



# The Role of Accountability Benchmarks to Increase Equity and Diversity in K-12 Computer Science Education

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## ABSTRACT

In March 2021, Illinois Governor Pritzker signed into law the Education and Workforce Equity Act (Public Act 101-0654) — an omnibus bill that included state-wide mandates to expand K-12 computer science (CS) education by requiring each high school district to offer students the opportunity to take at least one CS course. Because the bill did not include benchmarks for measuring equitable access and outcomes for all students, state-wide policies are open to interpretation and vulnerable to widening gaps for various student groups. Ongoing research efforts and partnerships are needed to ensure policies to increase access do not unintentionally harm students.

## CCS CONCEPTS

•Social and professional topics ~ Professional topics ~ Computing education ~ K-12 education

## KEYWORDS

Policy, K-12 education, Equity

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## 1 INTRODUCTION

Since the unveiling of Computer Science for All in 2016 with the aim of “offering every student hands-on CS and math classes that make them job-ready on day one,” [38] many state-level initiatives have been taken to address diversity and equity issues in computer science (CS) K-12 education. Despite some progress, in 2023, only 57.5% of public high schools across the country offered foundational CS courses, and disparities still exist between states and various student subgroups [5]. Like many other initiatives to broaden participation in CS, the Education and Workforce Equity Act (Public Act 101-0654) bill signed into law in 2021 in Illinois mandated each high school district to offer students the opportunity to take at least one CS course. Throughout this paper, we note gaps in this legislation concerning equity in CS, highlight possible solutions to address these gaps and suggest critical metrics for tracking progress and measuring success to ensure the objective of broadening participation in CS education K-12 is met in the state of Illinois.

### 1.1 The Illinois Context

Illinois places high importance on computer and information sciences in both its education and workforce. It has been ranked 7th in the United States for STEM employment, with CS jobs accounting for nearly half of the STEM jobs in 2021 [14]. Additionally, the state is among the top ten states with the highest growth of STEM graduates. However, despite making up 33% of the state’s population, Black/African American and Hispanic/Latinx individuals in Illinois represent only 15% of the STEM workforce. Furthermore, the percentage of women employed in STEM jobs in Illinois has increased by less than 1% since 2012. Lastly, only 54% of public high schools offered a foundational CS course and only 6.2% of high school students took foundational CS in the 2021-2022 school year [5]. Therefore, the high school provision of the Illinois Education and Workforce Equity Act (Public Act 101-0654) plays a crucial role in enhancing access and promoting racial equity in K-12 CS education.

The Education and Workforce Equity Act (Public Act 101-0654) includes several mandates regarding CS education in the state [44]:

- The Illinois State Board of Education (ISBE) was to create rigorous K-12 CS learning standards by December 2021.
- An AP CS course may count towards the three years of math state graduation requirement.
- Starting with the 2023-2024 school year, each district that serves grades 9-12 (i.e., high school) must provide the opportunity for all students to take at least one CS course aligned to the standards.
- Districts are required to include CS curriculum information in their schools' report cards.

The bill was designed to ensure equitable access to CS education. However, it lacked specific goals and targets to achieve this objective. The lack of benchmarks prevents accountability of school districts, and the state, for broadening CS participation to all high school students.

## 1.2 A Framework for Equity

One critical aspect of ensuring that the bill delivers on its promises is the use of data to evaluate and inform the progress being made in expanding participation in and access to CS education. To address this issue, we will use the CAPE framework [9] to identify key indicators to track the progress in achieving equitable access to CS education for all students across the state. The CAPE framework [9] is an effective model for the analysis and interpretation of data, thereby furnishing the basis for informing policy decisions at various levels of educational systems [41]. The framework consists of four fundamental components, which are interconnected and built on each other to influence CS education: Capacity, Access, Participation, and Experience. The CAPE framework has been used to evaluate CS programs in West Hartford Public Schools, to create a K-12 CS education accessibility dashboard in Georgia, and to develop CS education profiles and interactive visualizations in Texas [31]. Using the CAPE framework as guidance, we can explore the bill's implications and the necessity for benchmarks. In the following sections, we delve into capacity by discussing the availability of CS teachers and the necessary resources to implement quality CS education. Access to and participation in CS education are also discussed around availability of CS courses, disparities in enrollment, and the quality of CS education.

## 2 POLICY GAPS & ACCOUNTABILITY

Below, we highlight several gaps in Illinois' Education and Workforce Equity Act (Public Act 101-0654) that should be considered when expanding CS education in the state with a lens of increasing equity and diversity. We then enumerate possible solutions to close such gaps as well as benchmarks to hold the state accountable for increasing access for *all* students.

### 2.1 Teacher Training

*2.1.1 Policy gaps in teacher training.* Implementing district offering requirements poses great challenges, such as meeting the

demand for certified CS teachers. In fact, nationwide, only 58% of public high school mathematics and CS teachers held both a degree and a teaching certificate in their respective fields [35]. This percentage was even lower in schools where 75% or more of students were from minoritized groups or were on free or reduced lunch programs. In the first statewide landscape report on CS in Illinois public schools, the shortage of skilled CS teachers was the no.1 barrier to providing more CS courses in K-12 settings [13]. When the primary way of training teachers is through four-year teacher preparation programs, producing the required number of CS teachers in a short period to ensure state policies are met by their target dates will be challenging.

*2.1.2 Possible solutions to close the gap in teacher training.* Creative training opportunities, such as industry partnerships, are needed to quickly increase the pool of certified CS teachers while finding ways to fill current school open positions with available resources.

**Short-term professional development (PD)** to train teachers from other subject areas is one way to increase the pool of CS teachers quickly. An example in Illinois is Computer Science PD Week, available in 2024 through the partnership between the Learning Technology Center (LCD), CS4IL, Discovery Partners Institute, Peoria County Regional Office of Education (ROE 48), and Peoria Public Schools in Illinois. It offers a 5-day learning experience with different learning tracks to new and experienced K-12 teachers who are interested in teaching CS [27]. However, these training opportunities often come with a cost for teachers, and districts might not always be able to cover the training fees when meeting the funding requirement [34]. One way to address this challenge and offer free PDs to teachers could be securing partnerships, like the Chicago Public Schools collaboration with Northwestern University and Apple [1]. Another challenge is brought by the short duration of some trainings, sometimes only a couple of days long, which may not be enough to prepare teachers to teach an entirely new subject adequately [4]. Thus, it is essential to have a reliable support system for newly trained teachers to help them become more effective and comfortable with the curriculum, such as in-school coaching and mentorship. For example, the Indiana Department of Education has established a program called CS Champs, which provides experienced CS educators across the states as a resource for CS teachers who need guidance or have questions about teaching and learning, especially if they are new to the field [17].

**Industry partnerships** bring tech professionals to assist teachers in teaching CS concepts, such as the Microsoft's TEALS program [33]. The program offers two types of models: the co-teach model and the lab-support model. The first is geared more towards novice CS teachers, and it connects industry volunteers with high school teachers to deliver courses such as Introduction to CS and AP CS. In the second, the teacher completes at least 80% of planning and lessons independently, and volunteers assist a teacher with small group instruction and grading. This program serves as a model of industry partnerships that allow teachers and students to learn from someone who has firsthand experience.

**Endorsements** would provide current teachers with added CS content knowledge to fill CS teacher vacancies. There are two

types of endorsements: content area endorsements and testing-out endorsements. The *content area endorsements* allow licensed teachers to teach additional subjects and provide another opportunity for CS training. In Illinois, the CS content area endorsement can be obtained by completing eighteen semester hours of coursework and an exam [21]. *Testing-out endorsements* on the other hand involve obtaining CS credentials by passing state-approved content knowledge exams, like Praxis or Pearson CS exams. Already used in Arkansas, Connecticut, and Louisiana, this could be an option for teachers who already have CS content knowledge. Illinois could also consider this option for endorsement. There are fees associated with both options, which can be a financial burden for teachers. Once more, funding issues are a barrier to reaching teacher capacity. One solution is subsidized endorsement fees, such as Chicago Public Schools covering 80% of the endorsement fees for their teachers [30], though this may not be feasible for every school district in the state. Currently, only four Illinois universities offer CS endorsement [30], signaling the need to expand opportunities to obtain a CS teaching endorsement to reach teachers throughout the whole state.

**2.1.3 Reporting and accountability in teacher training.** To address the state’s shortage of CS teachers, it is essential to keep track of the number of licensed teachers obtaining a CS endorsement, the number of unfilled positions in CS, and vacancy rates in CS each year. However, a challenge arises as CS is not included in the indicators currently collected at the state level. Each fall, ISBE collects information on unfilled positions in all school districts [22]. The information can be broken down by subject area and is publicly available. However, there is no predefined field for CS in the subject area field. Tracking the number of unfilled CS positions would help determine how many school districts are meeting capacity for CS education. The same issue arises when tracking the number of educators’ preparation completers by school year and the type of endorsement held by educators [20]. CS is again missing from the data. Moreover, which courses are categorized as CS often needs to be clarified. To improve this situation, it is recommended that school districts clearly understand what courses qualify as CS, and ISBE maintains an updated list of courses that count towards CS courses to ensure the accuracy of this indicator.

## 2.2 CS Standards

**2.2.1 Policy gaps in CS standards.** ISBE met its mandate of releasing the Illinois K-12 CS standards [15] in January 2022, which were developed with input from a stakeholder group of educators throughout the state and based on the Computer Science Teachers Association (CSTA) standards. School districts have these standards as a reference for adopting and developing new CS courses. These standards detail eight CS content domains (Computing Systems, Networks and the Internet, Data and Analysis, Algorithms and Programming, Impacts of Computing, and Emerging and Future Technologies) and were divided into five grade bands (K-2, 3-5, 6-8, 9-10, and 11-12) to be mastered [15]. However, many teachers are beginning to engage with the CS standards for the first time and the Education and Workforce

Equity Act (Public Act 101-0654) did not include specifics on how equity could be achieved with such standards. Promoting equity in education requires “meaningful instruction, challenging systemic oppression, and using STEM and CS to empower students and their communities” [29]. Meaningful contents encompass the curriculum’s quality and its cultural relevance to the population context, but it can be an intricate task for teachers without adequate guidance.

**2.2.2 Possible solutions to close the gap in CS standards.** To support teachers in teaching CS, research has suggested that PD sessions concentrate on introducing teachers to CS standards, providing guidance on how to attain proficiency in a standard, and demonstrating how lesson plans align with these standards [2]. ISBE must work assertively and collaboratively with school districts to ensure that teachers receive proper training and that the course provided to fulfill this requirement genuinely imparts CS skills to students rather than just being labeled as such.

To ensure that the application of CS standards is effectively promoting equity and broadening participation in CS, it is crucial to engage students from minoritized identities and capture their interests. Teachers play a vital role in engaging their students and require practical tools to reach their diverse audiences effectively. Unfortunately, many teachers feel ill-equipped to do so. A US-wide survey found that 77% of teachers value diverse cultures and experiences in their teaching, but only 57% feel prepared to do so [26]. With CS standards still being new and in early stages of implementation, there is an opportunity to provide teachers with the appropriate tools to include a diversity of identities in their lessons and adopt elements of culturally responsive pedagogy (CRP) in their CS classes. PD could include modules on CRP in CS to increase accessibility, student engagement, and retention [25,29,32,37]. Furthermore, it would be advantageous to collaborate with representatives from various identities and cultures to adapt the curriculum and provide practical examples that students can relate to daily. With CRP guidelines specifically linked to CS standards, teachers would be better prepared to help students from minoritized identities feel more connected and engaged in their learning.

**2.2.3 Reporting and accountability in CS standards.** Unlike the Illinois Standardized Assessment for Readiness (IAR) in math and reading [23], which has defined yearly proficiency level targets, no standardized tests are available for CS to assess and evaluate students’ learning standards. Therefore, it is complicated to ensure that students are meeting the standards defined. The first step could be ensuring that teachers understand how to assess their students’ progress, knowledge, and skills described in the standards. Formative assessment modules could be added into the PD meetings about the CS standards requirements taken by teachers. Research suggests that PD offer opportunities for teachers to author assessment tasks and examine students work [2]. ISBE could have a list of state-approved providers’ recommendations for high-quality professional training to refer to and then track the number of teachers trained in these PDs and the total students enrolled in high-quality CS courses taught by a teacher trained in high-quality professional learning sessions by a state-approved provider. Alabama is already tracking these

numbers in its CS Equity dashboards [6]. ISBE’s new professional system PD+ is a new professional system designed by ISBE that could help track the enrollment and completion data of vetted providers and teachers in PDs. The interactive PD platform for teachers and providers is still under construction, and CS PDs could be included [24]. Additionally, training programs should include sections to equip teachers with the tools necessary to create equitable and inclusive environments —such as acknowledging and addressing any potential biases toward minoritized students.

School observations could be scheduled for districts that do not use vetted providers to ensure that the providers cover the required CS standards during training. The number of observations conducted each school year and the number of providers that adjusted the training after observations could be tracked. The results of these observations can then guide future improvements in standards and corrections to any problems identified during observation through targeted PD sessions. However, funding availability could be a limitation of this approach, as conducting school observations requires additional resources.

## 2.3 Disparities in Enrollment

*2.3.1 Policy gaps in enrollment disparities.* Most middle-skill decent jobs now require basic digital skills [43]. However, certain groups, such as female students, students of color, and students residing in remote areas, still face underrepresentation and marginalization in the CS field. During the 2021-2022 school year, only 36% of high school girls took foundational CS vs 64% of boys in Illinois [5], and nationwide, girls represented only 31% of AP CS exam test takers [40]. Stereotypical gender associations, underrepresentation of women in STEM, and lack of encouragement for girls in these fields hinder progress [28]. During the same school year, only 33% of rural high schools in Illinois offer foundational CS courses, compared to 81% of suburban schools. Also, while 91% of large schools provide these classes, only 31% of smaller schools do [5]. Furthermore, between the school years 2018 and 2022, only 6.8% of students enrolled in the most popular course, Computer Programming, were Black/African American students (after removing Chicago Public Schools) [3]. These statistics reveal the need to address the digital divide and promote equitable access to CS education. The Education and Workforce Equity Act (Public Act 101-0654) did not include plans for tracking CS enrollment trends over time. Without these metrics, it is impossible to know if gaps in enrollment are closing or widening.

*2.3.2 Possible solutions to close the gap in enrollment disparities.* Making CS courses available to everyone and ensuring the content is inclusive is not enough. If there are still barriers to enrollment and students’ success, progress on equity will be limited. Therefore, it is crucial to identify and address the obstacles preventing students with historically marginalized identities from enrolling in CS courses. One way to create a more inclusive learning environment is by educating students and parents on the importance of CS and increasing their awareness of new CS course opportunities in their schools and policy

changes in graduation requirements related to CS. One way to start tracking awareness of new CS offerings in schools is to monitor the number of communications sent to parents and students. It is important to ensure that these communications are translated into languages other than English, depending on the school’s distribution of English Language Learners. Additionally, conducting a student satisfaction survey in high schools can help track the number of school counselors who have discussed the CS course option with their students and the number of students aware of the CS offering. If such conversations are not happening, this may explain why students are not enrolling in these courses. This can lead to a discussion about improving school counseling services and communication.

Moreover, encouragement and exposure are proven to be factors positively influencing students who have been historically marginalized in this space [12,36]. Schools could arrange events and talks with successful women and Black/African American and Hispanic/Latinx computer scientists in the field as role models to encourage more students to pursue careers in computing. Additionally, it may be helpful to partner with organizations like Girls Who Code to offer free clubs, summer camps, or university network support specifically for girls interested in coding and other computing activities [11]. Such initiatives can help create a supportive community and provide opportunities for students to develop their skills.

For rural schools specifically, states can implement a collective impact model by using an existing network of organizations across the state to provide PD opportunities to teachers in rural areas, as WeTeach [42] did in Texas. The WeTeach CS provides teachers with a stipend and certification. Teachers can join through 30 region-level organizations, with UT Austin STEM Center coordinating the program. These partnerships provide services to many schools and teachers who lack resources compared to wealthier districts.

*2.3.3 Reporting and accountability in enrollment disparities.* To ensure that various groups of students (such as girls, Black/African American, Hispanic/Latinx, and rural students) are equitably enrolled and successful in CS courses each school year, proportionality indices [39] could be used as measures of equitable success for schools, districts, or student groups of interest. An equity index could be generated for all CS courses at the end of each school year. For example, the index could be used to ensure that girls enrolled in CS courses are earning a passing grade proportionally to their enrollment. The tracked indicator could be the ratio of girls receiving a passing grade to the number of girls enrolled in CS courses. A ratio greater or equal to one will be considered equitable. Additionally, the state could also track enrollment trends in CS, with a positive trend denoting an improved interest.

## 3 SYSTEMATIC REPORTING

Establishing a robust reporting mechanism that can efficiently monitor the progress made in every school district is crucial. This can be a collaborative effort between ISBE and school leaders, where standardized metrics are agreed upon and reported on a dashboard. These metrics can be used for accountability purposes

in each subcategory of interest. For example, collecting data on CS course indicators, like socio-demographic data breakdown of students taking courses or participating in advanced classes, or the number of schools meeting the legislation requirement. This data can be used to monitor access and participation in CS education through state dashboards, which can be created in partnership with local organizations. The Expanding Computing Education Pathways (ECEP) Alliance is an example of collaboration that resulted in the creation of dashboards in 15 states [7]. The dashboard could be the one-stop-shop that will give a quick snapshot of CS progress and ensure that the state is working towards providing equal access to CS education for all students and not widening existing inequities.

The Illinois Report Card [18] provides reliable information about public schools in the state. It provides data on academic performance and school environment, which can help individuals make informed decisions about education. It could also be useful for ensuring accountability in CS education. The Education and Workforce Equity Act (Public Act 101-0654) requires districts to include CS curriculum information in their school report card. It is essential to define the relevant information they need to report on. The report card currently does an interesting job of tracking the demographic breakdown of students' participation [16] in the fine arts, as well as the demographic breakdown of the teachers [19] providing these classes. Similar indicators could be added to the report card for CS courses and tracked annually to increase school accountability for the promise of CS equity.

ISBE can evaluate the quality of CS education by considering the presence of certified CS teachers and diverse demographic representation among teachers. This can be gauged by calculating the number of students who have access to certified CS teachers by race, geographic region, and type of school. Studies have shown that matching students with teachers of the same race leads to better academic outcomes [8,10]. Therefore, the district could track a *same-race CS teacher-student ratio* as a basis for implementing targeted measures to increase diversity in the teaching staff. This information could also be captured through the "Percentage Point Difference Between Teacher and Student Proportionality" by race already calculated in the state. According to the data from the 2022-2023 school year, the percentage of Black/African American and Hispanic/Latinx teachers was lower than their representation in the student population [20]. These data could be disaggregated by content area and calculated for CS specifically.

Establishing a deadline and unifying the CS curriculum data that school districts present on their report cards is also crucial. By implementing clear goals and deadlines, providing solutions, and dismantling systemic barriers and oppression, we can create a truly inclusive and equitable learning environment in CS.

#### 4 Positionality Statement

The first author identifies as an African immigrant who relocated to the United States during adulthood. She has experience in K-12 education, having worked in school districts in the Washington, DC metro area, where she analyzed student assessment data and helped with program evaluation. She holds a

master's degree in Applied Economics and is pursuing a Doctorate in Education with a specialization in "Diversity and Equity in Education." The second author identifies as a Hispanic woman and migrated to the US from Spain in her early adult life to earn a master's and then a doctoral degree in Education ("Language, Equity, and Education Policy" specialization). She has gained her perspectives on K-12 contexts mostly through research endeavors to advance equity through culturally responsive CS teaching. The third author identifies as a White woman who holds an advanced graduate degree in a STEM subject. She completed secondary education in an Illinois school district that had extensive CS learning opportunities, though was never enrolled in a CS course herself. Her research expertise is in STEM education, with a focus on equitable access, representation, and retention of students with historically marginalized identities. Our different identities, education backgrounds, and experiences with CS education contexts bring a variety of perspectives into this paper. While one of us completed high school in the US, specifically in Illinois, the other two experienced it abroad. None of us were exposed to CS learning in high school, but the first and third author had some isolated experiences in CS courses in college and graduate school. Nonetheless, we all possess expertise in equity work in education, and our current research efforts focus on improving CS learning opportunities for historically minoritized students.

#### 5 Implications for the RESPECT Community

This paper aligns with this year's conference theme (Equity-focused CS Education Research: The reciprocal influences of research and policy) and provides important insights on how research on CS education in the state of Illinois is affected by and responds (or should respond) to policy. The implications of this work are discussed within national efforts to increase equity in CS education, providing a space for reflection and discussion where researchers, teachers, students, advocates, and policymakers can come together to improve the CS educational landscape. It is essential to note that each state has distinct realities and is in varying stages of expanding CS education and policies. Some are more advanced than others, and the RESPECT communities provide a valuable opportunity for state stakeholders to learn from one another and exchange best practices, thereby advancing the field of CS education.

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