Exploring Predictive Factors for Chicago Public Schools to Expand Advanced Placement Computer Science Principles

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Submitted in partial fulfillment of the requirements for the degree of

Doctor of Education

in

Leadership and Learning in Organizations

Peabody College of Education and Human Development

Vanderbilt University, Nashville, Tennessee

May1, 2023

Abstract

Background

The purpose of this quantitative project was to explore school-level factors that may impact a Chicago public high school's likelihood of offering Advanced Placement Computer Science Principles (AP CSP). We collaborated with the Chicago Alliance for Equity in Computer Science (CAFÉCS), a researcher-practitioner partnership (RPP) dedicated to expanding computer science access for all students, especially those typically underrepresented in computer science. This study quantitatively analyzed 52 school-level variables that The Learning Partnership received from Chicago Public School (CPS) high schools from school years (SY) 2016-2017 through 2020-2021. This project sought to examine the following questions:

1. What student-factor variables impact the likelihood that AP CSP is offered in CPS high schools?
2. What teacher-factor variables impact the likelihood that AP CSP is offered in CPS high schools?
3. What school context-factor variables impact the likelihood that AP CSP is offered in CPS high schools?

Methods

We obtained our data on CPS school-level variables from The Learning Partnership, which has a data share agreement with CPS. We developed a conceptual framework for this project consisting of 19 independent variables that were a synthesis of the data set and of the literature review of student, teacher, and school context factors that might impact curricular expansion. We used multiple logistic regression to analyze the data due to the binary nature of our dependent variable: did a high school offer AP CSP, yes or no.

Results

Our results showed that five of the 19 variables were statistically significant. The presence of AP CSP partially qualified teachers and a five-year high school graduation rate correlated with an increased chance of a CPS high school offering AP CSP, while increased percentages of Black students, increased percentages of students enrolled in special education, and the presence of a Career and Technical Education – Information Technology (CTE-IT) track correlated with decreased chances of a CPS high school offering AP CSP. Our findings were consistent with the literature surrounding two of the five statistically significant variables. Increased percentages of Black students were linked to reduced curricular offerings, and teachers, as a resource, were linked to expanded curricular offerings. Surprisingly, the remaining three statistically significant variables, a five-year graduation rate, the percentage of students participating in special education, and the presence of a CTE-IT track in a high school did not appear in the literature as impacting curricular expansion, which may indicate opportunities for future research.

Recommendations

Our recommendations include an initial expansion of AP CSP in STEM high schools that do not offer the course but have an AP CSP teacher who is at least partially qualified to teach it, while simultaneously working to make those partially qualified teachers fully qualified through local professional development credentialing sessions. Another recommendation is to conduct a case study of the schools that currently offer AP CSP to determine how they were able to implement the course into their curriculum. Our final recommendation is from the literature, not the results, and it is to expand the professional community of practice opportunities for all computer science teachers as one way to address potential pipeline issues in obtaining and

retaining more AP CSP teachers. This project can assist with informing educational stakeholders about future research when determining optimal environments and support systems that might be needed when deciding where AP CSP courses might be initiated within CPS.

Keywords: high schools, curriculum expansion, teacher professional development, logistic regression, equity, College Board

Acknowledgments

Cynthia Hargrow Lightner

I praise my Lord and Savior, Jesus Christ, who has always provided the strength I needed to successfully complete any task at hand, in His time, according to His will. Thank you Lord. Thank you, Virginia and Frank Hargrow, for being excellent parents, life-long educators, and for teaching us how to build and maintain a relationship with God. Thank you, Vernon Lightner, for being my husband, my rock, my covering, and for providing wise counsel since we met. Thanks to our children: C. Alex M. H. L. Jackson for being the reason I tried to work hard and emulate excellence, to be a good example for you; Jaquese and Ashley Lightner, for letting me share your dad because he has been my biggest supporter during this process. Thanks to my brothers, my sisters-in-law, my mother-in-law, my nephews and nieces, my cousins, my family, my friends, and my godmother, Dr. Brenda (Gupton) Flowers. Besides my husband, Vernon, we did not get to choose one another, but you stuck by me. Thanks to my sisters and brothers in arms. Thanks to the naysayers over the decades for the additional fuel on top of all the love and support I have received. Some folks that started with me have died in Christ, but they encouraged me through this process and continue to remain ever-present in my heart and mind.

I want to express my profound professional gratitude to the many people who supported this journey, and these are but a few: Dr. Erin Henrick, our capstone advisor, Dr. Rafael Garcia, our quantitative advisor, all the LLO staff and faculty, Dr. Ken Maaz and Dr. Toni Shub, for guidance; and Dr. Steven McGee, President of The Learning Partnership and our point of contact for the Chicago Alliance for Equity in Computer Science and Chicago Public Schools.

True friends are rare, and to have folks keep their friendship unconditional is even harder to find, but not impossible, as I learned again with Cohort 8 of LLO Peabody College and others

in the program with whom I shared this journey. We were all strangers until January 2020, and over the past three years, we have become colleagues, friends, and a support system to one another. I could not imagine going through this journey with any other group. The cohort was encouraging, kind, and thoughtful, as iron sharpens iron.

It was a privilege to share this path with Dr. Beverly S. Hamilton (Ph.D.), who was an amazing STEM educator and a quantitative wizard all by herself before deciding to partner with me on this capstone. Thank you, Beverly, for being so gracious and for all that you have done and continue to do. They say it takes a village, and truly this work and the accompanying journey took a large village. I cannot name everyone, but I am grateful to you all.

Beverly S. Hamilton

First and foremost, all honor and glory goes to God because without Him nothing is possible, and all things are possible. He has sustained me through this process, and I thank Him.

My husband, Gary Hamilton, Sr., has been my rock throughout this endeavor, and I truly am blessed to be sharing this life with him. My boys, William, Benjamin and Gary Jr., have encouraged me to keep pressing through even when I would get tired. I want to thank my mother, Helen Shands, who is the epitome of what I hope to be one day. She has shown me through her love and actions how to be the matriarch of the family.

I want to express my sincere gratitude to my capstone advisor, Dr. Erin Henrick. Her guidance and continued support has been invaluable.

To my LLO partner, Cynthia Hargrow Lightner, I appreciate you more than you will ever know. I could not have prayed for a better compliment. I know that people are put in your life for seasons and for certain reasons. I know that you were meant to be my partner through this process. I have and will continue to cherish the bond that we have formed.

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Part I: Introduction

The purpose of this quantitative study was to explore school-level factors that may impact a Chicago public high school's probability of offering Advanced Placement Computer Science Principles (AP CSP). We partnered directly with The Learning Partnership, which is a part of the Chicago Alliance for Equity in Computer Science (CAFÉCS) researcher-practitioner partnership (RPP), to examine their available data to determine the main factors that influence whether schools offer AP CSP.

Chicago Public Schools (CPS) system is the third largest school district in the United States, serving approximately 371,000 students, 78 percent of whom are from low-income families and 18 percent of whom are English language learners (Chenoweth & Brown, 2018; de Brey et al., 2022). The district has made steady improvements from its 1987 worst-in-the-nation status (Banas & Byers, 1987; Kelleher, 2015) to a standardized test score growth rate from 2009 through 2014 that was higher than 96 percent of all school districts in the United States (Reardon & Hinze-Phifer, 2017), due in part to committed partnerships with key stakeholders and a commitment at many levels to making data-informed decisions (Chenoweth & Brown, 2018; Kelleher, 2015).

One specific CPS partnership is with the CAFÉCS RPP, which consists of CPS, three universities in Chicago, and The Learning Partnership. In 2016, CPS made CS a high school graduation requirement (Dickey, 2016; Elahi, 2016), and one way this has been facilitated has been with the introduction of a new course, Exploring Computer Science (ECS), and its companion course, AP CSP (McGee et al., 2022). Exploring Computer Science was designed and released in 2008 (Margolis et al., 2015). In 2011, CPS adopted the ECS curriculum and through local initiatives obtained the funding and support needed to implement ECS by 2016

(Margolis et al., 2015). Meanwhile, a College Board Commission, with National Science Foundation (NSF) funding, partnering with an advisory committee, created the framework for AP CSP (Cuny, 2011; Briggs & Snyder, 2012). The district decided to use these courses to help expand its computer science (CS) curricular offerings, in part because both courses were designed to reach a more diverse group of students than previous CS courses, making them a good fit for CPS student demographics.

In 2016, CPS had 82 percent of students participating in the federal free and reduced lunch program, 16 percent of students participating in a special education program, and 6 percent of students who were English as second language learners. At the end of SY2020-2021, the CPS student population included 47 percent Latinx, 36 percent Black, 11 percent White, and 6 percent Asian, Pacific Islander, Indigenous, and multi-ethnic students (Chicago Public Schools, 2023).

The success of having an introductory CS course has led to a new challenge related to all students having access to subsequent CS courses. The Department of Computer Science (DoCS) would like to continue to design pathways that support CS integration capacity to ensure that all students have expanded CS options available to them at their school, and expanding AP CSP offerings allows the DoCS to create more CS pathways. Given the goal to bring more diversity to CS, our partner's desire to focus on scaling initiatives in these schools first is one way to make sure access is equitable in Chicago. This is one way our project nests within CPS's goal of AP CSP course expansion.

Advanced Placement Courses

Advanced placement courses and exams are governed by the College Board, a non-profit headquartered in New York State (College Board, n.d.-c). The courses were initially created in the 1950s for high-achieving students at private schools ("College Board Plans," 2002; Kolluri,

2018; Long et al., 2019; Rothschild, 1999). Under the auspice of the College Board, AP courses have expanded across numerous types of educational settings, improving the ability of students from less privileged areas to take AP courses (Deaton, 2018; Helmet & Swiderski, 2022; Rodriguez & McGuire, 2019; Rowland & Shircliffe, 2016). While altruism is a motivator, as some states pay the AP exam fee for students (Lively, 1993), the College Board benefits from the revenue, and students benefit because if they pass an AP exam, they may receive college credit for a first-year CS course and/or placement in higher-level college CS courses, potentially saving students time and money while in college (Ackerman et al., 2013; Lively, 1993).

Additionally, CPS wants to increase the number of students who achieve early college credit in any area (S. McGee, personal communication, September 28, 2022). After completing an AP CSP class, students may sit for the AP CSP exam. If students pass this exam with a score of "3" or higher, they may receive college credit for a first-year CS course and/or placement in higher-level college CS courses (College Board, n.d.-b; Mattern et al., 2013). If more district high schools offer AP CSP, in theory, more students will be prepared to take and pass the AP CSP exam. This is another way our project nests within CPS's desire to increase the number of students who achieve early college credit.

Challenge

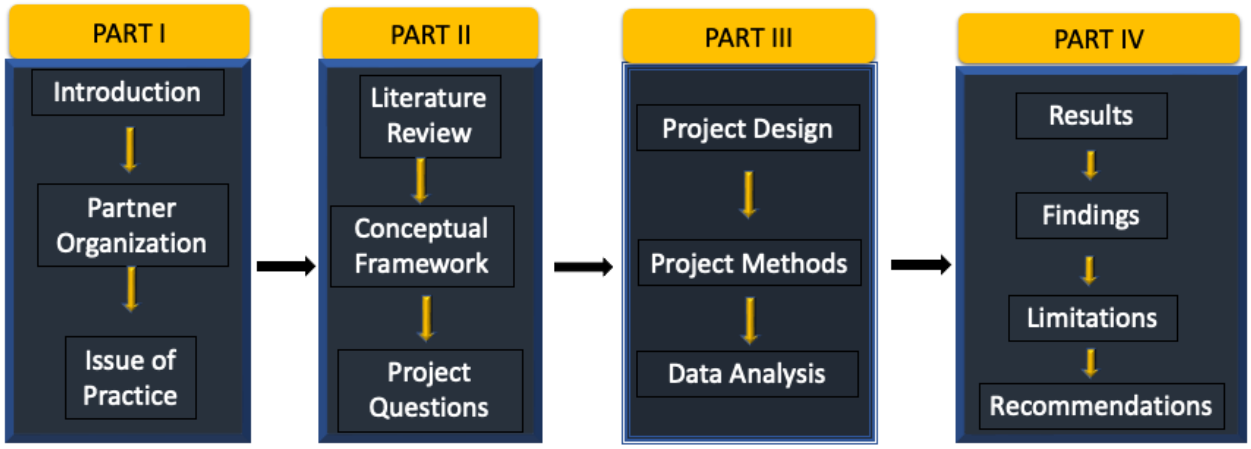
One of the immediate challenges for our partner organization is trying to determine the main factors that influence whether a Chicago Public high school offers AP CSP. To refine our project's scope, our partner recommended using the CAPE (Capacity for, Access to, Participation in, and Experience of equitable CS education) framework (Fletcher & Warner, 2021) when examining adding AP CSP to existing curricular offerings. This project focused on the capacity component of CAPE when exploring these variables. Our partners may use this

project, along with other data, to examine another dimension of CAPE or the CAPE framework in full for AP CSP in CPS. As we partnered with CAFÉCS, their members asked if we could examine available data to determine the school-level factors that influenced whether high schools offer AP CSP, and this study endeavored to accomplish that.

Outline of the Capstone

Figure 1

Capstone Outline



This capstone is divided into four parts as outlined in Figure 1. In Part I, we introduce our project, discuss our partner organization, and determine the issue of practice. In Part II, we have our literature review, conceptual framework, and project questions. In Part III, we discuss our data source, the variable selection process, lay out our project design and methods, and discuss our analysis. We conclude in Part IV by discussing the evaluation of results, findings, limitations, and recommendations. Results from the analysis feed into the formalized problem-solving cycle used by this RPP. In the past decade, RPPs have emerged as long-term partnerships formed to analyze educational issues or problems of practice (Penuel et al., 2020; Sjölund et al., 2022). The problem-solving cycle for CAFÉCS includes the following steps: First, the DoCS identifies an issue. Next, the CAFÉCS team brainstorms and prioritizes hypotheses to test. Next,

data analysis clarifies the issue, and the research findings are shared and interpreted by the entire team. Next, the findings are used to inform DoCS improvement strategies and subsequent steps for the CAFÉCS research agenda, and the process continues (Henrick et al., 2021). There are slight variations in the problem-solving cycle, depending on the stage of understanding the issue, which impacts the mode of research (Shub & Maaz, 2021). This project is part of an initial planning step, and we hope our findings inform future planning and research strategies. We turn to the discussion of our partner organization.

Partner Organization

We partnered with CAFÉCS, an RPP, whose goal is expanding CS access for all students, especially those typically underrepresented in computer science. This RPP consists of Chicago Public School's DoCS; our client, educational researchers in The Learning Partnership; and computer science faculty from DePaul University, Loyola University, Chicago, and the University of Illinois, Chicago (UIC) (https://cafecs.org/about-us/). This project was possible because of a data-sharing agreement between The Learning Partnership and CPS to use collaboration and research to further the goal of expanding access to quality CS for all students. We highlight CAFÉCS and our client, the DoCS.

CAFÉCS

In 2009, a few CPS CS teachers decided students should have access to high-quality CS education, and these pioneers discovered that a like-minded group of computer science educators was working on developing a curriculum that engaged students in important computer science concepts regardless of their previous experience (Chicago Alliance for Equity in Computer Science [CAFÉCS], n.d.; McGee et al., 2022; Wilkerson, 2018). In subsequent years, they partnered with local researchers at DePaul, Loyola, UIC, and The Learning Partnership to secure

funding for teacher professional development (PD) and to create policies that emphasized equitable CS education for all students (CAFÉCS, n.d.). The Learning Partnership was our primary point of contact and essential partner as this organization leveraged the advantages of enduring partnerships within CAFÉCS to assist in research that informs solutions and studies how to support learning from an individual cognitive perspective as well as from the perspective of systems and social contexts (The Learning Partnership, n.d.).

With funding from the NSF, CAFÉCS was codified as an RPP to influence policy as well as aid and assist teacher PD as the cornerstone of expanding CS accessibility for all students, especially those typically underrepresented in CS. Through extensively tested curricula and PD programs, CAFÉCS provided evidence that fostered increased CS engagement across numerous student demographics. Those evidence-backed gains in CS and teacher development enabled the district to enact a CS graduation requirement for students entering high school in SY2016-2017 (Henrick et al., 2021; McGee, 2018; Shub & Maaz, 2021).

The Department of Computer Science, Chicago Public Schools

In 2008, the core group of educators within CPS sought external CS partnerships and started to advocate internally for the growth of computer science education in CPS. These pioneers initiated the first Computer Science for All (CS4All) movement in the nation, which grew into DoCS, a leading organization in CS education and teacher PD (Chicago Public Schools, n.d.-a; Hopper & Rahm, 2018; Wilkerson, 2018). The initial incarnation of CS4All, launched in 2013, established CPS's high school CS graduation requirement in 2016 (CSforAll, n.d.), which was the first in the nation. Through various incarnations, the group's focus has been the equitable integration of computing into every student's PK-12 course of study.

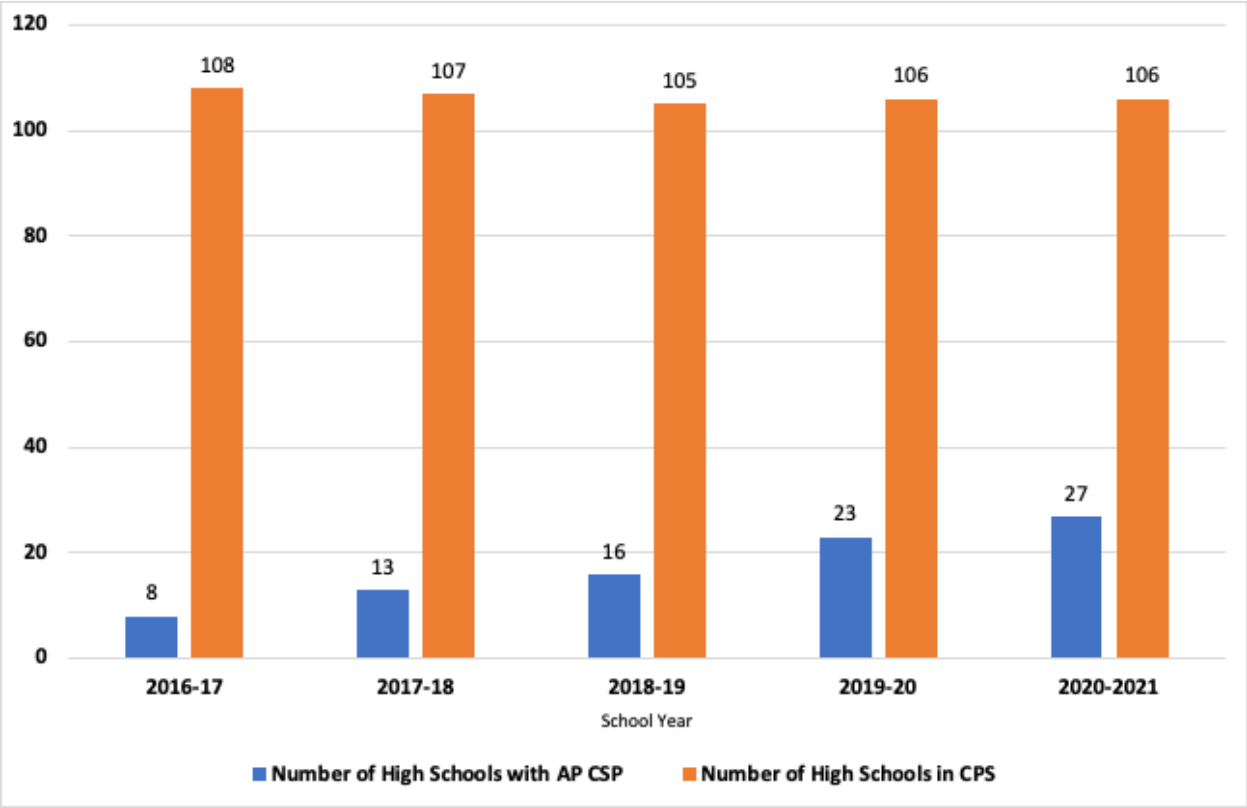
The current DoCS mission is "[t]o maximize the innate potential of every student through a computer science education defined by equity, empowerment, and opportunity" (Office of Computer Science, n.d.). This department has made equity, inquiry, and CS content core pillars of its mission by seeking to optimize all student learning through expanding CS access, especially to students traditionally underrepresented in those fields, which is a priority for CPS. This organization understands that equity and access are issues in the ongoing goal to ensure all high school students meet the CS course mandate. Regardless of CS courses being mandatory, DoCS knows it must develop students and teachers to gain the needed tools for current and future personal and professional development. Moving forward, DoCS and CPS will continue to prioritize all their curricular efforts to focus limited resources for maximum impact, while balancing competing needs and priorities and determining the best courses of action to achieve their goals. The hope is this partnership with CAFÉCS will inform these efforts.

Issue (Problem) of Practice and Its Importance

Our partner organization wanted to increase the AP CSP offerings across more high schools in CPS, and they are developing a strategy for how to best do this by investigating school characteristics related to whether AP CSP is offered. Our contacts wanted to know of the available school-level characteristics, which were most likely to predict where AP CSP might be introduced next in CPS to expand this curricular offering.

Figure 2

Number of High Schools with AP CSP Compared to Total High Schools in CPS from SY2016-2017 to SY2020-2021



Our partners want to extend this trend and introduce AP CSP across more high schools. They are developing a multi-phased strategy for how to best do this. We are participating in an initial phase, investigating what school-level variables impact whether a high school in the district offers the course. By understanding which of the available school-level variables are most likely to predict the likelihood AP CSP might be offered, researchers and practitioners may use this information to target finite resources and expand this curricular offering. There are numerous reasons why increasing AP CSP access is important.

Part II: Literature Review

We start with how we organized and explored the literature review surrounding the project. We present our conceptual framework which drew from our synthesis of the literature. We conclude with our project questions.

The investigation of the literature started with grouping the school-level variables on how they related to students, teachers, and school contexts. See Appendix A for the full list of variables and definitions. As we grouped the variables by how best they related to students, teachers, and school contexts, we used the terms factors or characteristics to describe the three variable groups. We did this so as to not confuse the school-level variables with actual student-level and teacher-level variables to which we did not have access, due to time constraints.

The literature review aimed to 1) capture what the literature said about student, teacher, and school characteristics that impact whether a school offers AP CSP and 2) investigate the literature related to each of the available variables to inform the study design. Not all the characteristics in the groupings had links to AP CSP, so we searched the literature to find research on how certain characteristics might impact CS and STEM curricular expansion, finding overlap and more gaps. Because of those continuing gaps, we opened our aperture again to include research on how certain characteristics might impact curricular expansion in general. Most of the literature surrounding these factors examined their impacts on student outcomes. However, there was research surrounding the importance of providing teacher PD when introducing AP CSP. We highlight other characteristics associated with curricular expansion in each summary section, but now we turn to examine the literature on student factors.

Student Factors

Research Indicated Higher Percentages of Underrepresented Students Were Linked to Reduced Course Offerings

The student factors we explored were characteristics of students typically underrepresented in CS and STEM courses. This was represented by student ethnicity (e.g., Black, Latinx, Indigenous, or any combination of ethnic backgrounds and bilingual students), students enrolled in special education, and students enrolled in the free and reduced lunch program. Appendix A provides the variables and definitions.

In general, larger percentages of non-White students are associated with fewer AP CSP offerings, but the reasons why are varied. Even as diverse student participation in AP CS exams has increased since 2003, a participation gap by ethnicity and gender persists (Howard & Havard, 2019). Bright spots in the research have shown that while a gap still exists, greater numbers of Latinx, Black, and female students have participated in AP CSP compared to AP CS A, a course offered before AP CSP was created that focuses on programming (AP Students, n.d.), and these underrepresented students have scored higher on the AP CSP exam (College Board, 2018; Howard & Havard, 2019; Jones, 2018; Partovi, 2018; Sax et al., 2022). One reason the gap exists is ethnic minorities are more likely to attend lower-resourced schools that do not offer opportunities for computing (Cuny, 2012), and in general, larger percentages of non-White students in a school usually mean lower property taxes in the area, which translates to fewer local funds for a school and a school district. Fewer funds for a school usually mean reduced resources to offer courses outside of the core curriculum.

Interestingly, some research has shown that college-bound Black and Latinx students are more likely than their White peers to be interested in a career in computing (Benyo & White,

2009; Royal & Swift, 2016), and in certain magnet schools, they are on par with (Davis, 2014) or more likely than (Conger et al., 2009) White students to take advanced courses. One could infer from these studies that increasing access to AP courses could be a crucial step in closing the underrepresented student gap generally, and specifically in AP CSP.

Research Indicated Schools With Higher Rates of Participation in Free/Reduced Lunch Programs Tended to Offer Fewer Courses

In a meta-analysis of socioeconomic status (SES) and academic achievement, Sirin (2005) noted that researchers have often used participation in free/reduced lunch programs as a proxy for SES. What the literature showed consistently was schools with large rates of participation in free/reduced meal programs and/or schools located in economically depressed neighborhoods were linked to lower student outcomes (Fowler & Walberg, 1991; Friedkin & Necochea, 1988; Jencks et al., 1972; Summers & Wolfe, 1975). A study of Catholic high schools mostly located in low SES neighborhoods tended to offer fewer courses in general (Bryk et al., 1993), indicating that the higher the families' SES, on average, the more course offerings a school is likely to have.

However, for the definitive study on links between SES and curricular offerings, we turned to Monk and Haller (1993). They noted that with high schools of similar size, higher SES schools in urban areas offered wider course options than schools with lower SES scores in non-urban settings. In this study, parental SES was reported by students, and SES was positively correlated with advanced course offerings. Subsequent research measuring SES as eligibility for subsidized meals (Betts et al., 2000; Iatarola et al., 2011; Long et al., 2019) supported Monk and Haller's (1993) findings

Summary: Student Factors

The literature provided evidence that student ethnicity, specifically Black and Latinx students, and SES were linked to course offerings. We now turn to the literature synthesis on teacher factors.

Teacher Factors

The teacher factors we explored surrounded ECS and AP CSP teacher qualifications, PD, the number of teachers available to teach those courses at a high school annually, and the average years of teaching ECS. Appendix A provides the variables and definitions.

Research Indicated Teacher PD was a Central Feature of Successful ECS and AP CSP Launches

This was a bright spot where literature had direct links to examined factors and AP CSP. Specifically, when AP CSP was launched, the College Board and the NSF understood teacher effectiveness was going to be essential to its initial success and longevity, so they created specific training and support for those selected to teach the course (Aspray, 2016; Astrachan et al., 2015; Briggs & Snyder, 2012; Cortina et al., 2012; Cuny, 2011, 2012; Goode et al., 2014; Margolis & Bernier, 2014). This indicates teacher PD was critical not only to the implementation but also to the continued growth of AP CSP. Also, researchers found that having well-prepared teachers was an important element for the ideal implementation of AP science courses in under-resourced areas (Long et al., 2019). Moreover, stakeholders have known and research has supported the idea that teacher PD and training are important to student outcomes at all educational levels (Boyd et al., 2008; Clotfelter et al., 2010; Cohen & Hill, 2000; Coleman et al., 1966; Corey, 1957; Darling-Hammond, 1996, 2000; Darling-Hammond et al., 2005; Desimone et al., 2002; Goode et al., 2014; Griffin, 1983; Guskey, 1986; Kane et al., 2007; Lankford et al.,

2002; Loucks-Horsley, 1998; Loucks-Horsley et al., 1996; No Child Left Behind, 2002; Seebruck, 2015; Swinton et al., 2010; Valencia, 2000), and AP CSP and STEM courses, in general, are no exceptions (Shub & Maaz, 2021; National Research Council, Center for Education, & Committee on Science and Mathematics Teacher Preparation, 2001).

Research Indicated Teacher Experience Did Not Generally Impact Curricular Expansion

Another component of teacher effectiveness was the length of time teaching or experience (Darling-Hammond, 2000; Kim & Seo, 2018). Educational stakeholders know and research has supported the idea that teacher experience is important to student outcomes (Betts et al., 2000; Clotfelter et al., 2010; Hanushek & Rivkin, 2009; Harris & Sass, 2011; Huang & Moon, 2009; Peske & Haycock, 2006; Rockoff, 2004; Wolters & Daugherty, 2007; Xu et al., 2015). More importantly to this project, and as mentioned previously, national-level stakeholders implementing ECS and AP CSP targeted teacher capacity and experience by ensuring there were funds available for teacher input and the presence of accessible teacher learning communities during the formation and initial rollout of these courses (Aspray, 2016; Astrachan et al., 2015; Cuny, 2011, 2012; Margolis & Bernier, 2014) and CS courses in general (Cortina et al., 2012).

Recently, AP curricular expansion in Florida has garnered international attention because input from national interest groups and state-level politicians was contrary to and overrode teacher input gained through years of classroom experience and who had run pilot classes over the past year (Halpert, n.d.; Hartocollis & Fawcett, 2023; The Associated Press, 2023). In summary, teacher input gained through experience and training has not impacted the initiation of curricular expansion in general.

Another facet of teacher experience to note is that research has shown that students of first-year teachers learned less, on average, than students of more experienced teachers (Boyd et al., 2008; Kim & Seo, 2018), and their academic gains were significantly lower than those of students taught by otherwise similar teachers with 10 to 15 years of experience (Kane et al., 2007; Rivkin et al., 2005; Rockoff, 2004; Wolters & Daugherty, 2007). The literature has also been clear that on average, schools with more economically disadvantaged students, often students of color, tend to have more inexperienced teachers than higher-income schools (Betts et al., 2000; Blankenberger et al., 2017; Boyd et al., 2008; Clotfelter et al., 2010; Coleman et al., 1966; García et al., 2022; Hanushek & Rivkin, 2009; Lankford et al., 2002; Peske & Haycock, 2006; Rice, 2010; Sass et al., 2012; Valencia, 2000), which speaks to an uneven distribution of educational resources at the student, teacher, and school levels.

Research Indicated the Number of Non-Certified Teachers May Impact Curricular Expansion

The number of teachers in a school can impact the courses that a school might offer. Teacher shortages can lead to canceled courses, classes with substitutes, or underprepared teachers who are not certified to teach the subject matter (Carver-Thomas, 2022; Davis & Davis, 2003; García et al., 2022). Conversely, if a school has an adequate number of certified teachers, it may be able to offer a wider range of courses, as there will be more people available to teach them. Moreover, specialized teacher availability can also impact the types of courses a school can offer.

While teachers have input into curricular options, they generally do not initiate them. Most curriculum expansion decisions are made by school administrators and politicians at various levels. The literature indicated that federal or state policy preceded curriculum change

(Blankenberger et al., 2017; Davis & Davis, 2003; Long et al., 2019; National Education Association, 1894, 1918), particularly expansion. Additionally, research by Iatarola et al. (2011) found that school administrators in Florida used students' standardized test scores and stakeholder demand, somewhat unburdened by teacher qualifications and experience when deciding whether to expand course offerings. Furthermore, school boards and state legislators in the early 2000s chose to expand the high school curriculum in Illinois as a way to create students who were better able to gain skills to compete for national and international jobs (Blankenberger et al., 2017), focusing on teacher inputs after the expansion decision.

Summary: Teacher Factors

Studies have indicated that NSF and other stakeholder organizations that partnered with the NSF focused on teacher PD and experience as central features of successful AP CSP curricular launches by funding PD oriented to ECS. More generally, studies have shown the sheer quantity of teachers can impact curricular expansion when viewing teachers as a resource, regardless of their certifications, education levels, or years of teaching. We turn to examine the literature synthesis on the final group of characteristics surrounding school context factors.

School Context Factors

The school context factors we explored were enrollment size, school quality, the college culture of a school, the attendance rate, the length of time it took to graduate from high school, and the presence of a CTE-IT track. Appendix A provides the variables and definitions.

Research Indicated High Schools With Larger Enrollments Tended to Have More Course Offerings

In general, larger high schools tend to be able to offer more course options, but estimating the impact of enrollment size on learning is complicated, in part because research

outcomes vary and because students in small and large high schools differ in numerous observed and unobserved ways. Optimal school size for maximum student academic achievement has been a perennial issue in education research (Berry & West, 2010; Bryk et al., 1993; Friedkin & Necochea, 1988; Garabito, 1980; Kenny, 1982; Lee & Smith, 1995, 1997; Lee et al., 1993, 1997; McMillen, 2004), with results indicating a range of optimal sizes (Crispin, 2016; Lee & Smith, 1997; Werblow & Duesbery, 2009). Research indicated that while larger schools tend to have more courses, studies have shown that one size does not fit all and that optimal school size was a complex and complicated issue.

Economists tend to look towards efficiency, maximizing inputs and outputs, so curricular expansion research with an economist's lens has highlighted the benefits of larger high schools by focusing on the ability of larger schools to amass and distribute more resources to more students (Gardner et al., 2000; Kenny, 1982; Ratcliffe et al., 1990). From an economist's lens and when cost efficiency was a primary goal, larger high schools tended to be able to offer more course options (Bryk et al., 1993; Conant, 1959; Conger et al., 2009; Lee & Bryk, 1989; Lee et al., 2000; Leithwood & Jantzi, 2009) and more AP courses (Malkus, 2016; Monk & Haller, 1993). Conversely, smaller schools tended to have limited course offerings (Davis & Davis, 2003), but researchers noted some benefits of smaller high schools, even with fewer resources. One benefit was the ability to connect deeply with more students, allowing educational stakeholders to recognize and resolve student issues earlier, heading off challenges such as failing and dropping out altogether. A few of these articles noted that while enrollment size impacted course offerings, the family's SES seemed to be the largest structural factor influencing course offerings (Monk & Haller, 1993).

Research Indicated School Quality Rating Policy Ratings Did Not Directly Impact Curricular Expansion

The School Quality Rating Policy (SQRP) is a CPS rating system that has provided stakeholders with information about schools annually and is a proxy for school quality. The SQRP scores, first issued for SY2014-2015 using SY2013-2014 data such as student test scores, academic growth, school culture, attendance, graduation, and other metrics, placed schools on a five-tiered scale, ranging from Level 1-plus for the best-performing schools to Level 3 for those with the most support required for improvement (Issa, 2022). Level 3 schools have been subject to administrator replacement, mandatory local school council elections, closure, or other actions (Department of School Quality Measurement and Research, 2019). The general thought has been that Level 3 schools need intensive infusions of resources and support and were less likely to engage in curriculum expansion and that Level 1 and 2 schools offered more courses. This was not a direct link in the literature but an implied link. The additional resources that Level 3 schools could potentially be distributed to any number of areas.

The literature did not indicate that the ratings directly impacted curricular expansion. Additionally, CPS is moving away from using SQRP to an evaluation system with greater consideration and accountability at the district level for resources (e.g., funding to schools) and conditions (e.g., safe and inclusive professional and student learning environments) that impact a high-quality educational experience in schools (Issa, 2022). If we frame the question of whether high-quality educational experiences impact curricular expansion, we find literature supporting this in schools promoting college readiness, discussed next.

Research Indicated High Schools Promoting a College Readiness Culture May Impact Curricular Expansion

An early college and career education (ECCE) score is a measure of a school's ability to provide access and support for rigorous, college-level, hands-on, and career-focused courses; facilitate the design and implementation of high-quality STEM learning environments; and establish secondary to employment pipelines that accelerate CPS students towards post-secondary success by offering college credit, professional credentials, and the soft skills needed to succeed in college, civic life, and the 21st-century labor market (Chicago Public Schools, n.d.-b). As noted previously, AP course offerings have expanded and improved the ability of students from less privileged schools to take AP courses (Deaton, 2018; Helmet & Swiderski, 2022; Rodriguez & McGuire, 2019; Rowland & Shircliffe, 2016). Schools offering more AP courses is a mark of their college readiness culture (Conley, 2007), and schools that want to appeal to college-bound students tend to expand their AP, International Baccalaureate (IB), honors, and dual credit offerings (Conley, 2007; Corwin & Tierney, 2007; Malin et al., 2017; Villavicencio et al., 2013). Adding advanced placement courses to existing high school curriculums to better prepare students for postsecondary education has been the mission of the College Board and its AP program from the beginning (College Board, n.d.-a; "College Board Plans," 2002; Cornog, 2020; Norton, 1956; Rothschild, 1999; Schultz, 1950).

The degree to which secondary schools foster a college culture for students can be an important factor in increasing underrepresented students in successful post-secondary educational endeavors (Aldana, 2014; Bryk et al., 1993; Martinez et al., 2020; Villavicencio et al., 2013). Increasingly, U.S. workforce participation will require some form of a college degree or certification (Atkinson, 2013; Briggs & Snyder, 2012; de Brey et al., 2022; Helmet &

Swiderski, 2022; Malin et al., 2017; President's Council of Advisors on Science and Technology, 2010; U. S. Bureau of Labor Statistics, 2022).

Conley (2007), operationalized college readiness as a level of preparation needed to succeed without remediation in a postsecondary institution that offers an undergraduate degree or transfers to an institution that offers an undergraduate degree. A college culture in K-12 can be imagined as one that resources districts and empowers students, parents, teachers, counselors, administrators, and the community to know that all students should be educated with high expectations and prepared for higher education (Aldana, 2014; Corwin & Tierney, 2007; National Education Association, 1894; Oakes, 2003; Sheehan & Rall, 2011; Tierney & Hagedorn, 2002). When schools are sufficiently resourced, academic outcomes and college preparedness may still be unequally realized among underrepresented students (Allen et al., 2011, as well as when underrepresented students attend inadequately resourced schools (Stanton-Salazar, 2011; Villavicencio et al., 2013).

Research Indicated Student Attendance Impacted Student Outcomes but not Curricular Expansion

We could not find research linking student attendance to AP CSP, CS, or expanding course offerings in general. However, many educational stakeholders agree that attending K-12 school is an important contributor to academic and future life success (Gonzales et al., 2002; Goss & Andren, 2014; McKee & Caldarella, 2016; National Center for Education Statistics, 2022; Onifade et al., 2010; U.S. Department of Education, 1996; Youth Justice Board, 2013; Zhang et al., 2007).

While there are many reasons for students not consistently attending high school, research has established solid correlations between low attendance and dropping out of school

(Gonzales et al., 2002; U.S. Department of Education, 1996; Zhang et al., 2007). Research also links schools with chronic student absenteeism to endemic poverty (Cheng & Balfanz, 2013; Singer et al., 2021). Generally, Black and ethnically underrepresented students experience chronic absenteeism more in urban areas, while White and Indigenous students experience it more in rural areas, and one common factor is poverty (Cheng & Balfanz, 2013; Goss & Andren, 2014; Singer et al., 2021). A study indicated that in Chicago, middle school attendance rates and grades were predictive of chronic high school absenteeism and dropout (Allensworth et al., 2014), which was similar to findings in a nationwide study where the researchers found that middle school attendance, grades, GPA, and standardized test score were predictive of students failing the ninth grade (McKee & Caldarella, 2016).

An interesting observation was that over time, the literature moved from focusing on individual factors surrounding school attendance and negative labeling (e.g., truancy) (U.S. Department of Education, 1996) to examining more environmental factors and using more neutral nomenclature (e.g., absenteeism) (Fornander & Kearney, 2019). With this larger examination of factors contributing to attendance, researchers acknowledged poverty, whether individual, family, or neighborhood, was an influence on attendance (Allensworth et al., 2014; Berliner, 2009; Cheng & Balfanz, 2016; Gennetian et al., 2018; Singer et al., 2021).

Even with research depicting this link between attendance rates and poverty, there was an absence of research linking student attendance to AP CSP, CS, or general curricular expansion. This area may need further exploration should the results lead us in that direction.

Research Indicated a Career and Technical Education-Information Technology Track did not Impact Curricular Expansion

Schools with CTE programs usually have higher numbers of underrepresented and non-college-bound students enrolled in those programs, but the literature does not show that CTE programs in general, detract resources from other curricular offerings, especially not from AP courses. Studies have shown CTE offerings tend to marginalize underrepresented students (Kao & Thompson, 2003; Kelly, 2009; Lee & Bryk, 1988; Nunn, 2011; Oakes, 2005; Southworth & Mickelson, 2007), while placing White and Asian students in college preparatory tracks and placing Black and Latinx students in different tracks (Kelly, 2009; Mickelson, 2001; Noguera, 2003). There was limited research showing that more vocational tracks help students (Plank et al., 2008; Tau, 2015) who do not see a four-college in their immediate future upon graduation. Furthermore, federal legislation has been designed specifically to structure CTE programs to prepare students for industry-recognized credentialing (Lewis & Kosine, 2008), realizing these students may need additional education outside of high school to earn certification. In general, CTE programs can place high school students further along the path in their chosen careers, which is similar to what AP classes do for students headed to four-year colleges.

Research Indicated a Five-Year High School Graduation Rate was a Positive Outcome for Students but did not Show That it Impacted Curricular Expansion

For this study, the variable, a five-year graduation rate, refers to the percentage of students who started high school five years earlier and graduated from that same high school, including students who graduated in four years (S. McGee, personal communication, February 15, 2023). The U.S. standard for the duration of high school is four years (Seastrom et al., 2006), referred to as on-time graduation. Some stakeholders may view taking more than four years to

graduate from high school in a negative light, but some see the five-year, or higher, graduation rate as an indication of the effective use of a school's resources in helping its students complete their high school education against certain odds (Rhode Island Department of Elementary and Secondary Education, 2012; West Virginia Board of Education, 2012).

Numerous studies have examined U.S. high school graduation trends, but the research does not indicate that five-year graduation rates impact curricular offerings. The No Child Left Behind Act of 2001 (2002) included reporting graduation rates as an accountability requirement, placing additional emphasis on tracking and reporting high school graduation rates. Since this law passed, researchers and stakeholders have exhibited renewed interest in examining high school graduation rates, exploring reasons for increases (Allensworth, 2005; Goldin & Katz, 2007; Mishel & Roy, 2006), numerous causes and potential solutions for decreases (Allensworth & Easton, 2007; Heckman & LaFontaine, 2007, 2010; Kena et al., 2015; Mishel & Roy, 2006; Murane, 2013; Roy & Mishel, 2008; Stark & Noel, 2015; Warren & Halpern-Manners, 2009), and reasons for discrepancies in various reported rates (Allensworth, 2005; Greene, 2002; Heckman & LaFontaine, 2007; Koenig & Hauser, 2011; Roy & Mishel, 2008; Swanson & Chaplin, 2003; Warren & Halpern-Manners, 2007). In summary, there has been a lack of consensus on the magnitude and trends of U.S. high school completion rates over the past few decades. Next, we will highlight research showing that over several decades, U.S. students have been taking more time to earn high school diplomas.

One study examining U.S. data from 1945 to 1984 found that while four-year public school graduation rates have declined, the rates of students earning a high school degree by age 24 have been relatively constant (Joo & Kim, 2016). This study also noted that male students have been taking longer to earn those degrees than female students and Latinx and Black

students overall have been taking longer to earn high school degrees than White students (Joo & Kim, 2016). This was interesting because it points to certain underrepresented student populations taking longer to earn a degree, and these same ethnic groups have been over-represented in other areas, such as participating in the free/reduced lunch program; having less experienced, less qualified teachers; being tracked into CTE programs in schools with large numbers of students; and having lower attendance rates. The article suggests that taking more than four years to earn a high school degree may be becoming more normalized.

Richard Murane (2013) conducted a smaller study prior to the Joo and Kim (2016) study but found similar results. Murane examined Massachusetts high schools and found over nine percent of Black and Latinx students took five years or more to graduate. Within that research, he examined one urban and suburban high school in Massachusetts. Both schools had high student enrollment and large numbers of non-White students. He found the urban school had substantially lower four-year graduation rates and higher five-year rates, and the differentiating factor was the urban school had a majority of students eligible for free/reduced lunch, while less than ten percent of the students in the suburban school were eligible for free/reduced lunch, indicating SES played an important part in explaining graduation rates. While this and other studies pointed to financial resources impacting high school graduation trends, the research does not indicate that five-year graduation rates impact curricular offerings.

Summary: School Context Factors

Schools with larger student enrollments and schools with a culture of preparing students to attend postsecondary education have been linked to expanded curricular offerings. While other contextual characteristics, such as quality ratings, student attendance rates, and graduation rates were linked to student outcomes, we did not find research indicating a link between these

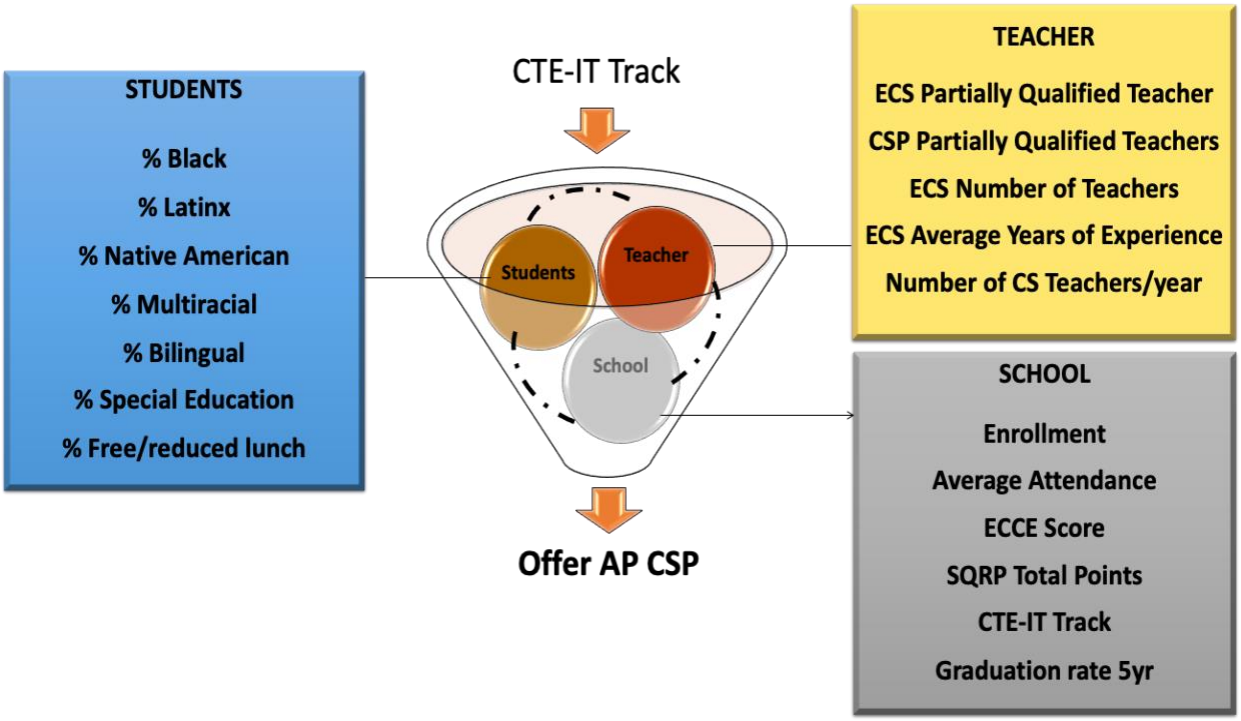
characteristics enhancing or detracting from any curricular offerings. We will transition from the literature review to the conceptual framework depicting the main objective studied, the key elements, and an explanation of how we determined linkages (Miles et al., 2014), based on the literature, the data, and input from our partner organization.

Conceptual Framework

There are many contributory factors that can play a role in the ability of a school to offer AP CSP. The initial set of variables can be found in Appendix A. These variables were classified into three broad categories: student, teacher, and school context factors. After synthesizing the literature, we established the most probable sets of variables within these categories that could provide explanations for a decision made at the school level to introduce AP CSP. Our partner organization felt that schools with the ability to offer the CTE-IT track might not have the resources, especially teachers, to be able to simultaneously offer AP CSP. For this reason, after sorting by school year, CTE-IT was the initial lens examined in our model (see Figure 3).

Figure 3

Conceptual Framework



Within the student factors, the percentages of ethnicities and special education students were included in the framework. Previous research supports that schools with higher numbers of students of color and schools with high numbers of students participating in the free and reduced lunch program do not have as many course offerings. In the teacher variables, we included the qualification and quantity of teachers. Teachers were partially qualified if they had completed at least part of the professional development training. Teachers were considered fully qualified if they completed the full professional development program or had a computer science endorsement. The *at least partially qualified* variable included those that were partially qualified and those that were fully qualified. Research has shown that teacher professional development and training directly correlate to better student outcomes. In fact, when looking at the

intersection of the cluster of teacher and student variables, schools with higher numbers of students of color tend to have less qualified teachers when compared to their companion schools.

The college preparatory culture and climate of the school as indicated by the ECCE score represents a possible predictor of whether AP courses would be in the curriculum at those schools. Schools with higher attendance have historically been shown to provide more course offerings in their curriculum. There is a gap in the literature examining attendance trends and their effect on AP courses, but there is literature that supports that lower attendance is related to poor student outcomes. The quality of the school as indicated by the SQRP score was associated with the number of resources allocated to that school, which could indirectly reflect the ability of the school to offer AP courses. Additionally, the literature did not show a link between graduation rates and student success or school curriculum offerings. From this process, we continued the project by building out project questions.

Project Questions

Based on the literature review, the data, and through consultation with our partners, we formulated our project questions. Initially, DoCS suspected four things, and this guided our inquiries. Through daily observation and practice, they thought it might be easier to offer AP CSP at schools with larger enrollment numbers, with an existing college culture, with larger numbers of qualified teachers, and that it might be more difficult to offer it at schools with an existing CTE-IT track. These hypotheses were developed over time through on-the-ground experience, but the RPP wanted a more systematic assessment of school-level variables associated with the likelihood a CPS high school offered the course. In doing this, our partners will be well on their way to using data to further expand the AP CSP curriculum across the district. Moreover, DoCS will have more data to advance its overarching aims to design

pathways that support CS integration. This project will help ensure finite resources are applied strategically within the district when deciding where AP CSP might be offered next on the path to having the course in all district high schools. Based on the literature review and the conceptual framework, we formulated the following project questions.

1. What student-factor variables impact the likelihood that AP CSP is offered in CPS high schools?
2. What teacher-factor variables impact the likelihood that AP CSP is offered in CPS high schools?
3. What school context-factor variables impact the likelihood that AP CSP is offered in CPS high schools?

Part III: Project Design and Research Methods

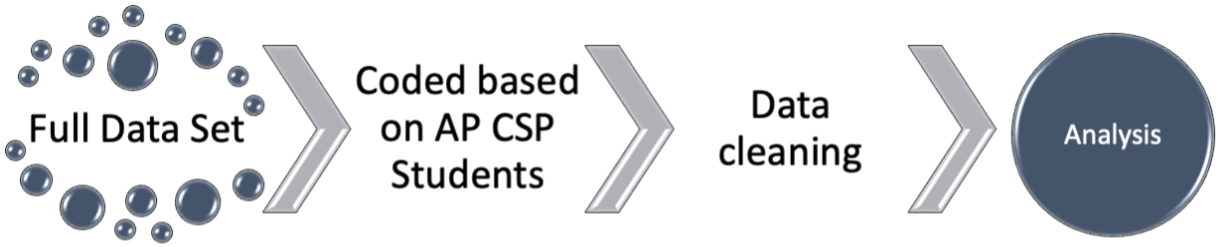
The following section discusses the methodology used to obtain, prepare, and analyze data that may be predictive of a CPS high school offering AP CSP. This quantitative project explored factors impacting a Chicago public high school's likelihood of offering AP CSP using descriptive and inferential statistics.

Design

This project used quantitative analysis and was designed in a step-by-step process through a systematic approach to clean the data, create a dependent variable, and select independent variables. The processes of preparing these data were essential, yet time-consuming. Figure 4 provides a brief preview of our processes.

Figure 4

Research Design



Data Source

Our secondary data were obtained from The Learning Partnership. This data was collected from CPS and provided to The Learning Partnership through a data-sharing agreement in collaboration with the CAFÉCS RPP. We received the information in Microsoft Excel files

via a secure Dropbox ® link. The longitudinal data set used contained information from SY2012-2013 through SY2020-2021. However, we used the most recent five years of information starting from SY2016-2017, as that was the year the district began offering AP CSP.

Our dependent variable was a dichotomous variable [Offer_CSP], created by assigning sites with a number of AP CSP students greater than one with a 1 and those that did not have AP CSP students as 0. In cleaning the data, duplicate variables were removed and errors that were identified were corrected. Of the variables used in our analysis, there was a minimum (<1%) amount of missing data which we coded as N/A. The result of our data cleaning efforts was a data set of 52 school-level variables, and that was the starting point for our independent variable selection.

Independent Variables

We began with a pool of 51 candidate independent variables for our multiple logistic regression analysis. After exploring the candidates through our literature review, our initial data exploration, and our discussions with our partners we settled on 27 variables. As we began our analyses, we saw some of the 27 variables were highly correlated. The relatively high correlations among several of these variables suggested that the condition of multicollinearity was present and needed to be addressed (Berry & West, 2010; Stoltzfus, 2011).

Multicollinearity occurs with a high correlation between two or more predictor or independent variables (Reason, 2003; Stoltzfus, 2011). One issue multicollinearity presented was that some of our 27 variables contained similar information and were likely measuring the same things (Mertler & Vannatta, 2017), potentially leading to unreliable estimates of regression coefficients (Stoltzfus, 2011). As we attempted to correct for multicollinearity (Allen, 1997; M.

Watts, personal communication, November 12, 2022; Stoltzfus, 2011), we further refined our data into the 19 variables listed in Figure 5.

Figure 5

Independent Variables

Categories	Variables
Student	% Black % Native American % Latinx % Multiracial % Biligual % Special Education % Free/Reduced Lunch
Teacher	ECS Partially Qualified Teacher AP CSP Partially Qualified Teacher CS Teachers per Year ECS Teachers per Year ECS Average Years of Experience
School Context	Enrollment Average Attendance Rate SQRP Total Points ECCE Score CTE-IT Track School Year Graduation Rate 5 Years

Predictions

In general, the null hypothesis states that all coefficients in the model are equal to zero, or that none of the predictor or independent variables have a statistically significant relationship with the response or dependent variable (Lottes et al., 1996). The alternative, or project, hypotheses state that not every coefficient is simultaneously equal to zero. In other words, there is a statistically significant relationship between the predictor or independent variables and the response or dependent variable. Multiple logistic regression uses the following null and alternative hypotheses:

$H\text{Ø}: \beta 1 = \beta 2 = \ldots = \beta k = 0$

$H1: \beta 1 = \beta 2 = \ldots = \beta k \neq 0$

The project hypotheses are grouped into student, teacher, and school context categories and are as follows:

- Student Hypotheses: The percentages of underrepresented students, the percentages of bilingual students, the percentages of special needs students, and students in the free lunch program predict AP CSP.
- Teacher Hypotheses: The number of teachers who participated in ECS PD, the number of teachers who participated in AP CSP PD, the number of CS teachers, the number of ECS teachers, and the average years of ECS teaching experience per year predict AP CSP.
- School Context Hypotheses: Student enrollment, student attendance rates, SQRP scores, ECCE scores, the presence of a CTE-IT program, the school year, and the 5-year graduation rate predict AP CSP.

Methods

We used multiple logistic regression analysis primarily due to the binary dependent variable [Offer_CSP]. Researchers often use logistic regression in medical, psychological, economic, agricultural, and social science research when studying outcomes that are represented by binary variables (Allen, 1997; Larsen et al., 2000; Mood, 2010; Sperandei, 2014; Szumilas, 2010). Logistic regression models can allow us to establish a relationship between a binary dependent variable and a group of independent variables. Logistic regression estimates the probability that an event will occur or that the event in question will have a particular outcome using information or characteristics thought to be related to or influence such events (Pampel, 2021; Tolles & Meurer, 2016). Multiple logistic regression allowed us to examine multiple variables simultaneously, as these variables might interact in the real world. Multiple logistic regression was also more informative than simple logistic regression because it revealed the unique contribution of each variable after adjusting for the others (Stoltzfus, 2011). In this project, the terms predictors and explanatory are used to refer to the independent variables for which the influences are being quantified, and the term outcome is also used to refer to the dependent variable in the logistic regression model (Altman & Royston, 2000; Rose & McGuire, 2019; Tolles & Meurer, 2016).

Using logistic regression can show which of the various factors being assessed has the strongest association with an outcome and provides a measure of the magnitude of the potential influence. It also can adjust for confounding factors (Tolles & Meurer, 2016). Confounding factors may be associated with other independent variables and the dependent variable, obscuring the true association between that independent and dependent variable, threatening

internal validity (Mertler & Vannatta, 2017; Pourhoseingholi et al., 2012; Sperandei, 2014; Stoltzfus, 2011; Szumilas, 2010). For example, SES could be a confounding factor in the relationship between ethnicity and the number of emergency room visits in a year because some ethnic groups tend to be overrepresented in certain SES categories, and people without healthcare insurance tend to use the emergency room more often for health care needs that would otherwise be treated by a primary care physician (Emerson et al., 2012; Stoltzfus, 2011; Werner et al., 2014).

In general, researchers differentiate between the types of variables they use to measure phenomena as discrete or continuous. A discrete variable has characteristics that are separate from each other, measured in whole units or categories (Privitera, 2018). This project uses a discrete dependent variable. In situations where an event occurs or it does not occur, researchers consider the outcomes as binary, either yes or no. A discrete variable that has only two outcomes is called dichotomous (Babbie, 2017; Privitera, 2018), and the yes and no outcomes are often represented with a 1 and a 0 (Doyle, 2020). Our event of interest was "Did a high school offer AP CSP in this school year?"

The mean of a dichotomous variable can be interpreted as a probability (Privitera, 2018), but the probabilities are contingent on the independent variables. When researchers have a binary dependent variable, they often use logistic regression to obtain odds ratios in the presence of more than one explanatory variable (Lottes et al., 1996). The procedure is like multiple linear regression, with the exception that the response variable is binary. The result is the impact of each variable on the odds ratio of the observed event of interest, with the advantage of avoiding some confounding effects by analyzing the association of all variables together (Mood, 2010; Sperandei, 2014). The higher the predicted value, the more likely a school with a certain score on

an independent variable will experience an event. In logistic regression, the coefficient calculated for each predictor determines the odds ratio (OR) for the outcome associated with a one-unit change in that predictor or associated with an outcome, that is, offering AP CSP, relative to a reference state, that is, not offering AP CSP (Pampel, 2021; Tolles & Meurer, 2016).

Data Analysis

Using the IBM SPSS version 29 statistical software, the analysis for this study was performed using descriptive and inferential statistics. During our analysis, we calculated the OR and confidence interval and used these calculations to help us interpret our data. The OR helps to explain the relationship between a variable and the likelihood of an event occurring. If the odds ratio is equal to one, there is no relationship. If the odd ratio is greater than one, there is a positive correlation, and less than one means a negative correlation (Szumilas, 2010). The confidence interval is the range of values that represents the degree of uncertainty surrounding an effect, and it is used to estimate the precision of the odds ratio. A small confidence interval indicates a higher precision of the odds ratio (Szumilas, 2010). We used a confidence level of 95 percent.

Part IV: Results

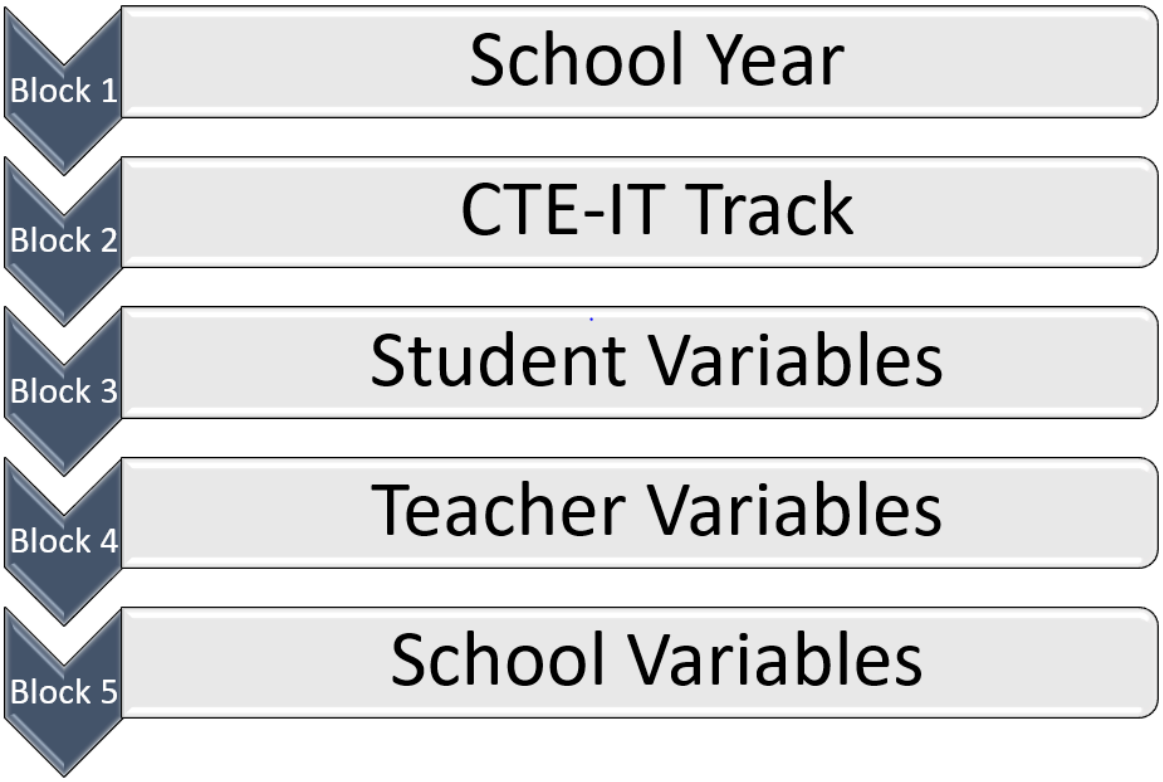
The final model shows the results which provided insights into the three research questions posed in Part I of this paper. However, Appendices B and C show where each variable was examined individually to determine its single effect on the dependent group of student, teacher, and school context factors, working towards our final predictive model.

Final Predictive Model

Figure 6 depicts the final model using all three categories in the stepwise regression. Time is in the first block with the CTE-IT track in the second block. Blocks three through five are the student, teacher, and school context variables previously described. We accounted for time, CTE-IT track, student variables, teacher variables, and then school context variables. The rationale for using this method was to ensure that if we made recommendations at the institutional level we controlled for any idiosyncrasies of students that may occur and the fact that these numbers will automatically increase over time. This model takes time in the first block and estimates that effect and then it takes the CTE-IT track in the second block and estimates its effects after controlling for time in the first block. The next block in the analysis contains the student variables and it will determine its effects after controlling for both time and the CTE-IT track. Each time a subset of variables will be selected, and the other variables will be retained in the previous blocks.

Figure 6

Final Predictive Model Using Stepwise Forward Conditional Regression



By blocking all the variables in this fashion, we were able to determine the best combination of variables that are predictive. With each block, the variables that are predictive are selected and then controlled for with each subsequent block. Table 1 shows the results of this final model.

Table 1

Multiple Regression Student-, Teacher-, and School Context-Factor Variables

	FINAL MODEL-BLOCKS 1-5			
	Variables	Odds Ratio	95% C. I for Odds Ratio	
			Lower	Upper
Block 1	*School Year* ♦	1.28	1.00	1.63
Block 2	**CTE-IT Track***	0.32	0.14	0.70
Block 3	**Percent of Black Students***	0.99	0.98	1.00
	Percent of Native American Students	^	^	^
	Percent of Latinx Students	^	^	^
	Percent of Multiracial Students	^	^	^
	Percent of Bilingual Students	^	^	^
	Percent of Special Education Students*	0.00	0.00	0.23
	Percent Free/reduced Lunch Students	^	^	^
Block 4	Number of at Least Partially Qualified ECS Teachers	^	^	^
	Number of at Least Partially Qualified CSP Teachers*	1.78	1.35	2.33
	Average years of ECS Teaching experience ♦	1.24	1.00	1.54
	Number of ECS Teachers/year	^	^	^
	Number of CS Teachers/years	^	^	^
Block 5	Enrollment	^	^	^
	Average Attendance	^	^	^
	ECCE Score	^	^	^
	SQRP Total Points	^	^	^
	5-year Graduation Rate*	1.03	1.00	1.05

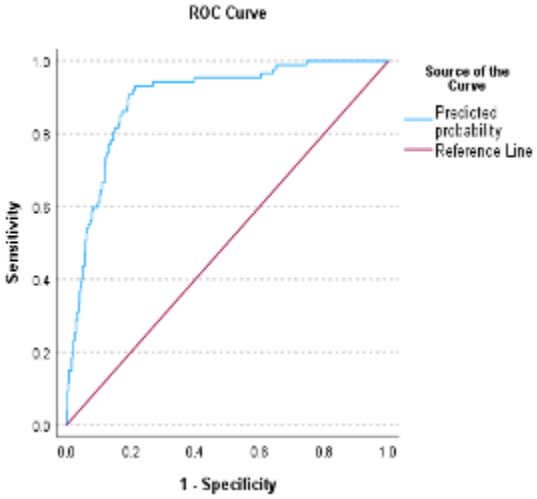
Statistically significant at <.05; ♦ Trending towards significance; ^ Not statistically significant

In Table 1, the variables that are bolded (percent of Black students, percent of special education students, number of partially qualified CSP teachers, five-year graduation rate, and CTE-IT track) were shown to be statistically significant. The number of at least partially qualified CSP teachers and the five-year graduation rate were positively correlated with probability while the percentage of Black students, the percentage of special education students, and the presence of a CTE-IT track were all negatively correlated with probability. The average years of ECS teaching experience and school year were trending towards significance. The variables with the greatest explanatory value in our model were the number of at least partially qualified CSP teachers followed by the five-year graduation rate and the percentage of Black students.

In our final predictive model, the Chi-square goodness of fit was 165.925 with 8 degrees of freedom and p-value < .001. The Chi-square goodness of fit is a statistical test that examines whether observed frequencies deviate from what might be expected based on a proposed hypothesis (Foster, 2021). The receiver operating characteristics (ROC) curve provides the area where the null hypothesis is true and where predictability associations between the variables are possible (Streiner & Cairney, 2007), measuring the usefulness of the test in general, and the area of the curve indicates the discriminatory ability of the variables. The primary statistic from the ROC is the area under the curve (Streiner & Cairney, 2007). The AUC for the final model is 0.894 which indicates that there is good discrimination of the independent variables predicting the dependent variable (see Figure 7). The interpretation of AUC values is such that a value of 1.0 is a perfect test, 0.9–0.99 is an excellent test, and 0.8–0.89 is a good test (Carter et al., 2016).

Figure 7

Final Predictive Model Using Stepwise Forward Conditional Regression



Findings

We started with single regression analyses and determined the individual predictive value of the student, teacher, and school variables. Next, we conducted multiple regression to determine the best combination of variables that would be predictive. In single regression, we held all other variables equal other than one individual independent variable, whereas, with multiple regression, there is a linear relationship between variables that is considered. So now some variables that were once significant are no longer significant once the other variables are factored in. Our final model had the highest Chi-square goodness of fit value of all the models ran which indicated that this model has the greatest statistically significant difference.

The first project question asked what student factors impact the likelihood that AP CSP is offered in CPS high schools. Our results indicate that the percentages of Black and special education students were negative predictors of whether a high school offered AP CSP. As the number of these two populations of students increased, there was a decreased chance that the course would be offered at that school. The number of students with free/reduced lunch, which indicates lower SES, was shown to be trending towards being a predictor. These results are consistent with the literature that has shown that minority student populations and SES are determinants of school course offerings. The other student variables were not statistically significant.

The second project question asked what teacher factors impact the likelihood that AP CSP is offered in CPS high schools. The results indicate that the number of at least partially qualified AP CSP teachers was the only predictive teacher factor in our final model. This is consistent with the literature that talks about the importance of professional development and teacher qualification to the promotion of positive student outcomes. As teachers gain more

knowledge through coursework and professional development, this directly translates to better educational outcomes for the students. The ECS-trained teachers participated in professional development that was primarily focused on pedagogical training, whereas the AP CSP professional development was more computer science-content focused. This type of development proved to be most beneficial and predictive for our model. Being ECS trained does not immediately lead to being AP CSP trained. There are instances where these are two different populations of teachers. There are instances when they overlap, so this may speak to why ECS training did not prove predictive in the final model.

The third project question asked what school/organizational factors impact the likelihood that AP CSP is offered in CPS high schools. Our results indicated that the five-year graduation rate was predictive. This study is the first to show a direct relationship between graduation rate and the prediction of AP CSP. An increase in the five-year graduation rate refers to the percentage of students who started high school five years earlier and graduated from that same high school, including students who graduated in four years. This could correlate to students who would have the opportunity to take more college preparatory courses like the AP-CSP course in their final year. As predicted by the partner organization, the CTE-IT track was a negative predictor. This may directly speak to a lack of resources to simultaneously support both the CTE-IT track and this advanced placement course offering. Appendix D contains an infographic summarizing the findings.

Limitations

We need to proceed with caution when interpreting the results from the final model because of the small sample size, which affects the power of our model. In statistical analysis, the likelihood of finding significance when the alternative hypothesis is true in the population (i.e., power) depends on sample size, the variance of the independent and dependent variable, effect size, and other factors (Newsom, 2021; Privitera, 2018), therefore a way to increase power is to increase the sample size. It is difficult to state a minimum sample size required to attain adequate statistical power (Demidenko, 2007), but our sample size was small. Over the five years that the course was offered, of the 532 CPS high schools, 87 offered AP CSP.

In quantitative research, validity refers to whether a measure or project accurately gauges what it was intended to assess (Babbie, 2017; Newcomer et al., 2004. The literature is consistent with the factors investigated in this study and their anticipated effects apart from a five-year graduation rate. This may indicate the need for further research. It may also indicate that the variable [GraduationRate_5yr] is a proxy for some underlying unnamed variable (Walsh et al., 2002). We discussed the issues with confounding variables and internal validity obscuring the true association between independent and dependent variables (Mertler & Vannatta, 2017; Pourhoseingholi et al., 2012; Sperandei, 2014; Stoltzfus, 2011; Szumilas, 2010). Even though the statistical method accounts for confounding variables, a small sample size may hinder logistic regression from adequately controlling for all confounders where there may be effects (Pourhoseingholi et al., 2012). While the number of high schools offering AP CSP has increased annually, schools offering the course did not exceed 25 percent of all the schools in the district. This study is not generalizable to high schools outside of CPS, even though it may provide valuable insights for future research.

The number of qualified teachers is going to be related to the size of the school because research indicates larger schools tend to have more teachers. Therefore, those variables could be conflated since enrollment size was not statistically significant in the final model.

The boundaries of this project were purposively narrow. We were bounded by the school-level variables in the data set, and we could not gain access to the true student- and teacher-level variables collected by CPS. The exploration of such data might expand the understanding of factors impacting AP CSP expansion. However, the procedures in place to collect the school-level variables provide confidence that the data were reasonably accurate, understanding all collected data have errors.

Recommendations

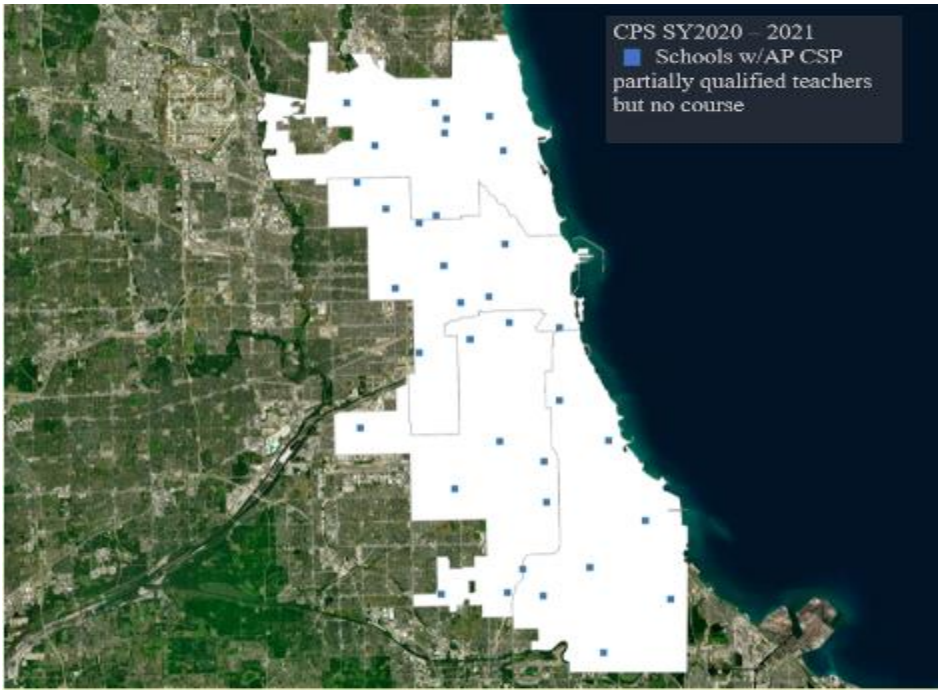
This is the first exploratory study that provides the groundwork for future studies to further investigate how to expand the number of schools that offer AP-CSP in their curriculum. Our recommendations are based on the analysis done and the next steps for our partner organization.

Recommendation 1

Chicago Public Schools should encourage schools with at least one partially qualified AP CSP teacher to consider offering the course. The number of at least partially qualified AP CSP teachers had the greatest explanatory value in our model. A school that has at least one partially qualified CSP teacher should be the next target for schools to offer the AP CSP course. Figure 8 shows the number of schools that have at least one qualified AP CSP teacher in the SY2020-2021, and those schools are designated by the blue squares.

Figure 8

SY2020-2021 CPS High Schools with AP CSP Partially Qualified Teachers but No Course



In the last year of available data which is SY2020-2021, there were 35 schools that had at least one partially qualified AP CSP teacher. In addition, STEM schools have historically been designated as the schools that focused on technology curricula like computer science. Of these 35 schools in the SY2020-2021, there are five that are designated as STEM schools that do not offer AP CSP. It may be worth considering these schools as the next potential schools for offering the AP CSP course, especially since they have the culture to support the advanced placement course in the science fields.

Recommendation 2

Chicago Public Schools should encourage STEM schools with a high percentage of Black students and at least one partially qualified AP CSP teacher to consider offering the course. In all of the models looking at the student variables, the percentage of Black students was consistently a negative predictor of whether or not the school would offer AP CSP courses. Previous studies have shown that schools with increased minorities have less qualified teachers. The goal of our partner organization is focused on equity and providing computer science for all students.

Figure 9

SY2020-2021 CPS High Schools Offering and Not Offering AP CSP

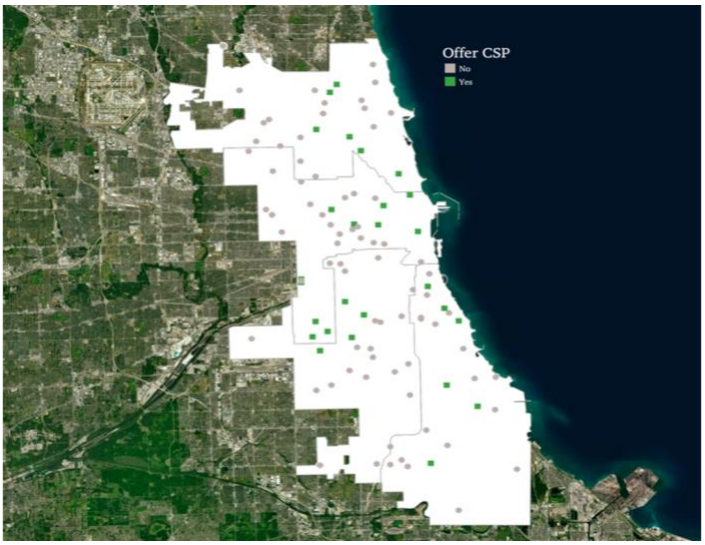


Figure 9 shows that in SY2020-2021, there were 79 high schools, depicted with gray circles, that did not offer AP CSP, and 27 high schools that offered the course, depicted with green squares. Forty-one of the 79 schools not offering AP CSP (51.3%) had at least 50 percent Black students. Of these 41 high schools, 15 (36.6%) had at least one partially qualified AP CSP teacher. It is important to note that three of those 15 high schools were STEM schools with greater than 90 percent Black students (92.4%, 95.8%, and 97.5%). It is important to mitigate the impact of the percentage of Black students as a negative predictor of the course and focus on these schools as those best equipped to provide access to this course for all students, regardless of ethnicity. Simultaneously, CPS may also want to examine any barriers to cultural competency. This could include lack of training, prejudices, and/or biases of the employees within the schools that might preclude them from gaining the requisite knowledge and experiences for best educating diverse student populations.

Recommendation 3

Chicago Public Schools should conduct case studies on the schools that offered AP CSP to determine the effectiveness of the course as measured by student outcomes and to determine the effectiveness of the implementation of this course into the curriculum. Figure 2 shows that in SY2020-2021, there were 27 high schools that offered AP CSP. There were four schools that had previously offered AP CSP but did not offer the course in SY2020-2021. Only one of the four schools did not have a qualified AP CSP teacher. Therefore, it would be germane to understand why those three schools did not offer the course in this last academic year although they had a qualified teacher and had previously offered the course. There may have been resource issues or other constraints that precluded the school that had offered AP CSP from offering in that SY. This would provide crucial information about possible implementation and execution problems

that schools have incurred. This would help as CPS devises the plan for the implementation of AP CSP in additional schools in the district.

Recommendation 4

Chicago Public Schools should continue to encourage teachers to become at least partially qualified. As already discussed, the literature has shown a direct correlation between teacher professional development and positive student outcomes. In addition, our data here clearly shows that teachers being at least partially qualified serve as the best predictor for the ability of the school to offer the AP CSP course. The district should continue to invest time, energy, and resources to increase the number of AP CSP-qualified teachers. This could be achieved through incentive programs and other benefits and compensation allotments offered to teachers if they participate in the training.

Conclusion

This explanatory study identified the predictors of whether schools within the CPS would offer AP CSP. Recommendations were made to guide CPS in its plan for determining which high schools in the district to target for consideration of offering AP CSP in subsequent school years. Moreover, the work done in this study will inform CPS about future research that needs to be conducted as part of its evidence-based research project focused on ensuring equitable CS access for all students in CPS.

Part V: References

Ackerman, P. L., Kanfer, R., & Calderwood, C. (2013). High school advanced placement and student performance in college: STEM majors, non-STEM majors, and gender differences. *Teachers College Record*: *The Voice of Scholarship in Education*, *115*(10), 1–43. https://doi.org/10.1177/016146811311501003

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college*. Office of Vocational and Adult Education, U.S. Department of Education. https://catalog.hathitrust.org/Record/005568101/Home

Aldana, U. S. (2014). Moving beyond the college-preparatory high school model to a college-going culture in urban catholic high schools. *Journal of Catholic Education*, *17*(2), 131–153. https://doi.org/10.15365/joce.1702092014

Allen, M. P. (1997). *Understanding regression analysis*. Plenum Press. https://doi.org/10.1007/b102242

Allen, J. P., Pianta, R. C., Gregory, A., Mikami, A. Y., & Lun, J. (2011). An interaction-based approach to enhancing secondary school instruction and student achievement. *Science*, *333*(6045), 1034–1037. https://doi.org/10.1126/science.1207998

Allensworth, E. (2005, January). *Graduation and dropout trends in Chicago: A look at cohorts of students from 1991 through 2004*. Consortium on Chicago School Research. https://consortium.uchicago.edu/sites/default/files/2018-10/p75.pdf

Allensworth, E. M., & Easton, J. Q. (2007, July). *What matters for staying on-track and graduating in Chicago public high schools: A close look at course grades, failures, and attendance in the freshman year.* Consortium on Chicago School Research.

https://consortium.uchicago.edu/sites/default/files/2018-10/07%20What%20Matters%20Final.pdf

Allensworth, E.M., Gwynne, J.A., Moore, P., & de la Torre, M. (2014). Looking forward to high school and college: Middle grade indicators of readiness in Chicago Public School. Chicago, IL: University of Chicago Consortium on Chicago School Research. https://consortium.uchicago.edu/publications/looking-forward-high-school-and-college-middle-grade-indicators-readiness-chicago

Altman, D. G., & Royston, P. (2000). What Do We Mean by Validating a Prognostic Model? *Statistics in Medicine, 19*(4), 453–473. https://doi.org/10.1002/(SICI)1097-0258(20000229)19:4<453::AID-SIM350>3.0.CO;2-5

AP Students. (n.d.). *AP computer science A*. College Board. https://apstudents.collegeboard.org/courses/ap-computer-science-a

Aspray, W. (2016). *Participation in computing: The national science foundation's expansionary programs*. Springer International Publishing. https://doi.org/10.1007/978-3-319-24832-5

Astrachan, O., Morelli, R., Chapman, G., & Gray, J. (2015). Scaling high school computer science: Exploring computer science and computer science principles. *Proceedings of the 46th ACM Technical Symposium on Computer Science Education*, 593–594. https://doi.org/10.1145/2676723.2677322

Atkinson, R. (2013, March 9). A short and long-term solution to America's STEM crisis. *The Hill.* http://thehill.com/blogs/congress-blog/technology/287435-a-short-and-long-term-solution-to-americas-stem-crisis

Babbie, E. (2017). *The basics of social research* (7th ed.). Cengage Learning.

Banas, C., & Byers, D. (1987, November 8). Education chief: City schools worst. *Chicago Tribune.* https://www.chicagotribune.com/news/ct-xpm-1987-11-08-8703230953-story.html

Barnard-Brak, L., McGaha-Gamett, V., & Burley, H. (2011). Advanced placement course enrollment and school-level characteristics. *National Association of Secondary School Principals. NASSP Bulletin, 95*(3), 165-174. http://proxy.library.vanderbilt.edu/login?url=https://www.proquest.com/scholarly-journals/advanced-placement-course-enrollment-school-level/docview/908807308/se-2

Benyo, J., & White, J. (2009, June 11). *New image for computing.* WBGH Educational Foundation. https://apo.org.au/node/14789

Berliner, D. C. (2009). *Poverty and potential: Out-of-school factors and school success*. Education and the Public Interest Center & Education Policy Research Unit. https://nepc.colorado.edu/publication/poverty-and-potential

Berry, C. R., & West, M. R. (2010). Growing pains: The school consolidation movement and student outcomes. *Journal of Law, Economics, & Organization, 26*(1), 1–29. https://doi.org/10.1093/jleo/ewn015

Blankenberger, B., Lichtenberger, E., Witt, M. A., & Franklin, D. (2017). Diverse students, high school factors, and completion agenda goals: An analysis of the Illinois class of 2003. *Education and Urban Society, 49*(5), 518–545. https://doi.org/10.1177/0013124516644047

Boyd, D., Lankford, H., Loeb, S., Rockoff, J., & Wyckoff, J. (2008). The narrowing gap in New York City teacher qualifications and its implications for student achievement in high-

poverty schools. *Journal of Policy Analysis and Management*, *27*(4), 793–818. https://doi.org/10.1002/pam.20377

Briggs, A., & Snyder, L. (2012). Computer science principles and the CS 10k initiative. *ACM Inroads*, *3*(2), 29–31. https://doi.org/10.1145/2189835.2189847

Bryk, A. S., Lee, V. E., & Holland, P. B. (1993). *Catholic schools and the common good*. Harvard University Press. https://doi.org/10.4159/9780674029033

Carter, J. V., Pan, J., Rai, S. N., & Galandiuk, S. (2016). ROC-ing along: Evaluation and interpretation of receiver operating characteristic curves. *Surgery*, *159*(6), 1638–1645. https://doi.org/10.1016/j.surg.2015.12.029

Carver-Thomas, D. (2022, February 9). Teacher shortages take center stage. *Learning Policy Institute*. https://learningpolicyinstitute.org/blog/teacher-shortages-take-center-stage

Cheng, H., & Balfanz, R. (2016, September). *Preventing missed opportunity: Taking collective action to confront chronic absence.* Attendance Works and Everyone Graduates Center. https://attendanceworks.org/wp-content/uploads/2017/09/PreventingMissedOpportunityFull_FINAL9.8.16_2.pdf

Chenoweth, K., & Brown, C. (2018, April 13). A few unique things about Chicago public schools. *The Center for American Progress*. https://www.americanprogress.org/article/unique-things-chicago-public-schools/

Chicago Alliance for Equity in Computer Science. (n.d.). Our history: Providing a relevant and compelling computer science experience for every Chicago student. https://cafecs.org/our-history/

Chicago Public Schools. (n.d.-a). *CS4All.* https://cs4allcps.github.io/

Chicago Public Schools. (n.d.-b). *Department narratives overview.* https://www.cps.edu/globalassets/cps-pages/about-cps/finance/budget/budget-2021/docs/departments.pdf

Chicago Public Schools. (2023). *Demographics*. https://www.cps.edu/about/district-data/demographics/

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2010). Teacher credentials and student achievement in high school: A cross-subject analysis with student fixed effects. *The Journal of Human Resources*, *45*(3), 655–681. https://doi.org/10.3368/jhr.45.3.655

Cohen, D. K., & Hill, H. C. (2000). Instructional policy and classroom performance: The mathematics reform in California. *Teachers College Record*, *102*(2), 294–343. https://doi.org/10.1111/0161-4681.00057

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Mood, A. M., Weinfeld, F. D., & York, R. L. (1966). *Equality of education opportunity study.* National Center for Educational Statistics. https://eric.ed.gov/?id=ED012275

College Board. (n.d.-a). *About us*. https://about.collegeboard.org/

College Board. (n.d.-b). *Discover AP*. https://ap.collegeboard.org/?navId=gf-ap

College Board. (n.d.-c). *Read our charter*. https://about.collegeboard.org/governance/charter

College Board. (2018, February 21). More students than ever are participating and succeeding in advanced placement. *College Board Newsroom.* https://newsroom.collegeboard.org/more-students-ever-are-participating-and-succeeding-advanced-placement

College Board. (2020). *AP computer science principles: Course and exam description*. https://apcentral.collegeboard.org/media/pdf/ap-computer-science-principles-course-and-exam-description.pdf

College Board plans to broaden mission of advanced placement program. (2002, August 2). *The Chronicle of Higher Education.* https://link.gale.com/apps/doc/A147120058/AONE?u=tel_a_vanderbilt&sid=bookmark-AONE&xid=6d1bd8a2

Conant, J. B. (1959). *The American high school today: A first report to interested citizens.* McGraw-Hill.

Conger, D., Long, M. C., & Iatarola, P. (2009). Explaining race, poverty, and gender disparities in advanced course-taking. *Journal of Policy Analysis and Management*, *28*(4), 555–576. https://doi.org/10.1002/pam.20455

Conley, D. T. (2007). *Redefining college readiness*. Educational Policy Improvement Center. https://files.eric.ed.gov/fulltext/ED539251.pdf

Corey, S. M. (1957). Introduction. In N. B. Henry (Ed.), *Inservice education: Fifty-sixth yearbook of the National Society for the Study of Education* (pp. 1–10). University of Chicago Press. https://archive.org/stream/inserviceeducati013920mbp/inserviceeducati013920mbp_djvu.txt

Cornog, W. H. (2020, May 13). The advanced placement program: Reflections on its origins. *The Elective.* https://elective.collegeboard.org/advanced-placement-program-reflections-its-origins

Corwin, Z. B., & Tierney, W. G. (2007). *Getting there – And beyond: Building a culture of college-going in high schools*. U. S. Center for Higher Education Policy Analysis https://files.eric.ed.gov/fulltext/ED498731.pdf

Crispin, L. M. (2016). School size and student achievement: Does one size fit all? *Eastern Economic Journal*, *42*(4), 630–662. https://doi.org/10.1057/eej.2015.2

CSforAll. (n.d.). *Chicago public schools, CS4All.* https://www.csforall.org/members/chicago_public_schools_cs4all/

Cuny, J. (2011). Transforming computer science education in high schools. *Computer*, *44*(6), 107–109. https://doi.org/10.1109/MC.2011.191

Cuny, J. (2012). Transforming high school computing: A call to action. *ACM Inroads*, *3*(2), 32–36. https://doi.org/10.1145/2189835.2189848

Darling-Hammond, L. (1996). The quiet revolution – Rethinking teacher development. *Educational Leadership*, *53*(6), 4–10.

Darling-Hammond, L. (2000). Teacher quality and student achievement. A review of state policy evidence. *Education Policy Analysis Archives*, *8*(1), 1–44. https://doi.org/10.14507/epaa.v8n1.2000

Darling-Hammond, L., Holtzman, D. J., Gatlin, S. J., & Heilig, J. V. (2005). Does teacher preparation matter? Evidence about teacher certification, Teach for America, and teacher effectiveness. *Education Policy Analysis Archives*, *13*(42), 1–52. https://www.redalyc.org/pdf/2750/275020513042.pdf

Davis, M. D., & Davis, O. L. (2003). Curriculum expansion in Texas high schools, 1900–1920. *American Educational History Journal*, *30*, 151–160.

https://www.proquest.com/openview/0a0e7a64d56bcb4a82120d42b20c0d6d/1?pq-origsite=gscholar&cbl=29702

Davis, T. (2014). School choice and segregation: "Tracking" racial equality in magnet schools. *Education and Urban Society*, *46*(4), 399–433. https://doi.org/10.1177/0013124512448672

de Brey, C., Zhang, A., & Duffy, S. (2022). *Digest of education statistics 2020*. National Center for Education Statistics. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2022009

Deaton, S. (2018). Impact of the English advanced placement (AP) program on college grade point average among rural Appalachian students. *The Rural Educator*, *35*(3), 1–11. https://doi.org/10.35608/ruraled.v35i3.344

Demidenko, E. (2007). Sample size determination for logistic regression revisited. *Statistics in Medicine*, *26*(18), 3385–3397. https://doi.org/10.1002/sim.2771

Dentith, A. (2008). Smart girls, hard-working girls but not yet self-assured girls: The limits of gender equity politics. *Canadian Journal of Education*, *31*(1), 145–166.

Department of School Quality Measurement and Research. (2019). *School quality rating policy (SQRP) handbook: Guide to the policy, indicators, and ratings.* Chicago Public Schools. https://www.cps.edu/globalassets/cps-pages/about-cps/district-data/metrics/school-quality-rating-policy-sqrp/sqrp-handbook.pdf

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S., & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis*, *24*(2), 81–112. https://doi.org/10.3102/01623737024002081

Dickey, M. R. (2016, February 24). Computer science is now a high school graduation requirement in Chicago's public school district. *Tech Crunch*. https://techcrunch.com/2016/02/24/computer-science-is-now-a-high-school-graduation-requirement-in-chicagos-public-school-district

Doyle, W. R. (2020). [Lecture notes on 5.5 training and testing. Analyzing data: Linear regression part 1]. Peabody College of Education, Vanderbilt University.

Elahi, A. (2016, March 1). CPS to roll out computer science requirement. *Chicago Tribune*. https://www.chicagotribune.com/business/blue-sky/ct-computer-science-graduation-cps-bsi-20160225-story.html

Emerson, J. S., Hull, P. C., Cain, V. A., Novotny, M., Stanley, R. E., & Levine, R. S. (2012). TennCare disenrollment and avoidable hospital visits in Davidson County, Tennessee. *Journal of Health Care for the Poor and Underserved*, *23*(1), 425–445. https://doi.org/10.1353/hpu.2012.0002

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://cacm.acm.org/magazines/2021/2/250074-cape/

Fornander, M. J., & Kearney, C. A. (2019). Family environment variables as predictors of school absenteeism severity at multiple levels: Ensemble and classification and regression tree analysis. *Frontiers in Psychology, 10*, 1–9. https://doi.org/10.3389/fpsyg.2019.02381

Foster, C. A. (2021). Race and the NFL: Teaching the chi-square goodness of fit test. *Significance*, *18*(5), 32–33. https://doi.org/10.1111/1740-9713.01571

Fowler, W. J., & Walberg, H. J. (1991). School size, characteristics, and outcomes. *Educational Evaluation and Policy Analysis*, *13*(2), 189–202. https://doi.org/10.2307/1164583

Friedkin, N. E., & Necochea, J. (1988). School system size and performance: A contingency perspective. *Educational Evaluation and Policy Analysis*, *10*(3), 237–249. https://doi.org/10.3102/01623737010003237

Gándara, P., Orfield, G., & Horn, C. L. (Eds.). (2006). *Expanding opportunity in higher education.* State University of New York Press.

Garbarino, J. (1980). Some thoughts on school size and its effects on adolescent development. *Journal of Youth and Adolescence*, *9*(1), 19–31. https://doi.org/10.1007/BF02088377

García, E., Kraft, M. A., & Schwartz, H. L. (2022, August 26). Are we at a crisis point with the public teacher workforce? Education scholars share their perspectives. *Brown Center Chalkboard*. https://www.brookings.edu/blog/brown-center-chalkboard/2022/08/26/are-we-at-a-crisis-point-with-the-public-teacher-workforce-education-scholars-share-their-perspectives/

Gardner, P. W., Ritblatt, S. N., & Beatty, J. R. (2000). Academic achievement and parental school involvement as a function of high school size. *High School Journal*, *83*(2), 21–27. https://www.jstor.org/stable/40364507

Gennetian, L. A., Rodrigues, C., Hill, H. D., & Morris, P. A. (2018). Stability of income and school attendance among NYC students of low-income families. *Economics of Education Review*, *63*(2018), 20-30. https://doi.org/10.1016/j.econedurev.2018.01.003

Gibbs, N. M., & Gibbs, S. V. (2015). Misuse of 'trend' to describe 'almost significant' differences in anesthesia research. *British Journal of Anaesthesia*, *115*(3), 337–339. https://doi.org/10.1093/bja/aev149

Goldin, C., & Katz, L. F. (2007). *The race between education and technology: The evolution of U.S. educational wage differentials, 1890 to 2005* (Working Paper No. 12984). National

Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w12984/w12984.pdf

Gonzales, R., Richards, K., & Seeley, K. (2002, September). Youth out of school: Linking absence to delinquency. *Colorado Foundation for Families and Children.* https://www.yumpu.com/en/document/read/26083466/youth-out-of-school-linking-absence-to-delinquency

Goode, J., Margolis, J., & Chapman, G. (2014). Curriculum is not enough: The educational theory and research foundation of the exploring computer science professional development model. *Proceedings of the 45th ACM Technical Symposium on Computer Science Education*, 493–498. https://doi.org/10.1145/2538862.2538948

Goss, C. L., & Andren, K. J. (2014). *Dropout prevention.* The Guilford Press.

Greene, J. P. (2002, April). *High school graduation rates in the United States.* Manhattan Institute and Black Alliance for Educational Options. https://media4.manhattan-institute.org/pdf/cr_baeo.pdf

Griffin, G. A. (1983). Introduction: The work of staff development. *Teachers College Record, 84*(6), 1–12. https://doi.org/10.1177/016146818308400601

Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational Researcher*, *15*(5), 5–12. https://doi.org/10.3102/0013189X015005005

Halpert, M. (n.d.). AP African-American studies: Syllabus changed after Florida 'woke' claims. *BBC News.* https://www.bbc.com/news/world-us-canada-64493289

Hanushek, E. A., & Rivkin, S. G. (2009). Harming the best: How schools affect the Black-White achievement gap. *Journal of Policy Analysis and Management*, *28*(3), 366–393. https://doi.org/10.1002/pam.20437

Harris, D. N., & Sass, T. R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics*, *95*(7), 798–812. https://doi.org/10.1016/j.jpubeco.2010.11.009

Hartocollis, A., & Fawcett, E. (2023, February 1). The college board strips down its A.P. curriculum for African American studies. *The New York Times.* https://www.nytimes.com/2023/02/01/us/college-board-advanced-placement-african-american-studies.html

Heckman, J. J., & LaFontaine, P. A. (2007). *The American high school graduation rate: Trends and levels* [Discussion paper]. Institute for the Study of Labor. https://docs.iza.org/dp3216.pdf

Heckman, J. J., & LaFontaine, P. A. (2010). The American high school graduation rate: Trends and levels. *The Review of Economics and Statistics*, *92*(2), 244–262. https://doi.org/10.1162/rest.2010.12366

Helmet, S. W., & Swiderski, T. (2022). College comes to high school: Participation and performance in Tennessee's innovative wave of dual-credit courses. *Educational Evaluation and Policy Analysis*, *44*(2), 313–341. https://doi.org/10.3102/01623737211052310

Henrick, E., McGee, S., Dettori, L., Williams, T., Rasmussen, A. M., Yanek, D., Greenberg, R. I., & Reed, D. F. (2021, April 12). *Research-practice partnership strategies to conduct and use research to inform practice* [Paper presentation]. Virtual Annual Meeting of American Educational Research Association. https://doi.org/10.51420/conf.2021.3

Hopper, G., & Rahm, E. (2018). She's the new face of AnitaB.org. *Crain's Chicago Business*, *41*(28), 16.

http://proxy.library.vanderbilt.edu/login?url=https://www.proquest.com/trade-journals/shes-new-face-anitab-org/docview/2071709404/se-2

Howard, K. E., & Havard, D. D. (2019). Advanced placement (AP) computer science principles: Searching for equity in a two-tiered solution to underrepresentation. *Journal of Computer Science Integration*, *2*(1), 1–15. http://doi.org/10.26716/jcsi.2019.02.1.1

Huang, F. L., & Moon, T. R. (2009). Is experience the best teacher? A multilevel analysis of teacher characteristics and student achievement in low performing schools. *Educational Assessment, Evaluation and Accountability*, *21*(3), 209–234. https://doi.org/10.1007/s11092-009-9074-2

Iatarola, P., Conger, D., & Long, M. C. (2011). Determinants of high schools' advanced course offerings. *Educational Evaluation and Policy Analysis*, *33*(3), 340–359. https://doi.org/10.3102/0162373711398124

Issa, N. (2022, April 25). CPS to scrap school ratings, replace them with less 'punitive' system. *Chicago Sun Times.* https://chicago.suntimes.com/education/2022/4/25/23041599/cps-school-ratings-rankings-sqrp-accountability-level-1-2-3-performing-test-attendance

Jencks, C., Smith, M., Acland, H., Bane, M. J., Cohen, D., Gintis, H., Heyne, B., & Michelson, S. (1972). *Inequality: A reassessment of the effect of family and schooling in America.* Basic Books.

Jones, S. (2018, June 13). Participation in AP computer science principles grows again. *EducationWeek.* https://www.edweek.org/teaching-learning/participation-in-ap-computer-science-principles-grows-again/2018/06

Joo, M., & Kim, J. (2016). National high school graduation rate: Are recent birth cohorts taking more time to graduate? *Education and Urban Society*, *48*(2), 126–150. https://doi.org/10.1177/0013124514529328

Kane, T. J., Rockoff, J. E., & Staiger, D. O. (2007). What does certification tell us about teacher effectiveness? Evidence from New York City. *Economics of Education Review*, *27*(6), 615–631. https://doi.org/10.1016/j.econedurev.2007.05.005

Kelleher, M. (2015, November 13). Chicago schools: "Worst in the nation?" *The Chicago Reporter*. https://www.chicagoreporter.com/chicago-schools-worst-in-the-nation/

Kena, G., Muse-Gillette, L., Robinson, J., Wang, X., Rathbun, A., Zhang, J., Wilkinson-Flicker, S., Barmer, A., & Velez, E. D. (2015). *The condition of education 2015* (Report No. NCES 2015-144). National Center for Education Statistics. https://nces.ed.gov/pubs2015/2015144.pdf

Kenny, L. J. (1982). Economies of scale in schooling. *Economics of Education Review*, *2*(1), 1–24. https://doi.org/10.1016/0272-7757(82)90046-2

Kim, K. R., & Seo, E. H. (2018). The relationship between teacher efficacy and students' academic achievement: A meta-analysis. *Social Behavior and Personality*, *46*(4), 529–540. https://doi.org/10.2224/sbp.6554

Koenig, J. A., & Hauser, R. M. (Eds.). (2011). *High school dropout, graduation, and completion rates: Better data, better measures, better decisions*. National Academies Press.

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

Lankford, H., Loeb, S., & Wyckoff, J. (2002). Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational Evaluation and Policy Analysis*, *24*(1), 37–62. https://doi.org/10.3102/01623737024001037

Larsen, K., Petersen, J. H., Budtz-Jørgensen, E., & Endahl, L. (2000). Interpreting parameters in the logistic regression model with random effects. *Biometrics*, *56*(3), 909–914. http://www.jstor.org/stable/2676942

Lee, V. E., & Bryk, A. S. (1989). A multilevel model of the social distribution of high school achievement. *Sociology of Education*, *62*(3), 172–192. https://doi.org/10.2307/2112866

Lee, V. E., Bryk, A. S., & Smith, J. B. (1993). The organization of effective secondary schools. In L. Darling-Hammond (Ed.), *Review of research in education* (Vol. 19, pp. 171–267). American Educational Research Association. https://doi.org/10.3102/0091732X01900117

Lee, V. E., Smerdon, B., Alfeld-Liro, C., & Brown, S. (2000). Inside large and small high schools: Curriculum and social relations. *Educational Evaluation and Policy Analysis*, *22*(2), 147–171. https://doi.org/10.3102/01623737022002147

Lee, V. E., & Smith, J. B. (1995). Effects of high school restructuring and size on early gains in achievement and engagement. *Sociology of Education*, *68*(4), 241–270. https://doi.org/10.2307/2112741

Lee, V. E., & Smith, J. B. (1997). High school size: Which works best and for whom? *Educational Evaluation and Policy Analysis*, *19*(3), 205–227. https://doi.org/10.3102/01623737019003205

Lee, V. E., Smith, J. B., & Groninger, R. (1997). How high school organization influences the equitable distribution of learning in mathematics and science. *Sociology of Education, 70*(2), 128–150. https://doi.org/10.2307/2673160

Leithwood, K., & Jantzi, D. (2009). A review of empirical evidence about school size effects: A policy perspective. *Review of Educational Research*, *79*(1), 464–490. https://doi.org/10.3102/0034654308326158

Lively, K. (1993). More states encourage advanced-placement courses for college credit; Saving money is one goal. *The Chronicle of Higher Education*, *39*(38), A21–A22. https://www.proquest.com/trade-journals/more-states-encourage-advanced-placement-courses/docview/214524308/se-2

Long, M. C., Conger, D., & McGhee, R., Jr. (2019). Life on the frontier of AP expansion: Can schools in less-resourced communities successfully implement advanced placement science courses? *Educational Researcher*, *48*(6), 356–368. https://doi.org/10.3102/0013189X19859593

Lottes, I. L., Adler, M. A., & DeMaris, A. (1996). Using and interpreting logistic regression: A guide for teachers and students. *Teaching Sociology*, *24*(3), 284–298. https://doi.org/10.2307/1318743

Loucks-Horsley, S. (1998). The role of teaching and learning in systemic reform: A focus on professional development. *Science Educator*, *7*(1), 1–37. https://www.etsu.edu/coe/stem-education/documents/se.07.1.1998.pdf

Lucas, S. R. (1999). *Tracking inequality: Stratification and mobility in American high schools.* Teachers College Press.

Malin, J. R., Bragg, D. D., & Hackmann, D. G. (2017). College and career readiness and the every student succeeds act. *Educational Administration Quarterly*, *53*(5), 809–838. https://doi.org/10.1177/0013161X17714845

Malkus, N. (2016). *AP at scale: Public school students in advanced placement, 1990–2013*. American Enterprise Institute. http://www.jstor.org/stable/resrep35256

Margolis, J., & Bernier, D. (2014). *Taking toot: The LAUSD/ECS partnership story* (Working Paper No. 2). Exploring Computer Science Working Papers. https://www.exploringcs.org/wp-content/uploads/2014/04/Taking-Root-The-LAUSD-ECS-Partnership-Story.pdf

Margolis, J., Goode, J., & Chapman, G. (2015). An equity lens for scaling: A critical juncture for exploring computer science. *ACM Inroads*, *6*(3), 58–66. https://doi.org/10.1145/2794294

Martinez, R. R., Akos, P., & Kurz, M. (2020). Utilizing Latinx cultural wealth to create a college-going culture in high school. *Journal of Multicultural Counseling and Development*, *48*(4), 210–230. https://doi.org/10.1002/jmcd.12195

Mattern, K. D., Marini, J. P., & Shaw, E. J. (2013). *Are AP students more likely to graduate from college on time?* The College Board. https://files.eric.ed.gov/fulltext/ED556464.pdf

McGee, S. (2018). *CAFÉCS: Supporting quality CS access 4 all Chicago Students* [Video]. The Learning Partnership. https://stemforall2018.videohall.com/presentations/1178

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

McKee, T. M., & Caldarella, P. (2016). Middle school predictors of high school performance: A case study of dropout risk indicators. *Education*, *136*(4), 515–529.

McMillen, B. J. (2004). School size, achievement, and achievement gaps. *Education Policy Analysis Archives*, *12*(58), 1-24. https://doi.org/10.14507/epaa.v12n58.2004

Mertler, C. A., & Vannatta, R. A. (2017). *Advanced and multivariate statistical method: Practical application and interpretation* (6th ed.). Routledge. https://zums.ac.ir/files/socialfactors/files/Advanced_and_Multivariate_Statistical_Methods-2017.pdf

Miles, M. B., Huberman, A. M., & Saldaña, J. (Eds.). (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Mishel, L., & Roy, J. (2006). *Rethinking high school graduation rates and trends.* Economic Policy Institute. https://www.epi.org/publication/book_grad_rates/

Monk, D. H., & Haller, E. J. (1993). Predictors of high school academic course offerings: The role of school size. *American Educational Research Journal*, *30*(1), 3–21. https://doi.org/10.3102/00028312030001003

Mood, C. (2010). Logistic regression: Why we cannot do what we think we can do, and what we can do about it. *European Sociological Review, 26*(1), 67–82. https://doi.org/10.1093/esr/jcp006

Murane, R. J. (2013). U.S. high school graduation rates: Patterns and explanations. *Journal of Economic Literature*, *51*(2), 370–422. https://doi.org/10.1257/jel.51.2.370

National Center for Education Statistics. (2022). *Public high school graduation rates. Condition of education.* Institute of Education Sciences. https://nces.ed.gov/programs/coe/indicator/coi.

National Education Association. (1894). *Report of the committee of ten on secondary school studies.* The American Book Company. https://babel.hathitrust.org/cgi/pt?id=mdp.39015005353571&view=1up&seq=18

National Education Association. (1918). *Cardinal principles of secondary education: A report of the commission on the reorganization of secondary education.* Department of the Interior, Bureau of Education. https://babel.hathitrust.org/cgi/pt?id=uc2.ark:/13960/t9862kk64&view=1up&seq=7

National Research Council, Center for Education, & Committee on Science and Mathematics Teacher Preparation. (2001). *Educating teachers of science, mathematics, and technology: New practices for the new millennium*. The National Academies Press. https://doi.org/10.17226/9832

Newsom, J. (2021). *Psy 525/625 categorical data analysis, Spring 2021*. Department of Psychology. Portland State University. https://web.pdx.edu/~newsomj/cdaclass/ho_sample%20size.pdf

No Child Left Behind Act of 2001, P.L. 107-110, 20 U.S.C. § 6319. (2002). https://www.govinfo.gov/content/pkg/PLAW-107publ110/pdf/PLAW-107publ110.pdf

Norton, B. (1956). College admission with advanced standing. I. Report of the committee on chemistry. *Journal of Chemical Education*, *33*(5), 232–237. https://doi.org/10.1021/ed033p232

Oakes, J. (2003). *Critical conditions for equity and diversity in college access: Informing policy and monitoring results.* University of California All Campus Consortium on Research for Diversity. https://escholarship.org/uc/item/427737xt

Oakes, J. (2005). *Keeping track: How schools structure inequality* (2nd ed.). Yale University Press.

Office of Computer Science. (n.d.). *About us*. https://sites.google.com/cps.edu/cs4all/about-us?authuser=0

Onifade, E., Smith Nyandoro, A., Davidson, W., & Campbell, C. (2010). Truancy and patterns of criminogenic risk in young offender population. *Youth Violence and Juvenile Justice*, *8*(1), 3–18. https://doi.org/10.1177/1541204009338251

Pampel, F. C. (2021). *Logistic regression: A primer* (2nd ed.). SAGE.

Partovi, H. (2018, August 27). Girls and minorities break records in computer science as fastest-growing groups! *Code.org*. https://codeorg.medium.com/girls-and-minorities-break-records-in-computer-science-as-fastest-growing-groups-39d23425810e

Penuel, W. R., Riedy, R., Barber, M. S., Peurach, D. J., LeBouef, W. A., & Clark, T. (2020). Principles of collaborative education research with stakeholders: Toward requirements for a new research and development infrastructure. *Review of Educational Research*, *90*(5), 627–674. https://doi.org/10.3102/0034654320938126

Peske, H., & Haycock, K. (2006). *Teaching inequality: How poor and minority students are shortchanged on teacher quality.* The Education Trust. https://edtrust.org/wp-content/uploads/2013/10/TQReportJune2006.pdf

Pourhoseingholi, M. A., Baghestani, A. R., & Vahedi, M. (2012). How to control confounding effects by statistical analysis. *Gastroenterology and Hepatology from Bed to Bench*, *5*(2), 79–83. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4017459/

President's Council of Advisors on Science and Technology. (2010). *Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future*.

Executive Office of the President of the United States. https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/pcast-stem-ed-final.pdf

Privitera, G. J. (2018). *Statistics for the behavioral sciences* (3rd ed.). SAGE Publications.

Ratcliffe, K., Riddle, B., & Yinger, J. (1990). The fiscal condition of school districts in Nebraska: Is small beautiful? *Economics of Education Review*, *9*(1), 81–99. https://doi.org/10.1016/0272-7757(90)90034-3

Reardon, S. F., & Hinze-Pifer, R. (2017). *Test score growth among Chicago public school students, 2009–2014*. Stanford Center for Education Policy Analysis. https://cepa.stanford.edu/content/test-score-growth-among-chicago-public-school-students-2009-2014

Reason, R. D. (2003). Student variables that predict retention: Recent research and new developments. *NASPA Journal*, *40*(4), 172–191. https://www.cedu.niu.edu/~walker/research/Review%20Lit.pdf

Rhode Island Department of Elementary and Secondary Education. (2012, February 10). *2011 NECAP: Middle-school scores up, high-school mathematics down five-year graduation rate rises to 80 percent* [Press release].

Rice, J. K. (2010). *The impact of teacher experience: Examining the evidence and policy implications* [Policy brief]. National Center for Analysis of Longitudinal Data in Education Research. https://files.eric.ed.gov/fulltext/ED511988.pdf

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, *73*(2), 417–458. https://doi.org/10.1111/j.1468-0262.2005.00584.x

Rockoff, J. E. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *American Economic Review*, *94*(2), 247–252. https://doi.org/10.1257/0002828041302244

Rodriguez, A., & McGuire, K. M. (2019). More classes, more access? Understanding the effects of course offerings on Black-White gaps in advanced placement course-taking. *The Review of Higher Education*, *42*(2), 641–679. https://doi.org/10.1353/rhe.2019.0010

Rose, S., & McGuire, T. G. (2019). Limitations of p-values and r-squared for stepwise regression building: A fairness demonstration in health policy risk adjustment. *The American Statistician*, *73*(1), 152–156. https://doi.org/10.1080/00031305.2018.1518269

Rothschild, E. (1999). Four decades of the advanced placement program. *The History Teacher*, *32*(2), 175–206. https://doi.org/10.2307/494439

Rowland, M., & Shircliffe, B. J. (2016). Confronting the "acid test": Educators' perspectives on expanding access to advanced placement at a diverse Florida high school. *Peabody Journal of Education*, *91*(3), 404–420. https://doi.org/10.1080/0161956X.2016.1184947

Roy, J., & Mishel, L. (2008). Using administrative data to estimate graduation rates: Challenges, proposed solutions and their pitfalls. *Education Policy Analysis Archives*, *16*(11), 1–34. https://www.redalyc.org/pdf/2750/275020545010.pdf

Royal, D., & Swift, A. (2016, October 18). U.S. minority students less exposed to computer science. *Gallup*. https://news.gallup.com/poll/196307/minority-students-less-exposed-computer-science.aspx

Sadler, P. M., Sonnert, G., Tai, R. H., & Klopfenstein, K. (2010). *AP: A critical examination of the advanced placement program*. Harvard Educational Press. https://files.eric.ed.gov/fulltext/EJ1121425.pdf

Sass, T. R., Hannaway, J., Xu, Z., Figlio, D. N., & Li, F. (2012). Value added of teachers in high-poverty schools and lower poverty schools. *Journal of Urban Economics*, *72*(2), 104–122. https://doi.org/10.1016/j.jue.2012.04.004

Sax, L. J., Newhouse, K. N. S., Goode, J., Nakajima, T. M., Skorodinsky, M., & Sendowski, M. (2022). Can computing be diversified on "principles" alone? Exploring the role of AP computer science courses in students' major and career intentions. *ACM Transactions on Computing Education*, *22*(2), 1–26. https://doi.org/10.1145/3479431

Schultz, D.G. (1950). The comparability of scores from three mathematics tests of the college entrance examination board. *Psychometrika 15*(4), 369–384. https://doi-org.proxy.library.vanderbilt.edu/10.1007/BF02288865

Seastrom, M., Chapman, C., Stillwell, R., McGrath, D., Peltola, P., Dinkes, R., & Xu, Z. (2006). *User's guide to computing high school graduation rates, volume 2: Technical evaluation of proxy graduation indicators* (NCES 2006-605). National Center for Education Statistics. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2006605

Seebruck, R. (2015). Teacher quality and student achievement: A multilevel analysis of teacher credentialization and student test scores in California high schools. *McGill Sociological Review*, *5*, 1–18. https://www.mcgill.ca/msr/files/msr/seebruck_2015.pdf

Sheehan, K., & Rall, K. (2011). Rediscovering hope: Building school cultures of hope for children of poverty. *Phi Delta Kappan*, *93*(3), 44–47. https://doi.org/10.1177/003172171109300311

Shub, T. M., & Maaz, K. R. (2021). *Exploring ECS teacher persistence and attrition in Chicago public schools* [Doctoral capstone, Vanderbilt University]. Vanderbilt University Institutional Repository. https://ir.vanderbilt.edu/handle/1803/16779

Singer, J., Pogodzinski, B., Lenhoff, S. W., & Cook, W. (2021). Advancing an ecological approach to chronic absenteeism: Evidence from Detroit. *Teachers College Record*, *123*(4), 1–36. https://doi.org/10.1177/016146812112300406

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research*, *75*(3), 417–453. https://doi.org/10.3102/00346543075003417

Sjölund, S., Lindvall, J., Larsson, M., & Ryve, A. (2022). Using research to inform practice through research-practice partnerships: A systematic literature review. *Review of Education*, *10*(1), 1-25. https://doi.org/10.1002/rev3.3337

Smerdon, B., & Borman, K. M. (Eds.). (2012). *Pressing forward: Increasing and expanding rigor and relevance in America's high schools.* Information Age Publishing.

Smith, J., Hurwitz, M., & Avery, C. (2017). Giving college credit where it is due: Advanced placement exam scores and college outcomes. *Journal of Labor Economics*, *35*(1), 67–147. https://doi.org/10.1086/687568

Sperandei, S. (2014). Understanding logistic regression analysis. *Biochemia Medica*, *24*(1), 12–18. https://doi.org/10.11613/bm.2014.003

Stanton-Salazar, R. D. (2011). A social capital framework for the study of institutional agents and their role in the empowerment of low-status students and youth. *Youth & Society*, *43*(3), 1066–1109. https://doi.org/10.1177/0044118X10382877

Stark, P., & Noel, A. M. (2015). *Trends in high school dropout and completion rates in the United States: 1972–2012.* National Center for Education Statistics. https://nces.ed.gov/pubs2015/2015015.pdf

Stephenson, C., & Wilson, C. (2012). Reforming K-12 computer science education...What will your story be? *ACM Inroads, 3*(2), 43-46. DOI: 10.1145/2189835.2189850

Stoltzfus, J. C. (2011). Logistic regression: A brief primer. *Academic Emergency Medicine*, *18*(10), 1099–1104. https://doi.org/10.1111/j.1553-2712.2011.01185.x

Streiner, D. L., & Cairney, J. (2007). What's under the ROC? An introduction to receiver operating characteristics curves. *Canadian Journal of Psychiatry*, *52*(2), 121–128. https://doi.org/10.1177/070674370705200210

Summers, A. A., & Wolfe, B. L. (1975). *Which school resources help learning? Efficiency and equity in Philadelphia public schools.* Business Review. https://www.philadelphiafed.org/-/media/frbp/assets/economy/articles/business-review/1975/br75fas.pdf

Swanson, C. B., & Chaplin, D. (2003). *Counting high school graduates when graduates count: Measuring graduation rates under the high stakes of NCLB.* Urban Institute Education Policy Center. https://www.researchgate.net/publication/237412958_Counting_High_School_Graduates_when_Graduates_Count_Measuring_Graduation_Rates_under_the_High_Stakes_of_NCLB/link/00b7d528fbafee23dc000000/download

Swinton, J., De Berry, T., Scafidi, B., & Woodard, H. (2010). Does in-service professional learning for high school economics teachers improve student achievement? *Education Economics*, *18*(4), 395–405. https://doi.org/10.1080/09645290802470434

Szumilas, M. (2010). Explaining odds ratios. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, *19*(3), 227–229. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2938757/

The Associated Press. (2023, February 1). Revised AP African American studies class drops controversial topics after criticism. *NPR.* https://www.npr.org/2023/02/01/1153364556/ap-african-american-studies-black-history-florida-desantis

The Learning Partnership. (n.d.). *About the Learning Partnership*. https://www.jointhepartnership.net/about-us/

Tierney, W. G., & Hagedorn, L. S. (Eds.). (2002). *Increasing access to college: Extending possibilities for all students.* State University of New York Press.

Tolles, J., & Meurer, W. J. (2016). Logistic regression: Relating patient characteristics to outcomes. *The Journal of the American Medical Association*, *316*(5), 533–534. https://doi.org/10.1001/jama.2016.7653

U.S. Bureau of Labor Statistics. (2022, September 8). *Occupational outlook handbook: Computer and information technology occupations*. https://www.bls.gov/ooh/computer-and-information-technology/home.htm

U.S. Department of Education. (1996). *Manual to combat truancy*. U.S. Department of Justice. http://archives.gadoe.org/DMGetDocument.aspx/policy_attendance_manual_truancy.pdf?p=4BE1EECF99CD364EA5554055463F1FBBF5D074D5FB1F2CAEB3B63B3ECB220CDD26C2114F3C57D8D23595B5420AC335DD&Type=D

Valencia, R. R. (2000). Inequalities and the schooling of minority students in Texas: Historical and contemporary conditions. *Hispanic Journal of Behavioral Sciences*, *22*(4), 445–459. https://doi.org/10.1177/0739986300224005

Villavicencio, A., Bhattacharya, D., & Guidry, B. (2013). *Moving the needle: Exploring key levers to boost college readiness among Black and Latino males in New York City.* The

Research Alliance for New York City Schools. https://files.eric.ed.gov/fulltext/ED543855.pdf

Walsh, M. E., Katz, M. A., & Sechrest, L. (2002). Unpacking cultural factors in adaptation to type 2 diabetes mellitus. *Medical Care*, *40*(1), I129–I139. https://doi.org/10.1097/00005650-200201001-00014

Warren, J. R., & Halpern-Manners, A. (2007). Third annual brown lecture in education research: Is the glass emptying or filling up? Reconciling divergent trends in high school completion and dropout. *Educational Researcher*, *36*(6), 335–343. http://www.jstor.org/stable/30133809

Warren, J. R., & Halpern-Manners, A. (2009). Measuring high school graduation rates at the state level: What difference does methodology make? *Sociological Methods & Research*, *38*(1), 3–37. https://doi.org/10.1177/0049124109339374

Werblow, J., & Duesbery, L. (2009). The impact of high school size on math achievement and dropout rate. *High School Journal*, *92*(3), 14–23. https://doi.org/10.1353/hsj.0.0022

Werner, R. M., Canamucio, A., Marcus, S. C., & Terwiesch, C. (2014). Primary care access and emergency room use among older veterans. *Journal of General Internal Medicine*, *29*(Suppl 2), 689-694. https://doi.org/10.1007/s11606-013-2678-8

West Virginia Board of Education & National Dropout Prevention Center for Students with Disabilities. (2012). *West Virginia's adjusted cohort graduation rates: Question and answer guide.* https://wvde.state.wv.us/osp/Transition/WV4-yearAdjustedCohortRevisedMay2012.pdf

White, J., Hopkins, R., Shockley, D., Lewis, M., Hutzel, M., & Crabtree, D. (2018). Effective science professional development in a small Appalachian school district. *Research in the*

Schools, *25*(1), 59–71. https://www.proquest.com/openview/4378599eaf690c2890c75d551869b2c0/1?pq-origsite=gscholar&cbl=10235

Wilkerson, B. D. (2018, February 21–24). *The evolution before the revolution* [Conference session]. SIGCSE '18: The 49th ACM Technical Symposium on Computer Science Education, Baltimore, MD, United States. https://doi.org/10.1145/3159450.3166085

Wolters, C. A., & Daugherty, S. G. (2007). Goal structures and teachers' sense of efficacy: Their relation and association to teaching experience and academic level. *Journal of Educational Psychology*, *99*(1), 181–193. https://doi.org/10.1037/0022-0663.99.1.181

Xu, Z., Özek, U., & Hansen, M. (2015). Teacher performance trajectories in high- and lower-poverty schools. *Educational Evaluation and Policy Analysis*, *37*(4), 458–477 https://doi.org/10.3102/0162373714561513

Youth Justice Board. (2013). *From absent to present: Reducing teen chronic absenteeism in New York City.* Center For Court Innovation. https://www.courtinnovation.org/sites/default/files/documents/TruancyReport.pdf

Zhang, D., Katsiyannis, A., Barrett, D. E., & Willson, V. (2007). Truancy offenders in the juvenile justice system: Examinations of first and second referrals. *Remedial and Special Education*, *28*(4), 244–256. https://doi.org/10.1177/07419325070280040401

Part VI: Appendices

Appendix A

Data Set Codebook of School-Level Variables

Dark Green Fill = Dependent Variable Used		
1	SchYr	school year
2	School_Year_ID	School ID for each school year. School ID then school year end after decimal point (example - school 1234 for school year 2011-2012 would be 1234.12)
3	schoolid	school id
4	school_short	school name
5	SCH_TYPE	school type (OLD - Discontinue using) AUSL - academy for urban school leadership. district run Charter - exclude from analyses Contract - exclude from analyses ISP - Independent School Principals - designed for highest-performing principals in district. More independence than others, still district oversight Network # - district run schools Military - district run OS4 - Office of Strategic School Support Services. district run for specific set of CPS schools. see file details for more information Options - exclude from analyses Service Leadership Academies - airforce/military schools; district run district
6	Sch_Type_OCS	School Ttypes (after discussion with Andy at OCS) Neighborhood - Traditional district run school OCS (Contract) - Contract school but part of OCS and subject to graduation requirement OCS (Option) - Option school but part of OCS and subject to graduation requirement Selective - Selective enrollment school Specialty - Significantly Modified Schools STEM - STEM Schools
7	GRADE_CAT	Primary Grade Category HS = High School
8	enroll	school enrollment

9	pct_white	school % of white students
10	pct_black	school % black/african american students
11	pct_naa	school % native american/alaskan students
12	pct_api	school % asian/pacific islander students
13	pct_latinx	school % latinx/hispanic students
14	pct_mr	school % multiracial students
15	pct_asian	school % asian students
16	pct_hpi	school % hawaiian/pacific islander students
17	pct_notav	school % students with race/ethnicity not available
18	pct_bilingual	school % bilingual students Note: "Bilingual" refers to the state definitions of students who are English learners. (2017-2021)
19	pct_sped	school % special education students In 2011-12, this column is labeled IEP, and SPED 2013-21
20	pct_frl	school % free/reduced lunch students Note: column name changes over time - 2011-12 labeled free; 2013-14 labeled free/reduced lunch; 2015 economically disadvantaged; 2016-21 free/reduced lunch Note: "Economically Disadvantaged Students" come from families whose income is within 185 percent of the federal poverty line. The District formerly referred to these students as "Free or Reduced Lunch Eligible Students," and adopted the new term after the federal government, under the Community Eligibility Provision, funded breakfasts and lunches for all students if more than 40 percent of students qualify.
21	5Es_E_Ins	Measure Name: Essential: Ambitious Instruction | Years Available: Data available for sy14, sy15, sy16, sy17, sy18, sy19, sy21

22	5Es_E_Env	Measure Name: Essential: Supportive Environment | Years Available: Data available for sy14, sy15, sy16, sy17, sy18, sy19, sy21
23	5Es_E_Fam	Measure Name: Essential: Involved Families | Years Available: Data available for sy14, sy15, sy16, sy17, sy18, sy19, sy21
24	5Es_E_Tch	Measure Name: Essential: Collaborative Teachers | Years Available: Data available for sy14, sy15, sy16, sy17, sy18, sy19, sy21
25	5Es_E_Ldr	Measure Name: Essential: Effective Leaders | Years Available: Data available for sy14, sy15, sy16, sy17, sy18, sy19, sy21
26	5Es_OverallPoints	(Intentionally left blank)
27	5Es_OverallScore	(Intentionally left blank)
28	SQRP_TotalPoints	SQRP - Total points
29	SQRP_Rating	SQRP Rating category Levels 1+ - 2+ = Good Standing | Level 2 = Provisional Support | Level 3 = Intensive Support
30	SQRP_AccountabilityStatus	SQRP Status category Levels 1+ - 2+ = Good Standing | Level 2 = Provisional Support | Level 3 = Intensive Support
31	ECCE_Score	Percent of students graduating from the school in the most recent year who have earned at least one credit from an approved early college course, a 3+ on an AP exam, a 4+ on an IB exam, the State Seal of Biliteracy, or an approved career certification (From SQRP reports)
32	CS_StartYr	Year the school started offering CS courses
33	ECS_NumTchrsQual	Number of Qualified ECS teachers at the school for a given year
34	ECS_NumTchrs_AtLeastPartialQual_FIXED	Number of At Least Partially Qualified ECS teachers at the school for a given year
35	CSP_NumTchrsQual	Number of Qualified CSP teachers at the school for a given year
36	CSP_NumTchrs_AtLeastPartialQual_FIXED	Number of At Least Partially Qualified CSP teachers at the school for a given year

37	CS_TeachersPerYr	Number of Computer Science teachers at the school for a given year
38	CS_CoursesPerYr	Number of Computer Science courses available at the school for a given year
39	CS_StudentsPerYr	Number of Computer Science students at the school for a given year
40	ECS_StudentsPerYr	Number of students taking ECS at the school for a given year
41	*Offer_ECS	0=No; 1=Yes (created-not part of the original data set)
42	Robotics_StudentsPerYr	Number of students taking a Robotics course at the school for a given year
43	APCSA_StudentsPerYr	Number of students taking AP CS A at the school for a given year
44	APCSP_StudentsPerYr	Number of students taking AP CSP at the school for a given year
45	*Offer_CSP	0=No; 1=Yes (Created)
46	Ratio_EnrollToECS_NumTchrsQual	Total Enrollment divided by number of Qualified ECS teachers
47	Ratio_EnrollToECS_NumTchrs_AtLeastPartialQual_Fixed	Total Enrollment divided by number of At Least Partially Qualified ECS teachers
48	Ratio_EnrollToCSP_NumTchrsQual	Total Enrollment divided by number of Qualified CSP teachers
49	Ratio_EnrollToCSP_NumTchrs_AtLeastPartialQual_Fixed	Total Enrollment divided by number of At Least Partially Qualified CSP teachers
50	Address	School Street Address
51	Lat	School Latitude

52	Long	School Longitude
53	Avg_St_ATTD_Rate	Average attendance rate by school/year
54	ECS_TchrCountByYear	Total number of ECS teachers at the school/year
55	ECS_Exp_AvgYrs	Average years of ECS teaching experience/year
56	Pct_ECStakeFreshSoph	Perecnt of students at the school/year that take ECS as Freshman or Sophomores
57	CTE-IT_Sch	Does the school offer at CTE-IT track for the given year
58	GraduationRate_4yr	The percentage of students in a cohort who graduated between the indicated year and the 4 school years before the indicated year.
59	GraduationRate_5yr	The percentage of students in a cohort who graduated between the indicated year and the year 5 school years before the indicated year.

Appendix B

Single Regression and Multiple Regression Within Categories: Analyses and Results

What Student-Factor Variables Impact the Likelihood That AP CSP is Offered in CPS High Schools?

Single regression analysis revealed that the percentage of multiracial students was the only positive predictor, with percentages of Black, special education, and free and reduced lunch students being negative predictors. All of these were significant at p value < .001. None of the other student-factor variables individually were predictive of whether AP CSP would be offered (see Figure 10).

Figure 10

Single Regression Student-Factor Variables

SINGLE REGRESSION Student Variables
% Black students***
% Latinx students
% Native American students
% Multiracial students***
% Bilingual students
% Special education students***
% free/reduced lunch***

***Statistically significant at p=<.001

After looking at the student-factor variables individually and determining their singular effects, we wanted to see the collective effects of all of the student-factor variables when considered together. We wanted to know if there would be an additive or synergistic effect of those factors that were singularly predictive. When all of the student-factor variables were blocked together, only the percent of Black and special education students remained predictive with the percent of free and reduced lunch trending towards significance. We use trending towards significance to show almost but not quite statistically significant p-values (e.g., p=0.06).

This does not imply that there was a subset of non-significant p values that suggest, support, or represent a trend, by being almost significant (Gibbs & Gibbs, 2015). The largest impact was the percentage of Black students (see Table 2).

Table 2

Multiple Regression Student-Factor Variables

STUDENT VARIABLES				
Variables	Odds Ratio	95% C.I for Odds Ratio		Probability
		Lower	Upper	
Pct of Black Students*	.980	.972	.989	49.5%
Pct of Special Education Students*	.000	.000	.002	0.00%
Pct of Free/reduced lunch Students ♦	.987	.971	1.002	49.7%
Pct of Native American Students	^	^	^	^
Pct of Latinx Students	^	^	^	^
Pct. Of Multiracial Students	^	^	^	^
Pct of Bilingual Students	^	^	^	^

* Statistically significant at <.05; ♦ Trending towards significance; ^ Not statistically significant

What Teacher Factors Impact the Likelihood That AP CSP is Offered in CPS High Schools?

Single regression analysis revealed that the number of ECS and CSP partially qualified teachers, the number of total ECS teachers per year, and the average years of ECS teaching experiences were all positive predictors of whether the school would offer AP-CSP. All of these were significant at p value < .001. None of the other teacher-factor variables individually were predictive of whether AP CSP would be offered (see Figure 11).

Figure 11

Single Regression Teacher-Factor Variables

SINGLE REGRESSION Teacher Variables
Number of partially qualified ECS teachers***
Number of partially qualified CSP teachers***
Number of ECS teachers/year***
Average number of ECS teaching experience***
Number of CS teachers/year

***Statistically significant at p=<.001

After looking at the teacher-factor variables individually and determining their singular effects, we wanted to see the collective effects of all of the teacher factors when considered together. We wanted to know if there would be an additive or synergistic effect of those variables that were singularly predictive. When all of the teacher-factor variables were blocked together, only the number of partially qualified AP CSP teachers remained predictive (see Table 3).

Table 3

Multiple Regression Teacher-Factor Variables

TEACHER VARIABLES				
Variables	Odds Ratio	95% C.I for Odds Ratio		Probability
		Lower	Upper	
Number of Partially Qualified CSP Teachers*	1.395	1.149	1.692	58.2%
Number of Partially Qualified ECS Teachers	^	^	^	^
Average Years of ECS Teaching Experience	^	^	^	^
Number of ECS Teachers per year	^	^	^	^
Number of CS Teachers per year	^	^	^	^

* Statistically significant at <.05; ^ Not statistically significant

What School Context Factors Impact the Likelihood That AP CSP is Offered in CPS High Schools?

Single logistic regression analysis revealed that enrollment, average attendance, and five-year graduation rate were all positive predictors of whether the school would offer AP CSP. All of these were significant at p-value < . 001. The ECCE score was a positive predictor at a p-value < .01. The SQRP total points and the CTE-IT track were both predictors at a p-value < .05 with the CTE-IT track being a negative predictor (see Figure 5.3).

Figure 12

Single Regression School Context-Factor Variables

SINGLE REGRESSION School Variables
Enrollment***
Average attendance rate***
5-yr Graduation rate***
ECCE score**
SQRP Total Points*
CTE-IT Track*

***Statistically significant at p=<.001,
**Statistically significant at p=<.01
*Statistically significant at p=<.05

After looking at the school context-factor variables individually and determining their singular effects, we wanted to see the collective effects of all of the school context-factor variables when considered together. We wanted to know if there would be an additive or synergistic effect of those variables that were singularly predictive. When all of the school variables were blocked together, only the five-year graduation rate and enrollment remained positive predictors (see Table 4).

Table 4

Multiple Regression School Context-Factor Variables

SCHOOL VARIABLES				
Variables	Odds Ratio	95% C.I for Odds Ratio		Probability
		Lower	Upper	
5-year Graduation rate*	1.068	1.039	1.099	51.6%
Enrollment*	1.001	1.000	1.001	50%
ECCE Score	^	^	^	^
SQRP Total Points	^	^	^	^
CTE-IT Track	^	^	^	^
Average Attendance rate	^	^	^	^

* Statistically significant at <.05; ^ Not statistically significant

Appendix C

Multiple Regression Across Categories: Analyses and Results

Student and Teacher Factors Combined Effects

We next wanted to look at multiple categories, and we performed a stepwise regression. Stepwise regression methods can be used in building predictive functions, where independent variables are used to estimate the effect of an exposure or intervention on the outcome (i.e., the dependent variable; Rose & McGuire, 2019). Our first block in our regression controlled for time. Alone, time was significant as expected since the number of schools offering AP-CSP increased each year. Since our partner organization wanted to know the effects of the CTE-IT track, our second block was the CTE-IT track. The third block was our student-factor variables, and the fourth block was teacher-factor variables. In this stepwise approach, we controlled for the variance from each of the previous blocks. Using this model, the percentages of Black and special education students were still negatively predictive, and the number of partially qualified CSP teachers was positively predictive. In this model, the average years of ECS teaching was also shown to be predictive (see Table 5).

Table 5

Multiple Regression Student- and Teacher-Factor Variables

STUDENT AND TEACHER VARIABLES				
Variables	Odds Ratio	95% C.I for Odds Ratio		Probability
		Lower	Upper	
Pct of Black Students*	.987	.978	.996	49.7%
Pct of Special Education Students*	.000	.000	0.14	0.00%
Number of Partially Qualified CSP Teachers*	1.821	1.384	2.395	64.6%
Average Years of ECS Teaching Experience*	1.313	1.059	1.627	56.8%

* Statistically significant at <.05

Student and School Context Factors Combined Effects

In combining the student- and school context-factor variables, the percentages of Black and special education students were still negatively predictive (see Table 6). The percentage of free/reduced lunch was trending towards significance.

Table 6

Multiple Regression Student- and School Context-Factor Variables

STUDENT AND SCHOOL VARIABLES				
Variables	Odds Ratio	95% C.I for Odds Ratio		Probability
		Lower	Upper	
Pct of Black Students*	.981	.972	.989	49.5%
Pct of Special Education Students*	.000	.000	.003	0.00%
Pct of Free/reduced lunch Students ♦	.987	.971	1.002	49.7%

* Statistically significant at <.05; ♦ Trending towards significance

Teacher and School Combination Effects

In combining the teacher- and school context-factor variables, the presence of the CTE-IT track at the school was a negative predictor (see Table 7). The positive predictors were enrollment, the five-year graduation rate, and the number of partially qualified CSP teachers.

Table 7

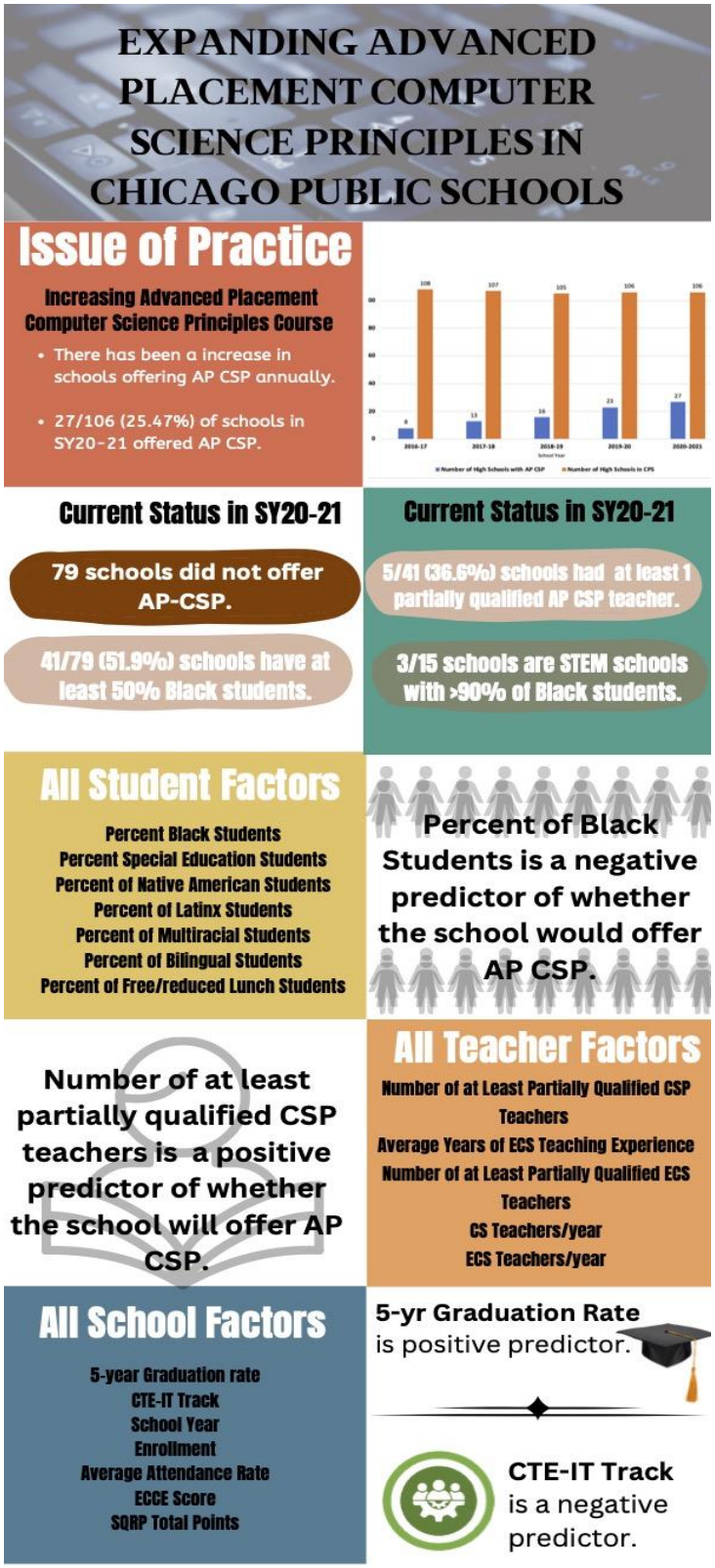
Multiple Regression Teacher- and School Context-Factor Variables

SCHOOL AND TEACHER VARIABLES				
Variables	Odds Ratio	95% C.I for Odds Ratio		Probability
		Lower	Upper	
CTE-IT Track*	.377	.181	.785	27.4%
5-year Graduation rate*	1.064	1.000	1.001	51.6%
Enrollment*	1.001	1.000	1.001	50%
Number of Partially Qualified CSP Teachers*	1.938	1.432	2.624	66%

* Statistically significant at <.05; ^ Not statistically significant

Appendix D

AP CSP Infographic



1. ENCOURAGE SCHOOLS WITH AT LEAST 1 PARTIALLY QUALIFIED CSP TEACHER TO CONSIDER OFFERING AP CSP

2. ENCOURAGE STEM SCHOOLS WITH HIGH % BLACK STUDENTS AND AT LEAST 1 PARTIALLY QUALIFIED CSP TEACHER TO CONSIDER OFFERING AP CSP

3. CONDUCT CASE STUDY OF SCHOOLS THAT OFFER CSP TO DETERMINE THE EFFECTIVENESS OF THE COURSE AND IMPLEMENTATION OF THIS COURSE INTO THE CURRICULUM

4. CONTINUE TO ENCOURAGE TEACHERS TO BECOME AT LEAST PARTIALLY QUALIFIED

VANDERBILT UNIVERSITY