nuanced understanding of the factors influencing AP CSP teacher availability across CPS schools while accounting for temporal and institutional variability.

3. Results

The analysis began with an unconditional multilevel logistic regression model which revealed minimal between-school-year variance in the likelihood of having an AP CSP teacher, as indicated by an intraclass correlation coefficient, $ICC = 0.009$. This suggests that only 1% of the variance in AP CSP teacher presence was attributable to differences across school years while the remaining variance was due to school-level or other unmeasured factors. The conditional demographic model (Table 1) incorporated schools' demographic characteristics as predictors, with results showing that higher percentages of White students ($\beta = -0.054$, $p = 0.004$), Hispanic/Latinx students ($\beta = -0.009$, $p = 0.012$), students with unreported race/ethnicity ($\beta = -0.495$, $p < 0.001$) and students eligible for free/reduced lunch ($\beta = -4.817$, $p < 0.001$) were associated with a reduced likelihood of a school having an AP CSP teacher. Conversely, schools with higher proportions of Asian students ($\beta = 0.087$, $p = 0.005$) demonstrated an increased likelihood of having an AP CSP teacher. None of the other variables in this model yielded significant contributions.

Table 1. Demographic Model				
Variable	***Estimate***	***SE***	***exp(B)***	***p***
White Students (%)	-0.054	0.019	0.947	0.004
Black/African American Students (%)	0.007	0.004	1.007	0.068
Native American/Alaskan Students (%)	0.159	0.304	1.172	0.601
Asian/Pacific Islander Students (%)	11.152	6.048	69698.212	0.065
Latinx/Hispanic Students (%)	-0.009	0.004	0.991	0.012
Multiracial Students (%)	0.031	0.161	1.032	0.846
Asian Students (%)	0.087	0.031	1.090	0.005
Hawaiian/Pacific Islander Students (%)	0.096	0.394	1.101	0.808
Race/Ethnicity Not Available (%)	-0.496	0.129	0.609	<0.001
Bilingual Students (%)	-1.804	1.018	0.165	0.077
Special Education Students (%)	-0.723	0.597	0.485	0.226
Students Receiving Free/Reduced Lunch (%)	-4.817	0.980	0.008	<0.001

The capacity model (Table 2) further identified school size ($\beta = 0.001$, $p = 0.005$) and the number of Exploring Computer Science (ECS) teachers ($\beta = 1.071$, $p < 0.001$) as positive predictors of AP CSP teacher presence which could reinforce the role of institutional resources in supporting computer science education. Interestingly, while family involvement ($\beta = 0.028$, $p = 0.005$) was positively associated with AP CSP teacher availability, collaborative teaching environments ($\beta = -0.065$, $p < 0.001$) showed a negative relationship which could suggest that structural or administrative factors may influence teacher placement in ways that diverge from conventional expectations. The capacity model exhibited better fit (marginal $R^2 = 0.747$) compared to the demographic model ($R^2 = 0.268$) which highlights the importance of school-level capacity factors in explaining AP CSP teacher distribution. None of the other variables in this model yielded significant contributions.

Table 2. Capacity Model				
Variable	***Estimate***	***SE***	***exp(B)***	***p***
School Size	0.001	0.0003	1.001	0.005
Effective Leaders	0.024	0.015	1.024	0.099
Collaborative Teachers	-0.065	0.017	0.937	<0.001
Involved Families	0.028	0.010	1.028	0.005
Supportive Environment	-0.003	0.019	0.997	0.858
Ambitious Instruction	0.016	0.019	1.016	0.392
At Least Partially Qualified ECS Teachers	1.071	0.180	2.920	<0.001

4. Discussion

The findings of the present study highlight critical disparities in the having AP CSP-certified teachers across Chicago Public Schools (CPS) from 2016 to 2023 and point to systemic inequities in computer science education. The minimal between-school-year variance (*ICC* = 0.009) suggests that differences in teacher presence may have been primarily driven by school-level factors rather than temporal trends (Snijders & Bosker, 2011). The demographic model revealed that schools with higher proportions of White, Hispanic/Latinx and low-income students were less likely to have an AP CSP teacher while schools with more Asian students showed increased likelihood. These results aligned with the established CAPE framework indicating that underserved populations often face barriers in accessing advanced computer science courses (Fletcher & Warner, 2021). The negative association with free/reduced lunch eligibility further emphasizes the intersection of socioeconomic status and educational inequity as schools serving economically disadvantaged students may lack resources to recruit or retain qualified instructors (McGee et al., 2018).

The capacity model provided additional insights that demonstrate that larger schools and those with more ECS-certified teachers were more likely to have an AP CSP teacher, reinforcing the role of institutional resources in supporting computer science education (Fletcher, 2021). The positive association with family involvement aligns with broader literature on the importance of community engagement in educational outcomes (Bryk et al., 2010). However, the negative relationship with collaborative teaching environments was unexpected and may reflect administrative or structural challenges in schools where collaboration does not translate into teachers being encouraged to obtain additional qualifications. The superior fit of the capacity model (marginal R^2 = 0.747) compared to the demographic model (R^2 = 0.268) reiterates the significance of school-level capacity factors in shaping AP CSP teacher distribution. This could suggest that policies targeting institutional resources such as funding for teacher professional development or incentives for underserved schools could be more impactful than demographic-focused interventions alone (Warner et al., 2022).

5. Implications

Our findings have important implications for policymakers and educators seeking to promote equity in computer science education. Addressing the shortage of AP CSP teachers in schools serving marginalized populations requires specific strategies such as expanding professional development programs for certification (Fletcher & Warner, 2021). Additionally, fostering partnerships between schools and community organizations could enhance teacher recruitment efforts (Bryk et al., 2010). The present study's longitudinal approach also highlights the need for sustained investment in capacity-building initiatives to ensure long-term equity in access to advanced coursework. CPS or similar school districts could move closer to achieving the goal of equitable computer science education for all students, regardless of race, socioeconomic status or institutional context by addressing these systemic barriers.

6. Conclusion

Findings revealed disparities in having AP CSP teachers based on school demographics and school characteristics in CPS. Efforts such as professional development for ECS teachers and incentives for diverse teacher recruitment could improve capacity. Strengthening family engagement and providing resources to underserved schools could be essential for fostering equity in computer science education in CPS.

References

Bryk, A. S., Sebring, P. B., Allensworth, S. L., Luppescu, S., & Easton, J. Q. (2010). *Organizing schools for improvement: Lessons from Chicago*. University of Chicago Press. https://consortium.uchicago.edu/publications/organizing-schools-improvement-lessonschicago

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods*, *12*(2), 121-138. https://doi.org/10.1037/1082-989x.12.2.121

Fletcher, C. (2021). *Equity in computing: Thoughts from Carol Fletcher*, Texascale Magazine. https://texascale.org/2021/peopleprograms/equity-computing/

Fletcher, C.L., Warner, J.R. (2021, February). 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

Jamovi Project. (2024). *Jamovi (Version 2.5)* [Statistical Software]. https://www.jamovi.org

McGee, S., McGee-Tekula, R., Duck, J., Dettori, L., Greenberg, R. I., Reed, D. F., Wilkerson, B., Yanek, D., & Rasmussen, A. M. (2018). *Does exploring computer science increase computer science enrollment?* [Paper presentation] Annual Conference of American Education Research Association, New York City, New York. https://doi.org/10.51420/conf.2018.1

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

Snijders, T. A., & Bosker, R. J. (2011). *Multilevel analysis: An introduction to basic and advanced multilevel modeling* (2nd ed.). SAGE. https://us.sagepub.com/enus/nam/multilevel-analysis/book234191

Warner, J. R., Fletcher, C. L., Martin, N. D., & Baker, S. N. (2022). Applying the CAPE framework to measure equity and inform policy in computer science education. *Policy Futures in Education*. https://doi.org/10.1177/14782103221074467