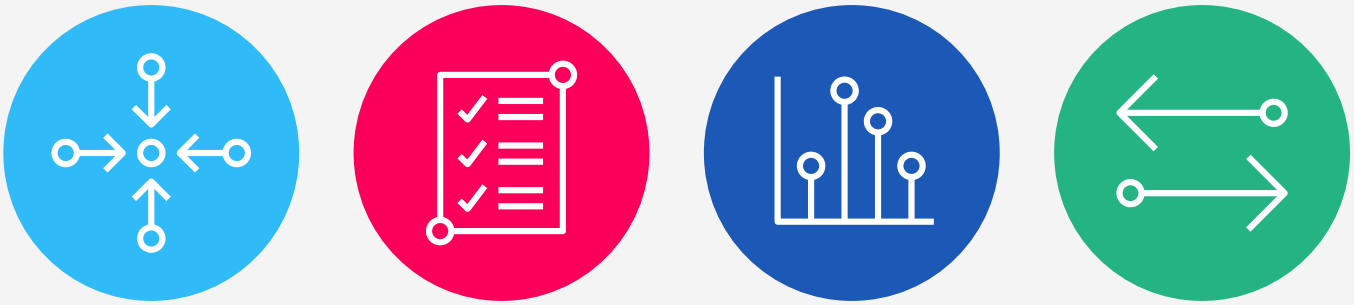
CS Policy to Practice:

Understanding Emerging Approaches to State-Level Computer Science Education Policy Design in the United States



CSforALL

IN PARTNERSHIP WITH:

ECEP Expanding Computing Education Pathways

SAGEFOX CONSULTING GROUP

About CSforALL

CSforALL is the national hub of the computer science for all movement, with a mission to make high-quality computer science an integral part of K–12 education in the United States. Our work spans national and local levels to provide equitable and accessible K–12 computer science education to every student. We engage with diverse stakeholders leading computer science initiatives across the nation to support and facilitate implementation of rigorous, inclusive, sustainable computer science. For more information, see www.csforall.org or follow us on Twitter: @CSforALL.

About the Expanding Computing Education Pathways (ECEP) Alliance

ECEP is an NSF-funded Broadening Participation (BPC) in Computing Alliance that focuses on increasing the number and diversity of students in computing through state-level CS education advocacy and policy reform. The ECEP model emphasizes building state-level capacity to address the diverse and intractable contextual factors that have stymied efforts to expand computing education pathways. ECEP collaborates with broad based teams in 22 states and Puerto Rico to develop and test interventions focused on systemic change. Interventions include: developing tools and resources for state-level support, defining BPC indicators and measuring state BPC goals.

About SageFox

SageFox is a research and evaluation firm located in Amherst Massachusetts. Our work is based on values of collaboration, transparency and meaningful contribution to the education community. Projects have focused on retrospective studies to uncover the long-term impacts of education programs, aggregating knowledge across programs and/or states and understanding emerging needs in STEM education. In CS education projects we address policy reform, teacher professional development, curriculum, research-practice partnerships, shared data collection and pathway development.

Acknowledgements

We would like to thank, first and foremost, the state, district, and school leaders who took the time to share their approaches and experiences supporting computer science education. Special thanks goes to Katie Hendrickson and Liz Gauthier from Code.org for their invaluable contributions to our methodology and for feedback on the final report. Kim Scardino and David Byer of Apple and Allyson Knox of Microsoft Philanthropies all provided context on state CS policy and feedback on our initial frameworks.

Support

Support for this project was provided by the Charles and Lynn Schusterman Family Foundation. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Foundation.

Suggested Citation: Santo, R. & DeLyser, L. (2020). *CS Policy to Practice: Understanding Emerging Approaches to State-Level Computer Science Education Policy Design in the United States*. New York, NY: CSforALL.

Contents

A Note from CSforALL

CSforALL is an organization committed to the equitable implementation of high quality computer science education for all students, and at the heart of this commitment are core principles we bring to the work each day. We believe that the ideal of access, without clarity on access to what, cannot yield equity in a country where resources are distributed inequitably. We believe in the hundreds of thousands of professional educators and administrators and value their deep local knowledge and focus on student and community needs, and believe this should be the starting point for thinking about computer science education. We believe that a one-size-fits-all approach can never be culturally responsive or sustaining and will do less for equity than an orientation towards collective responsibility for equity, backed up by real resources, clear communication, and strong community that supports the work. And overall, we believe the voices of those school leaders, teachers, students, and community members can help inform policy and the decisions we make about policy implementation.

This report seeks to lift the voices, concerns, and experiences of local education professionals, bridging them with lessons drawn from education policy more broadly. We hope you can hear the ways in which communication, context, and local realities color the way they experience policy initiatives. We encourage you to look for your own local stories, and maybe a few that are nearby but in a different community context, as you consider how best to support computer science for all.

CSforALL

In the United States, there is currently an unprecedented call for the inclusion of computer science (CS) education within K–12 school systems for all students. This computer science for all movement has resulted in funding, an increased focus by industry and nonprofit organizations, an increase in the number of educators teaching and students experiencing CS education, and policies aimed at broadening participation in K–12 pathways that lead to post-secondary study and eventual careers. At the same time, there is a call for critical evaluation and reformation of systems within the United States to reduce racism and bias, increase equity, and open blockades that have long prevented equality in society, and, importantly for this report, access to academic achievement.

State-level policies enacted to define and support instruction and learning are key drivers for achieving equitable education systems in the United States. The field of computer science education is increasingly focused on putting in place such policies, ones that encourage, and in some cases require, CS instruction in K–12 school systems. In this report, we offer an examination of state-level computer science (CS) education policies and the ways in which those policies are experienced by state and school system leaders in their efforts to broaden participation in computing and provide equitable experiences in CS education.

This report seeks to document progress, make recommendations, and highlight questions at the intersection of accountability, alignment, and data related to state CS education policy.

We build on existing scholarly work in educational policy, and share explicit examples, interview quotes, and case studies for readers to apply in their work as state leaders, school or district leaders, teachers, or advocates. Throughout the discussion, we include community voices and examples of equity goals and outcomes, explicit connections to current policies in a variety of states, and frameworks that synthesize examples for policymakers and advocates.

Educational institutions do not experience individual policies in isolation; instead, they must integrate any new policy within existing landscapes of overlapping policies. With this in mind, this report does not look at individual CS education policies in a vacuum, but uses community voices to reflect on the full landscape and the impacts policies can have when they intersect—sometimes in mutually reinforcing ways, and sometimes in ways that conflict.

In our efforts to strive for equity and anti-racism, we also acknowledge that earlier scholarship in educational policy and CS education has too often been grounded in colonialist systems mostly designed by white men—ones that presume that answers around what CS education should look like are held by actors outside historically marginalized communities. This leaves us to immediately acknowledge the risks of holding up privileged or mostly segregated school systems as models for success, and (2) conforming to educational institutions' definitions of high quality that do not respect or sustain historically minoritized communities' culture. In this report, we seek to be careful of the line between CS education goals in service to CS as a fundamental literacy and the daily trade off that school leaders make to serve their communities with limited resources. Policymakers themselves, advocates, school and district leaders, nonprofit organizations, researchers, and community members all have a stake in the design and implementation of policy for CS education outcomes. CS education policies in any regional context will also intersect with the broader landscape of educational policy within each state, and the interactions of policies will require communities to find thoughtful approaches that adapt broad goals to individual values and contexts without losing focus on goals for equity.

Policy is an important tool that is designed to create consistency, sustainability, and ultimately equity in society. In its earliest stages, implementation of CS education was driven by advocates, the enthusiastic core of teachers, faculty, parents, community members, and professionals who recognized the value of CS education for today's youth, and individually worked to bring CCS education to the communities they could. The work to implement policy should codify movement goals of quality, rigor, and equity for continued implementation even when the spotlight of educational initiatives moves. We hope to highlight opportunities to support those early enthusiasts and sole adopters and advocates, while ***enabling a landscape in which equity is not driven by the tireless actions of the few, but instead is a mutually agreed upon goal of the many.***

Key takeaways from the report include:

- ***Early teacher advocates are key to building interest and momentum, but insufficient alone to move the mechanisms of power to reach all students.*** Policy does not replace these individuals, but instead can support them and enable other actors to share the work.
- ***Equitable policy outcomes require equity to be a core priority from the start.*** Without clear goals, communication, and data routines around equity, policy may not produce desired results for all students, and it's harder to retrofit existing policies to make them more equitable than it is to design with equity at the center of policy in the first place.
- ***CS education policy design should balance rules and incentives (accountability) with clarity on goals and supports for reaching them (alignment).*** Too much accountability with too little support on the one hand, or substantial support with few modes of holding systems accountable on the other, are each likely to result in inequitable policy implementation.
- ***In a strong accountability and high alignment environment, clear targets are more likely to be reached, resulting in equitable institutional implementation*** no matter what individual preferences are, especially when there are competing priorities.
- ***The CS education field should embrace the perspective of "accountability as collective responsibility for learning," rather than the more traditional view of "accountability as sticks and carrots."*** This perspective views policy through a communal lens, as an expression of shared values, with accountability fostered internally within school systems and externally through communities and governance structures.
- ***Clear and consistent communication is key.*** For any policy, clear and consistent messaging that reaches all actors in the system, including administrators and decision makers, is key to reaching policy goals.
- ***Policies must take into account, and directly support, the broader systems supporting classrooms and students.*** Sustainable change needs to be woven into institutional structures in order to help set priorities and improve capacities to implement CS education—this is critical to reaching goals related to equitable learning. Strategic planning, funding, data, and the professional networks inhabited by teachers and administrators should all be considered as critical elements of systems that support equitable learning in CS education.
- ***Policy needs to be adaptable to individual locations.*** In order for state-level policy to apply across diverse geography and communities, the act of policymaking needs to include the voices of those who will be enacting the policies. Giving school and district leaders, teachers, parents, and community leaders a "seat at the table" can help prevent unintended consequences.
- ***Policy-linked data needs to focus on improvement, not just accountability.*** All education is in a state of continuous reflection and improvement. Policy and the data supporting the evaluation of the policy should look at multiple levels of equity, access, and implementation, and be used to iterate, not simply to evaluate and judge.

1
Introduction

The United States is currently undergoing a substantial shift in its education systems, with priorities around achieving equity in a new domain—computer science—now represented in state level policy in all 50 states. Active teams of advocates and leaders are working to put more of these policies in place and effectively implement ones that have already been established. The goals of this movement are reflected in its name, "CS for All"; an aspiration to bring high quality computer science education to all students. Specific motivations within it range from addressing issues of underrepresentation of historically marginalized groups in computing, to beliefs in the broad importance of a new set of computing-related competencies, to civic priorities around having a technologically proficient public (Blikstein & Moghadam, 2019; Santo, Vogel, & Ching, 2019; Weintrop, Holbert & Tissenbaum, 2020).

In order to reach valued outcomes around computer science (CS) education, a broad coalition of actors have mobilized to advance and coalesce into a fast-moving field. Pioneering teacher leaders have shown what it can look like to engage students in rich, project-based CS learning. Visionary school administrators have begun charting the way in broadening participation at scale within districts. Federal agencies have mobilized to support initiatives and groups across the country that are developing new courses, curriculum, learning tools, and professional development models. Researchers have broken new ground on how CS learning happens and have developed ways to remove barriers for historically marginalized communities. Industry-based and philanthropic groups have shown up to help resource efforts and provide expertise. All of these and many other efforts have advanced work towards equitable computer science education in a way that was unimaginable to many just a decade ago.

And of course, there's much more to be done. The nature of educational change in the United States means that while progress to address core equity goals has been made in some individual classrooms, schools, and even districts, state and local policy will play a critical role in whether the equity goals of the movement are successful on a broader scale. As such, it's promising that, at the time of writing, almost 80% of states in the United States have adopted K–12 CS education standards, among other policies. And as the values of equity in computer science education become inscribed into state legislation and education policy initiatives, it is critical for stakeholders in this movement to understand whether and how associated aspirations are being achieved, and what policy approaches have promise.

Compared to other well established instructional policy areas like literacy and science, the CS for All movement is still in the early stages of determining how to use education policy to make progress on broad goals for equity within CS education. Numerous long-standing CS education policy efforts, such as the Expanding Computing Education Pathways (ECEP) Alliance, the Code.org Advocacy Coalition, and others, have laid critical foundations in terms of advocacy and implementation. Yet fundamental policy-related questions are still being debated and defined, even those as fundamental as "what counts" as computer science education in the context of a given course.

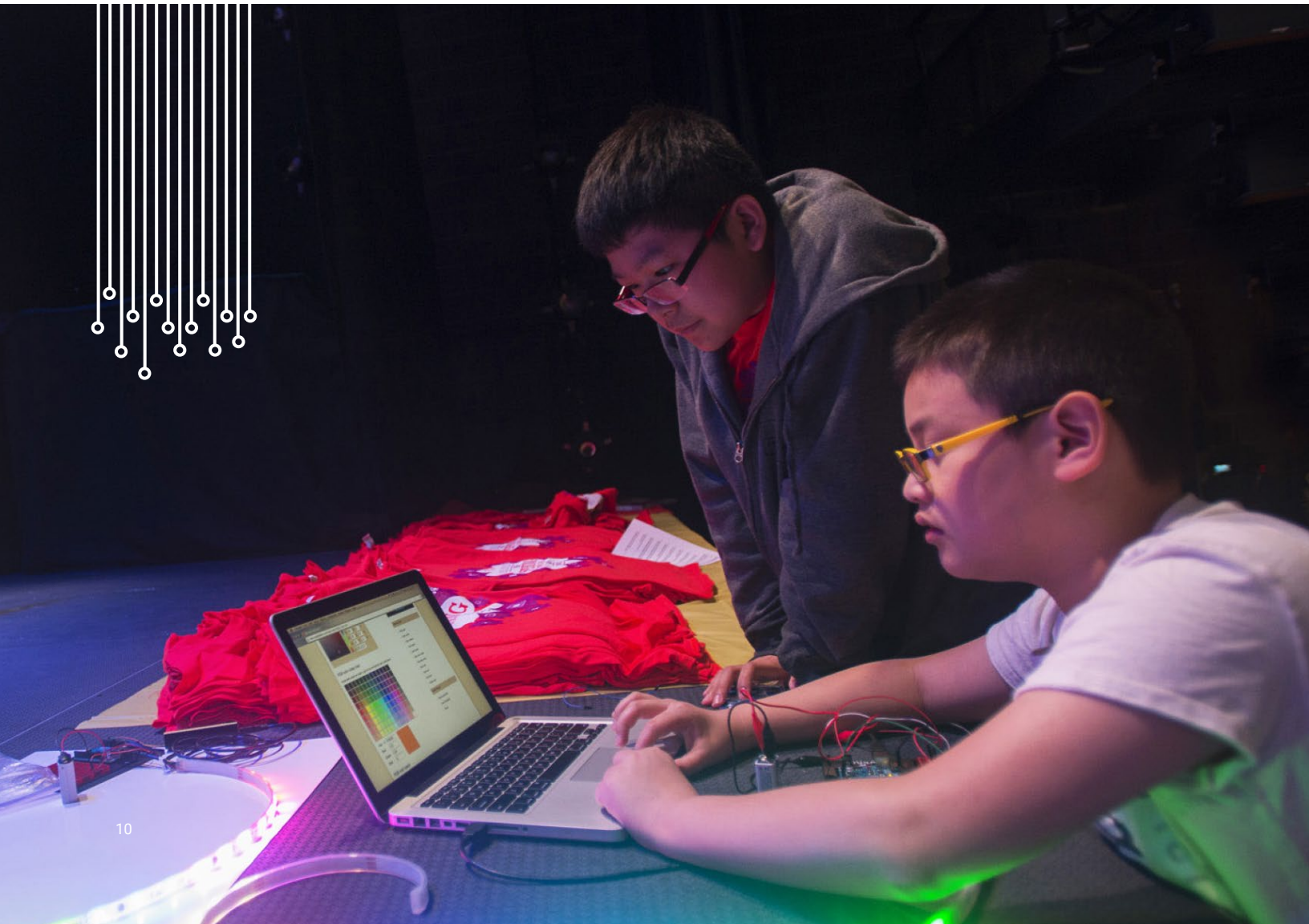
These questions are compounded by current approaches to understanding progress within nascent state CS education policies that tend to rely on a limited set of metrics focused on the end of a multi-year pipeline and not connected to outcomes meant for all students. Some examples of commonly used metrics that are available across state contexts include participation in and performance on Advanced Placement (AP) computer science courses (Collegeboard.org, n.d.; Ericson, 2019), and, to a lesser extent, whether CS is offered at the high school level (Code.org; CSTA & ECEP Alliance, 2019, 2020). These metrics do provide an important insight into one valued outcome of state policy efforts, though certainly not the only one.

Critically, metrics like AP participation and performance leave the field with something of a "black box" when it comes to understanding

state policy—policies go in, metrics come out, but there's little view into what's happening in between. And while analysis is beginning to show that more robust state policy adoption correlates with outcomes such as increased offerings of computer science in high school and increased participation of female students (Code.org, 2019), and working groups of leaders are connecting to do the critical work of implementing better measurement and policy goals, there is still more work to be done to understand how policy mechanisms operate and, critically, to build a knowledge base around how various policies might be configured to promote equity.

This report aims to build upon existing CS education policy efforts and advance the conversation around state level policy by doing three things:

1. Offer a framework for understanding different CS education policy mechanisms through existing evidence-based theories of education policy scholarship.
2. Provide greater detail on the nature of how CS education policies are currently being implemented.
3. And, critically, share insights coming from district and state leaders around their experience with emergent CS education policy.



To address each of these, we used a hybrid methodology that includes three elements.

Situating CS education policies in existing frameworks. Using an existing education policy framework around alignment and accountability, we categorize existing state CS education policies, highlighting the ways in which they can operate as a coordinated system. In order to do this, we engaged in extensive conversations with policy leaders in CS education, including leaders of the Code.org Advocacy Coalition and the Expanding Computing Education Pathways (ECEP) Alliance.

Highlighting hypotheses about CS education policy design. Using those existing education policy frameworks, we connect voices from the CS education community to framework descriptions with details of current progress and challenges for CS education. In addition, we outline how the frameworks and previous research provide a basis for how various education policy configurations are likely to lead to different outcomes.

Documenting CS education policy designs, implementations, and experiences. We apply the alignment/accountability policy framework to policy data gathered through interviews and focus groups with 23 district and state leaders, along with supporting policy documentation. We highlight details of approaches used by state leaders to implement policy, and the experiences district leaders had around these emerging policies.

Two considerations are important to note in terms of our methodology: First, data from interviews and focus groups with these district and state leaders is not meant to be representative of the entire landscape of CS education policy in the United States. We purposively sampled a small number of states—five in total—where we held focus groups with district administrators. We augmented that research with interviews and a focus group with state policy leaders in those and four additional states. The combined states represented in these discussions—nine in total—were selected because they represented distinct policy approaches and stages in their implementations that we felt would help shed light on issues that other advocates and those involved in CS education policy implementation might consider. A second consideration is that in the text of the report, we intersperse insights from existing education policy research with voices and examples that emerged from our interviews and focus groups with district and state leaders, as well as with broader examples drawn from publicly available policy documentation from other sources. We intend to make clear in the text when we are drawing from each of these. The full methodology for the report can be found in Appendix A.

In the next section of the report, we outline the policy framework of alignment and accountability (Coburn, Hill, & Spillane, 2016) that guides our analysis, and establish how this framework can be applied to current CS education policy goals and mechanisms. We highlight how the alignment/accountability framework can be used to inform policy design in the form of hypotheses around not just individual policies, but different policy configurations. In the third section, we go into detail around policies of alignment within CS

education—those policies meant to resource and support instructional change—and share in greater detail some of these alignment mechanisms and how they are playing out in emerging CS education policy work. In the fourth section, we explore mechanisms of accountability within CS education—policy approaches meant to monitor, incentivize, and enforce policy mandates and goals. In the fifth section, we explore the role of data and its relationship to equitable state policy around computer science more deeply. The sixth section highlights the importance of involving those working in schools—from district administrators and instructional coaches to teachers and building leaders—in the policy development process, and what it looks like to give them a "seat at the table." We conclude the report with recommendations for how the CS for All movement might advance its work to identify and implement equitable state-level CS education policy.

In our decisions about what to focus on in this report, we carefully considered the history of education policy and attendant inequities in the United States. In particular, we are cognizant of how policy has been wielded in ways that have too often harmed, rather than helped, marginalized communities in the name of "achievement." The technocratic language of policy—"account-ability," "compliance," "mandates," "data"—has, in too many cases, become code for more requirements coming down from above with few resources to accomplish them, rather than empowerment and support for those who do the everyday work of teaching and learning in schools. As we consider these and other ideas related to policy, we want to be unequivocal in our message, one based in evidence from scholars as well as a chorus of teacher and community voices: policy should never be used to defund, devalue, or deprioritize those who work within historically marginalized communities. The implications for accountability, mandates, and compliance can sometimes cause additional challenges without acknowledging and addressing deeply embedded structural inequities that historically marginalized communities must navigate to even approach equity in any educational outcomes. Indeed, we believe that developing equity-focused policy means ensuring that the populations that policy is meant to support are part of its development.

In many ways, this work to institutionalize an entirely new subject within the vast and complex education system in the United States is an unprecedented attempt to not only respond to a changing economy, but to also democratize access to the highly powerful cultural space of computing. However, we firmly believe that there is value in developing a connective framework that builds on existing ideas, and successes, from outside the CS education field in terms of how education policy can be equitably and effectively designed. We also know that there are critical, emergent lessons to be learned from those embedded in the day-to-day work of the movement to understand how nascent policies are playing out. Through attempting to honor both commitments—prior scholarship and current, on the ground knowledge—this report offers a modest contribution to the complex, but critically important, challenge of providing equitable opportunities for our nation's students through rigorous, inclusive, equitable computer science education.

2

Alignment and Accountability as Drivers for Equity in Education Policy

To explore a new perspective on state policies around computer science education (CS education), it's important to step back and consider what is known about education policy design more broadly. Policy discussions in CS education often start by detailing and analyzing specific policy levers, such as teacher certification, standards, or funding. The goal of this report, however, is to view specific policies as tools within a larger policy tool kit that can be designed and deployed in various configurations. To better characterize the nature of this tool kit, we draw on an established policy framework that highlights two dominant approaches to instructional change and improvement: policies that support **alignment**, and policies that support **accountability** (Coburn, Hill, & Spillane, 2016).

Policies of alignment aim to clearly communicate broad policy goals and actively help districts achieve them, while policies of accountability create implications for school systems in terms of what happens if policy goals are, or are not, met.

According to Coburn et al., policies of alignment aim to clearly communicate broad policy goals and actively help districts achieve them, while policies of accountability create implications for school systems in terms of what happens if policy goals are, or are not, met—often these consequences are colloquially referred to as "carrots and sticks." Naturally, having one without the other is likely to create challenges and unintended consequences.

Policies of alignment create structures that support instructional change through mechanisms that are both directly linked to policy goals and coherent with one another. By "coherent," we mean that these mechanisms are mutually reinforcing: interconnected in ways that support, rather than conflict with, one another. Alignment-oriented policies include things like clear communication about an instructional reform effort, provision of or funding for goal-aligned professional development and curriculum materials, development of capacity-building and planning contexts in which instructional leaders can learn about and develop implementation approaches, and support for development of pre-service teacher preparation programs.

Policies of accountability, on the other hand, aim to enforce or incentivize compliance with rules, mandates, and goals for school systems in ways that tie back to broader policy priorities. These rules and mandates may include required instructional offerings, teacher certifications, specific learning goals, and performance outcomes. In the broader sphere of education, such policies take place in their most extreme forms in the usage of high-stakes testing and associated outcome targets, with, in some cases, funding implications for reaching or not reaching those targets, to motivate changes in instruction. However, there are a wide range of other mechanisms used to monitor, enforce, and incentivize accountability with policies, such as monetary rewards for students, teachers, and schools, and public data systems that make progress transparent to broader publics.

Alignment-oriented policies include things like clear communication about an instructional reform effort, provision of or funding for goal-aligned professional development and curriculum materials, development of capacity-building and planning contexts in which instructional leaders can learn about and develop implementation approaches, and support for development of pre-service teacher preparation programs.

Coburn, Hill and Spillane (2016) hypothesize that each of these broad approaches, executed independently of one another, would be ineffective. They offer four possible scenarios for a given instructional reform effort, depending on the degree of alignment and accountability in place.

Under **weak accountability** and **low alignment**, change depends on individual actors who must rely on their own motivation, enthusiasm, and knowledge about a new instructional area. This can allow for individual priorities and perceptions to create inconsistent implementation across a region, as these individuals lack broader centralized support to prioritize equity outside their own sphere of influence. In this situation, those in school systems lack consistent messages about policy goals and supports, have little incentive to change their existing instructional practices, and don't have good sources to refer to in order to find out what shifts they should be trying to make in their schools and classrooms.

Approaches with **strong accountability** but **low alignment** create pressure, but provide little support. This can lead to superficial shifts in classroom practice, "gaming" of accountability systems and resistance to changes, along with inconsistent messages and few opportunities for teachers and administrators to learn in ways that would support changes to instructional practice.

Systems of **weak accountability** and **high alignment** are likely to lead to effective changes in instructional practices for those administrators and teachers who are more committed to a particular reform, but little, limited, or superficial change in those who are not.

Finally, combinations of **strong accountability** and **high alignment** can create conditions in which effective support for teacher and leadership learning is provided through coordinated mechanisms, and substantive incentives are created to motivate all teachers and administrators to engage with these learning mechanisms as intended, with a likely result being more equitable changes to instruction at scale within a school system. To be clear, in a strong accountability and high alignment environment, there is enough clarity to support consistency in implementation, and support for all institutions to proceed with implementation despite individual preferences or competing priorities.

In a strong accountability and high alignment policy environment, there is enough clarity to support consistency in implementation, and support for all institutions to proceed with implementation despite individual preferences or competing priorities.

Table 1: Hypothesized outcomes associated with different configurations of policy alignment mechanisms and policy accountability mechanisms (Coburn, Hill, & Spillane, 2016).

	Weak Accountability	Strong Accountability
Low Alignment	**Expected outcomes:** • Little support around intended instructional changes • Inconsistent messages about educational policy and the nature of desired instructional changes • Little incentive or pressure to change existing practices	**Expected outcomes:** • Teacher and administrator resistance • Symbolic or superficial changes to classroom practice • "Gaming" of accountability systems • Inconsistent messages to schools and districts about policy goals and support structures • Few opportunities to learn how to change instructional practice
High Alignment	**Expected outcomes:** • Changes in instructional practices for those who are reform inclined • Little, limited, or superficial change in those who are not	**Expected outcomes:** • Coordinated mechanisms for teacher and leadership learning around new policies • Substantive motivation and incentives for participation in such mechanisms through mandates and rules • More consistent implementation of valued instruction within schools and classrooms

The CS education movement got its start as a distributed, grassroots effort primarily by engaged educators working within the confines of their local schools and sometimes communities. Naturally, this was an incredibly small subset of teachers. Before the current focus on CS education policy, most states operated in a weak accountability, low alignment environment. Studies of early broadening participation efforts, and the collective voices of teacher leaders, led to a critical focus on teachers as a linchpin in the movement to bring CS education to all students (CSTA, 2005; Stephenson, Gal-Ezer, Haberman, & Verno, 2005). While we acknowledge the critically important efforts of those teacher advocates (one of the co-authors was one herself), we also acknowledge that a strong accountability, high alignment environment may change their role as the central figures in the CS education movement efforts, causing the work to move forward in a way that ensures that they are no longer lone, unsupported voices, but rather work together with a range of other actors in an environment of collective responsibility for equitable CS education.

In a weak accountability, low alignment environment, those teacher leaders are able to construct individual programs based solely upon their visions of high quality. Some teachers may adopt a workforce development stance and construct a pathway aligned with career and technical education goals, while others focus more on computer programming as part of a larger program including data science, impacts of computing, and general digital literacies. As policy seeks to specify desired learning outcomes and support with alignment measures, this can reduce the dependence upon, highly engaged teacher leaders in every school. Instead, such policy approaches aim to empower a broader range of teachers to contribute to the broader equity goals of the movement, and existing teacher leaders can be elevated into roles that support these aspirations. Organizations like the CSTA still offer avenues for those teachers to have regional leadership and voice, but alignment and accountability are important for equity, as administrators also need to be engaged in the work and see its importance for students when making local policy decisions.

2.1 Equity-Oriented Policy Goals and Mandates in State CS Education Policy

None of the above means that high alignment and strong accountability will inevitably lead to *equitable* policy outcomes—the framework simply hypothesizes that *whichever* goals are defined or mandated by state policies are more likely to be achieved in that case. Policy initiatives in different localities employ these approaches around distinct sets of policy goals. It is those goals and mandates, rather than alignment and accountability mechanisms themselves, that set a "north star" in terms of policy success in that locality. And it's in those goals that key priorities around equity are established, with the policy approaches of alignment and accountability being the mechanisms for achieving them.

In the context of state education policy this report focuses on, for instance, one state might say that certain learning goals and certain levels of access and participation by students are the target, while another might prioritize a different, and perhaps less rigorous, set of learning goals and a less ambitious target in terms of student access and participation. Essentially, policy goals may differ in terms of whether they truly embody a "for all" ethos, versus simply high standards "for some."

This is not to say that the only differences in state CS education policy goals are "better" or "worse" priorities around equity. For instance, one state may set a more clear priority on CS education as a means to economic mobility for students and workforce development, while another might prioritize broader civic orientation, focusing more on learning social impacts of computing and thinking through the implications and uses of data science. Each of these, in their own way, reflects priorities around equity, each legitimate, but distinct from one another.

In short, even when a state has strong mechanisms of accountability and high alignment, if the policy goals themselves do not specifically identify commitments to equity, inequitable outcomes are still possible even when goals are met. In the table on page.18, we outline different sets of CS education policy goals and mandates currently present, in different ways, in localities across the United States.

Even when a state has strong mechanisms of accountability and high alignment, if the policy goals themselves do not specifically identify commitments to equity, inequitable outcomes are still possible even when goals are met.

Table 2: Goals and mandates in state CS education policy

- Mandated or voluntary computer science standards
- Required high school course offerings in CS
- Required elementary and middle school course offerings in CS
- CS high school graduation requirements
- Broader graduation requirements that CS courses can fulfill (e.g. math, science, technology)
- Allowing CS courses to fulfill higher education admission requirements
- Mandates or suggested guidance around CS teacher certification

Examining these goals and mandates around CS education can reveal different commitments to and ways of conceptualizing equity (Santo et al., 2019). Equity can mean different things to different people, and, therefore, it is important to be specific about what, precisely, is meant by equity in a given context. Within the context of state CS education policy, the CAPE framework (Fletcher & Warner, 2020) offers a useful lens. It considers equity through the dimensions of teacher and systems *capacity*, and student access, *participation*, and experience vis-a-vis CS learning opportunities. In doing so, it offers a way to disaggregate and consider not just how many students participate or what opportunities are available to them, but the quality of that participation, and overall preparedness of teachers and districts to support those outcomes as well.

In applying the CAPE framework to CS education policy goals, policy requirements around teacher certification define equity through the lens of having qualified educators who have the capacity required to provide equitable learning experiences to students. Requirements around offering courses either at the secondary or elementary level operationalize equity through the lens of access, maintaining a commitment to making learning opportunities available to all students. A mandate in the form of a high school graduation requirement maintains a commitment to equity in terms of *participation*. Policies like these reflect the reality that simply having access to CS learning experiences alone is insufficient with regard to equity outcomes, and aim to ensure that all students actually participate in these experiences. However, having both access to and participation in learning opportunities does not ensure that the nature of CS learning experiences

is equitable—high quality learning goals must be present in these opportunities. As such, we can understand computer science standards as containing equity commitments with regard to the rigor of what gets taught and the nature of what is considered a quality *experience* in the context of learning goals and outcomes for students. While standards don't ensure that students receive a high quality experience, they play a foundational role in defining what might count as one.

These interrelated equity outcomes of capacity, access, participation, and experience can and should be reflected across the policy goals that states articulate. See Figure 1 below for an application of the CAPE framework to CS education policy goals.

Figure 1: Application of CAPE equitable policy framework (Fletcher & Warner, 2020) to possible state-level education policy goals around computer science education.

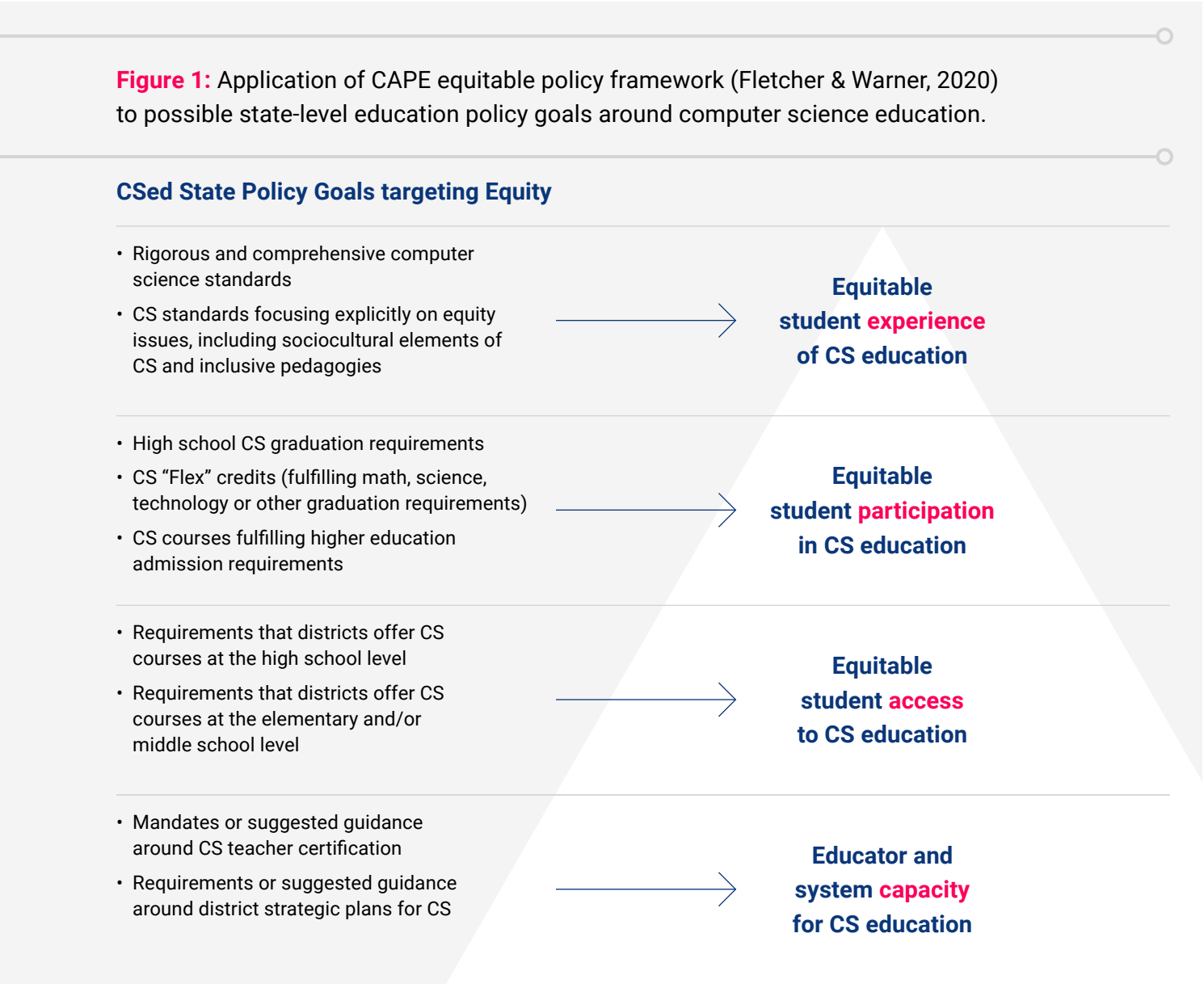
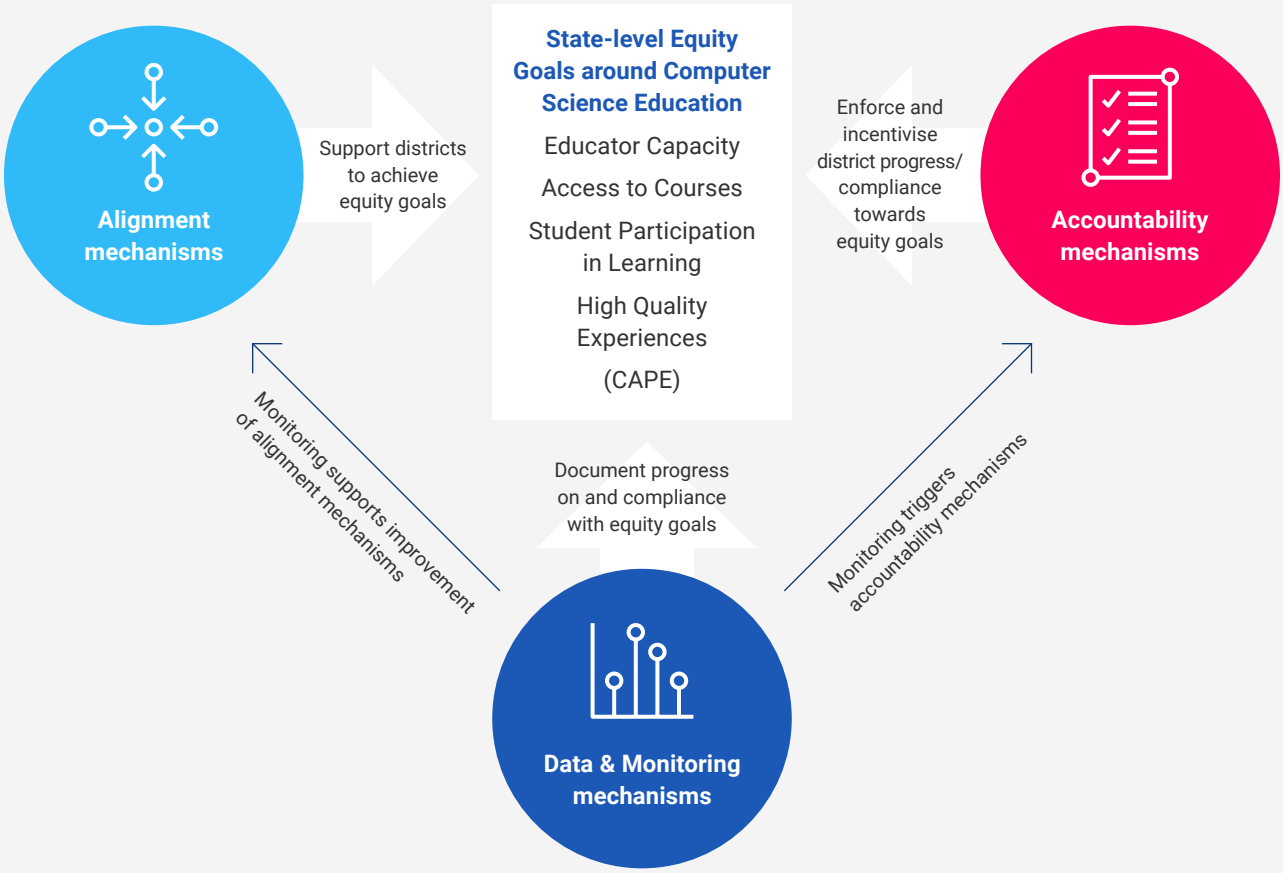


Figure 2: Relationship between elements of a state CS education policy system.



The configuration of goals and mandates within a state serve to orient all relevant stakeholders towards the "what" of the policy aspirations: what are we trying to achieve? Do we have a sense of what success means? In contrast, the mechanisms of alignment and accountability represent the "how": the ways of reaching those goals and achieving those mandates through a mix of support, incentives, and potential repercussions. Each of these elements of a state policy initiative is supported by a final one, that of data and monitoring, which answers the question, how will we be able to measure our progress? Monitoring mechanisms serve to document progress on and compliance with equity goals, to support improvement of alignment mechanisms, and, as needed, trigger accountability mechanisms based on whether goals are, or are not, reached. See Figure 2, above, for a representation of how these elements of a CS education policy system should interact.

2.2 Alignment and Accountability in State Computer Science Education Policy

In order to apply the framework of alignment and accountability to the context of state education policy on CS education, it's useful both to understand where computer science "sits" within the broader landscape of education policy, and to specify what current policy mechanisms are being employed around CS education and how they fit into that framework. It is also important to acknowledge that policy does not happen spontaneously, and that advocates and state leaders have been working to not just change, but initiate implementation of policies that support goals around equity and broadening participation.

Currently, CS education policy can be contrasted with other areas of instruction, most notably English language arts and mathematics, that are characterized by high stakes policies of accountability and monitoring in the form of mandated testing that exist at federal and state levels (Amrein & Berliner, 2002; Au, 2007). There is little evidence that advocates are arguing for CS education to be treated in a similar way. CS education also bears little resemblance to an area like special education, where provision of services at the local level is protected by federal policy and often enforced through mechanisms like civil rights lawsuits.

To best understand the current nature of CS education policy, it's helpful to look to two very different disciplines: arts and science. CS education has similarities to arts education from a policy perspective in that it tends to have fewer mandates than mathematics or language arts at the state level in terms of learning goals and course offerings, though there is greater movement towards at least mandated course offerings at the high school level for CS education in many states. However, CS education does have some parallels to arts education in terms of its overall place in the curriculum—it is deeply valued by some, but is in no way a "high stakes" subject from a policy standpoint.

On the other hand, the policy landscape around CS education bears some resemblance to science education when it comes to the nature of the field that exists around it. In science education, public actors at the federal level, as well as private actors including foundations, national organizations,

researchers, and administrative and teacher leaders, have worked together to put in place more consistent, ambitious, and equitable learning goals through efforts like the Next Generation Science Standards and wide support for their implementation. In the context of state policy, there have been concerted efforts towards adoption of these standards and other supportive policies such as state-supported professional and curricular development across a wide range of states. However, there are important differences as well. Science occupies a more central place in state education policies, with mandates around certain numbers of science credits being required for each student to graduate.

With that said, it's possible to understand the current range of state policies being implemented around CS education through the alignment and accountability framework. In the table on page 23, we draw on multiple sources, including a review of landscape reports and additional data provided by the Expanding Computing Education Pathways Alliance (ECEP), Code.org's Nine Policy Ideas for Making Computer Science Fundamental to K–12 Education (2019), and data collected on states through documentation and interviews with state and district leadership. We synthesized across these sources to outline a range of existing policy mechanisms and how they fit into the alignment and accountability framework.

This table is not exhaustive, and throughout this report, we reference additional approaches and variations on those noted below.

The list below is not exhaustive, but rather represents at a high level some of the most common approaches currently taken around CS education policy by states, though their presence varies greatly across states. Within each, there are a wide range of ways to define, structure, and implement these mechanisms, and varying levels of quality within the actual implementation of a given policy. Each policy mechanism requires an infrastructure of implementation—configurations of people and processes that must be carefully brought together to provide the requisite specificity to support the policy being carried out effectively. The people and

Table 3: Policy Approaches to Alignment and Accountability in Computer Science Education

Alignment approaches include:

- CS education supervisor at the state level
- State CS education strategic plan
- State communications efforts around CS education
- Financial support for pre-service CS education programs
- Support for connections to third party curricular and professional development providers
- State-sponsored/organized CS professional development
- State-sponsored/organized CS education summits
- State-sponsored/organized district network development mechanisms
- State-sponsored/organized support for district strategic planning around CS education
- District-focused CS education grant programs

Accountability approaches include:

Monitoring and evidence of progress and/or compliance with policy goals:

- letters of attestation/assurance
- submission of course offering data to state education agencies
- submission of disaggregated enrollment data to state education agencies
- making data on course offerings publicly available
- making disaggregated enrollment data publicly available
- submission of documentation and data related to district strategic planning
- district site visits by state education agencies or contracted third-parties

Enforcement and incentives around progress and/or compliance with policy goals:

- weighted funding for CS education courses
- linking grant funding to implementation progress
- public data transparency on CS access and participation
- public district report cards/ratings incorporating CS education indicators (ESSA-linked or solely state-determined)
- monetary-based incentives around CS education-related activities for schools, teachers and/or students
- loss of district accreditation
- restricted funding for only state vetted or approved PD or curriculum materials

processes that work out policy details play just as important a role as the policy mechanism itself, and the voices engaged in that implementation can also impact the overall equity outcomes of any initiative.

Each policy mechanism requires an infrastructure of implementation—configurations of people and processes that must be carefully brought together to provide the requisite specificity to support the policy being carried out effectively.

For example, a state might choose to motivate districts to offer CS by requiring them to publicize district data on whether they offer CS courses, which can be understood as a policy of accountability. This may seem like a straightforward policy on its face. However, there is an enormous amount of work involved in ensuring that such data is, in fact, valid, and many points where things may go wrong in its implementation. In order to ensure accuracy of course data, a state may need to set up a process for reviewing how course codes are defined and applied. This may first involve forming a committee that defines what course codes should look like. Who should be on this committee? Do committee members have the requisite expertise? What are their backgrounds, and how attuned are they to how equity issues may play into their work? Once formed, a group like this would likely need to gather existing course codes, review them, consolidate them, and then offer guidance on how to implement new codes to districts around the state. All of this is necessary to make sure that a seemingly straightforward policy of "making course data public" actually achieves its goal of being an effective motivator for districts to offer these courses. If this work doesn't happen or doesn't happen well, the actual publicising of district course data could be counterproductive, and may even give a false sense of progress—districts and states may declare victory based on data that "looks good," while students are, in reality, receiving courses that teach them computer applications, instead of computer science. This specificity is extremely important for equity goals, as students in under-resourced communities often will get computer applications instead of high quality computer science (Banilower et al., 2018; Gordon & Heck, 2019).

3

Alignment: Mechanisms for Communicating and Supporting Implementation of State CS Education Policy

In considering policy mechanisms oriented towards alignment in state CS education initiatives, Coburn, Hill and Spillane (2016) note that the central aims of such mechanisms are twofold. First, alignment mechanisms must communicate overall policy goals, along with associated details and opportunities, in a way that is consistent and clear, and leads to administrators, teachers, and other stakeholders learning about what the policy entails. Second, alignment mechanisms must provide the resources to make real and equitable change possible. This means supporting development of knowledge and instructional approaches around CS education within school systems for both teachers and administrators. Notably, alignment efforts must include resources around change processes at the systems, and not just classroom, levels—mechanisms that support whole districts in developing intentional, well-supported, coherent instructional systems across their schools (Cobb, Jackson, Henrick & Smith, 2020).

Alignment mechanisms may include one of more of the following:

- **Policy communication** around standards and required course offerings that make clear what should be taught and to whom.
- **State strategic plans** that outline broad north stars and plans for governmental action to put aligned instruction in place.
- **Professional development** that supports teachers and administrators in developing instructional capacity and is aligned with state standards.
- **Curriculum selection or development efforts** that support instructional options aligned with state standards.
- **District strategic planning supports** that allow leadership teams to create intentional plans for aligned instructional systems.
- **Convening contexts** such as state summits that galvanize action, highlight north stars and link actors together in synergistic ways.

While the activities above, as well as others, are each important, prior studies in educational policy have shown that policies of alignment, rather than a patchwork, should form a coherent and reinforcing whole, with each indexing the central goals of CS education in a state (Cohen & Hill, 2001; Kaufman, Thompson, & Opfer, 2016). If equity in CS education is a central goal of the state, policies throughout the CS education ecosystem should support and explicitly address that goal.

This section explores different approaches and policy choices around alignment. Specifically, it highlights policy communication, support for district strategic planning, provision of state funding, and the development of statewide networks as a mechanism that can support district instructional change. These are not the only mechanisms for policy alignment in CS education that are available to states, but rather ones that came up consistently in our data collection. We explore this smaller set that highlights the importance of intentionality in state CS education policy design and implementation—that the particulars of how alignment mechanisms are constructed and carried out, as well as the ways multiple alignment mechanisms interact, or don't, make a real difference on the ground in terms achieving equity in CS education. Readers of this section should consider both the future design of policies and how they fit within a landscape of existing efforts, as well as opportunities to enact policies in a way that best supports desired equity outcomes.

Throughout, we draw on interviews and focus groups held with state and district leaders, highlighting both tensions and challenges along with what they saw as promising practices. We intersperse context and findings from existing research where it applies, and also include case examples from a number of states that speak to these themes.[1,2]

[1] Throughout the report, we de-identify both states and individuals in the main body of the text to address tensions with more candor. In case examples, placed in call-out boxes, we identify states, actors, and organizations engaged in promising approaches in order to elevate these practices and allow others to more easily draw from their work.

[2] Throughout, when using the word "states," we may be either referring to state education agencies, or to intermediaries established through either state legislatures or state education agencies.

3.1 Clarity in Communicating State CS Education Policy

A key theme that emerged in interviews with state and district leaders was the critical need for clear and consistent communication around state CS education policy, which has previously been identified as a key factor in successful policy implementation around new instructional initiatives (Kaufman et al., 2016). Some challenges shared in this area were linked to CS being a new instructional area and one that few school leaders have prior knowledge of, but others were simply a matter of clarity around requirements, rules, and opportunities for support. Of course, given that policy guidance was still being developed and rolled out in many states at the time of this study, communication was often in its early stages.

Misconceptions in policy requirements. In our data, we found several instances of misconceptions about what, specifically, new policy mandates required of schools in terms of teaching CS. For instance, in one focus group, district leaders debated among themselves about what their state's guidance was around CS course offering requirements. One administrator shared that he had read the state's strategic plan, and interpreted it as saying that students at every grade level must be offered CS learning opportunities. Another administrator noted that while this was indeed a recommendation within the state strategic plan, it was not reflected in the state's eventual legislation, which she clarified only mandated that CS courses be offered at the high school level.

In a similar example, administrators in one state pointed to what they perceived as a lack of policy specification around a new requirement that all middle-schoolers in the state receive instruction around computational thinking. One shared the following:

> *"One of the things with this computational thinking [requirement], when the state pushed it out, I don't even think they knew what the ruling was. For example, some counties were just sticking kids in for a week of computational thinking, but we were told at the last meeting that they really want them to have one term of experience to meet that [requirement]. So it was a little clearer when we left. Then I was able to come back and talk to my directors and share that, "Hey, it's not just a checkbox."*

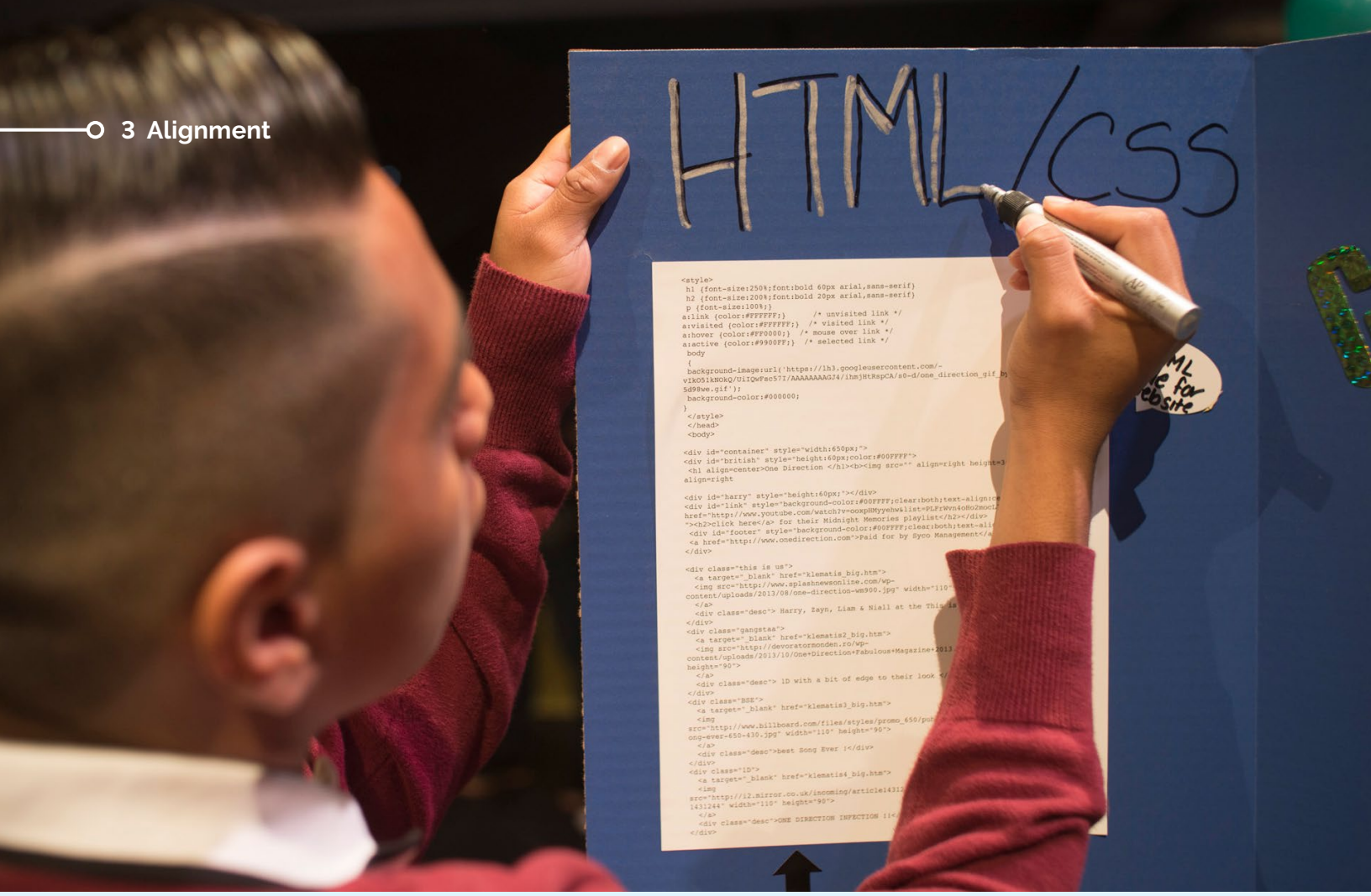
Supportive communal contexts for policy communication. The example above, in which a policy mandate was clarified in a meeting of administrators, while it highlights the reality of policy misconceptions, also contains something that can be seen as a policy communication best practice—the development of communal contexts by state leaders in which administrators can make sense of and clarify emerging policies. In that same focus group, administrators expressed that they felt that they had strong understandings of emerging CS education policy in their state—something confirmed in the nature of their discussion—attributing this to the fact that their state was small, and that the state-sponsored intermediary responsible for supporting CS education statewide held quarterly, cross-district meetings. Administrators specifically noted how, beyond other purposes, the meetings provided a context where emerging policies were shared,

discussed, and clarified in conversations with state leaders (as the previous excerpt exemplifies), pointing to the role of communal contexts for administrative sensemaking as key to achieving policy clarity and avoiding misconceptions.

Misconceptions in instructional focus and definitions of CS learning. An additional communication issue evidenced in focus groups concerned basic understandings of what constitutes CS. In one instance, an administrator conflated CS education with use of educational technology in classrooms, sharing his experience of trying to help teachers understand that CS wasn't about "tak[ing] away [their] job," but rather that "this is about saying how do we take what you're doing and then make it better or give you a different tool, just like a pencil or just like something else in your classroom," implying there, and in other parts of the conversation, that CS education was about use of educational technologies, a common misunderstanding for those not familiar with computer science. This kind of misconception, as one more tied to the particulars of introducing a new discipline and limited knowledge of that domain, rather than confusion about the particulars of policy requirements, points to a greater need for clear communication as well as professional development for administrators around what counts as computer science and what does not.

Without clear communication around the instructional focus of CS education policies, the definitions of CS education outcomes, and the nature of policy mandates, inequity rooted in our educational institutions will drive inconsistencies in urgency and depth of implementation on the ground. As such, the kind of administrator misconceptions noted previously have substantive implications for equity, even in cases where teachers in schools receive effective and state-aligned professional development around CS education. Decisions to allocate scarce instructional time toward computer science or computational thinking and to focus on rigorous learning outcomes for students needs support not only from teacher advocates but also from school leadership in order to be implemented equitably and to be considered a priority among other educational and budgetary considerations for a district or school. Additionally, if administrators don't fully understand "what counts" as computer science, their ability to provide support for teachers will be limited, or even counter-productive, potentially sending messages about what CS instruction should look like that aren't aligned with state standards.

Policy approaches that don't address this sort of inconsistent implementation and lack of alignment with rigorous learning goals most often disadvantage students who attend under-resourced schools (Banilower et al., 2018; Villavicencio et al., 2018), and communities that have been historically marginalized and disenfranchised in education. As such, while it might simply be seen as a tactical issue, effective communication about the nature of policy requirements and a policy's instructional focus with administrations is consequential to equity considerations.



Case example: Arkansas

Non-Traditional Communications, the "Bully Pulpit" and Activating Community-Based Support for CS Education

Traditionally, communications by state departments of education about a new education policy related to instruction focus on reaching administrators, teachers, and others working in schools and districts. But why should these be the only people who learn about new policies? In Arkansas, State Director of Computer Science Education Anthony Owen, shared his reflections about the non-traditional approach taken in his state, which focused on creating more broad public awareness as part of the state's larger strategy to implement CS education.

While the Arkansas Department of Education did reach school and district leaders through more established approaches such as emails, webinars, and information sessions related to CS education policies, other communication efforts targeted a wider array of stakeholders in order to galvanize broader support and activate those stakeholders as advocates for CS education in schools. Arkansas' approach is in line with research that there is broad support among, for example, parents,

(Case example continues on the following page)

Case example: Arkansas

for CS education learning opportunities in schools (Google Inc. & Gallup Inc., 2016). Mr. Owen described it as follows:

> *Prior to this initiative, and still in most of our content areas, we're very school centric in information dissemination. If we want to get a message out to the community, we send it out to principals and superintendents, and basically expect it to filter to the teachers and out to the community. [...]*
>
> *I took a very different approach. [...] This was a governor's initiative. It was a key focus of his administration. If you go to his first two years of his governorship, and you look at every speech he gave, somewhere in there he mentions his computer science initiative. In over 80% of his speeches, he mentions the computer science initiative.*
>
> *We started putting advertisements in theaters. First time our agency had ever done it. Talking about the jobs that were available, the high paying jobs. The requirement that every school must offer CS, we put that in theaters. We've done social media. We've sent information to community partners to try to disseminate it, not only through the school, but to the parents.*

The approach of both using the "bully pulpit" as well as direct communication to families and communities was one that he saw as working in tandem with the larger educational policy environment of school choice in his state, something that could motivate administrators to ensure that their schools would offer computer science as part of their desire to distinguish the learning opportunities they offer from those of other schools.

Beyond this, existing research on inequalities in technology learning shows the critical roles that parents and other informal mentors play in advocating for and connecting young people to learning opportunities in these areas (Barron, Martin, Takeuchi, & Fithian, 2009; Ching, Santo, Hoadley, & Peppler, 2016). As such, activating parents and informal mentors as part of a community-based ecosystem around CS education can strengthen overall efforts to broaden participation within local schools. Not only are parents and community members part of a chorus of encouraging voices that might motivate schools to bring CS education to students, but they also play an active role in supporting students as they navigate a landscape of learning opportunities.

3.2 State Support for Strategic Planning around District CS Education Initiatives

State support for district-level strategic planning[3] around CS education emerged in interviews and focus groups as a prominent alignment mechanism utilized by some states, an approach that reflects the reality of district local control in many states. At the time of writing, at least 12 states had active support for districts to develop CS education strategic plans, often through funding for districts to develop plans and offering or support for technical assistance around strategic planning. A focus on developing coherent local strategy within districts is particularly important from the perspective of rigor, equity, and sustainability of CS learning, as it moves beyond seeing individual classrooms or courses as the only site of change, instead taking a whole-systems approach, including broader curricular and professional development systems across a district.

Coherence at the district level means that all elements of an instructional system—curriculum, professional learning, and student learning supports—are in line with an articulated vision, student learning goals, and pedagogical principles (Cobb et al., 2020). For example, a district may have articulated student learning goals, but professional development efforts for teachers that don't align with them. District strategic plans aim to ensure that all these elements are aligned with each other, make it viable for leaders to see how all the moving parts are working together, and, if they are not, support course corrections as needed.

[3] Note that these district-level strategic planning efforts are distinct from state-level strategic plans for CS education, but, ideally, they should be aligned with a given state's CS education policy goals.

District strategic planning around CS education varies in its focus. It can involve the development of high level goals around student outcomes, district visions in terms of rationales for CS learning, planning for coherent district-wide professional development, vertically-aligned curriculum and scope and sequence across grades, and leadership structures and staff roles that support continuous improvement and sustainability of CS education initiatives. This approach has been used in domains other than CS education; for example, it has been used in mathematics and science, when new curricular initiatives have called for major shifts in content and classroom instruction (National Research Council, 2015; Tyler & Britton, 2018). CSforALL borrowed from these approaches and created a tool kit to actively support districts through its SCRIPT systems change methodology (DeLyser & Wright, 2019; DeLyser et al., 2020). In ten states, SCRIPT has become one element of policy alignment support provided to districts. In this section, we give an overview of various approaches states have taken to providing strategic planning support.

Linkage of state funding to district strategic planning around CS education. In an effort to ensure that state funding to districts is tied to coherent local approaches, a number of states included in our study provided planning grants to districts, to support developing local strategic plans, and linked the development of these plans to district eligibility for future CS education implementation funding. This approach has a number of benefits. First, it ties strategic planning to an incentive and accountability structure, making it more likely that districts will in fact complete a high quality plan and align future requests for funding to that plan. Second, it creates a feedback loop between districts and state departments of education that provides greater visibility into and early stage data around local implementation efforts. Strategic plans that are submitted to state agencies for funding can help state leaders better understand what kinds of challenges and needs districts have. Such plans inform the provision of further support structures, and help state actors connect districts facing similar challenges to share learnings with one another.

Provision of technical assistance and contexts for strategic planning. In addition to providing funding and making future funding contingent on strategic plans, a number of states included in this study also provided technical assistance to districts to develop strategic plans, often in the form of planning workshops, including but not limited to those using the SCRIPT approach and resources. In those utilizing the SCRIPT approach, districts are required to bring cross-district teams made up of administrators, school leaders, and instructional faculty. During a workshop, trained facilitators support initiation of activities around strategic planning, including development of a local vision around CS education in terms of the values driving the initiative, a rubric-based self-assessment around the current state of their district's CS education efforts, and setting near, mid-term, and long-term goals around leadership, curriculum, and professional learning.

Such contexts are important for a number of reasons, leading to key near-term outcomes necessary for successful implementations down the line (Tyler & Britton, 2018). Internal to a district, they often serve as a formal "kick-off" for

districts to move from unaligned and scattershot activity around CS education to a more coherent approach. These planning settings can also result in new district-level leadership teams and empowered "change agents" around CS education, support processes of developing buy-in from those participating in planning, create clearer pictures around implementation needs, and begin the process of monitoring progress locally. Critically, planning contexts also normalize equitable decision-making practices in CS education by creating a "seat at the table" for those beyond administrators and school leaders, including teachers, guidance counselors, librarians, coaches, and other instructional faculty (Santo et al., 2020).

These kinds of planning settings also have administrators and faculty participating in contexts where their peers in other districts are visibly engaging in making concrete and long term CS plans, creating a broader sense that CS education is a collective priority across the state rather than simply a "flavor of the month." Finally, these planning settings provide an additional context in which communication concerning the nature of state policy requirements and objectives can be reinforced by state leaders, and then directly addressed within a formal district planning process.

Case example: California

Administrators Codesigning Equity-Focused CS Education Strategic Planning Supports for Districts

In California, the Alliance for California Computing Education for Students and Schools (ACCESS) launched #CSforCA in 2016 with the support of the governor and state department of education, as well as a broad coalition of district leaders, community groups, and advocates for equity in CS education.

As part of its work bringing together district leaders to engage in strategic planning around equitable CS education in their districts, certain questions came up again and again. How can I add CS into a master schedule? How can we recruit underrepresented students into CS courses? Who's even allowed to teach CS in our state? These and many other common questions led to a collaboratively written resource, The *CS Equity Guide: An Administrator's Guide to Implementing K–12 Computer Science Education in California* (CSforCA, 2019).

The guide was not only focused on developing strategies around implementing equitable CS education, but was also itself developed through an equitable process. It centered on the needs and desires of districts themselves, rather than a directive that "came down from on high." Researchers from UCLA worked with administrators from five districts across the state to create the guide and an associated workshop model through a participatory knowledge building process (Santo, Ching, Peppler, & Hoadley, 2017).

The UCLA team first worked with two administrators from early adopter districts who documented the many questions they consistently were asked by other administrators across the state about their local CS education initiatives, and then added to these through interviews with leaders from four other districts and counties. Bringing together everything they'd surfaced by that point, the group of administrators and researchers worked together during a one day workshop to brainstorm answers to the questions that they'd gathered. This local knowledge formed the basis for the guide, which was then used along with a broader workshop model to support strategic planning by districts across the state.

Challenges in ongoing support for district strategic planning. One theme that emerged from our data was challenges in ongoing engagement with districts following initial strategic planning workshops. In some cases, those responsible for providing planning workshops indicated that they often did not know whether districts that attended actually continued to engage in the development and implementation of their CS education strategies after workshops were completed. Two states we spoke with attempted to mitigate this by creating contexts in which the state department of education staff, along with their facilitators who had led initial workshops, brought districts back together three, six, and nine months after the initial planning sessions in order to have them share progress and challenges. In one of these states, which had also linked funding to district strategic planning for CS education, the state simply made such meetings a requirement for districts who had received planning grants. In another state, a state-contracted provider who facilitated planning workshops provided more ad-hoc and needs-based support, but only in the case of districts that reached out to them. While helpful for some, such ad-hoc approaches could mean that districts with the greatest need, and fewest resources, might not be in a position to take advantage of these supports, reinforcing existing inequalities. In general, most states employing this approach voiced the need to create more formal ongoing structures for engaging districts following initial planning workshops.

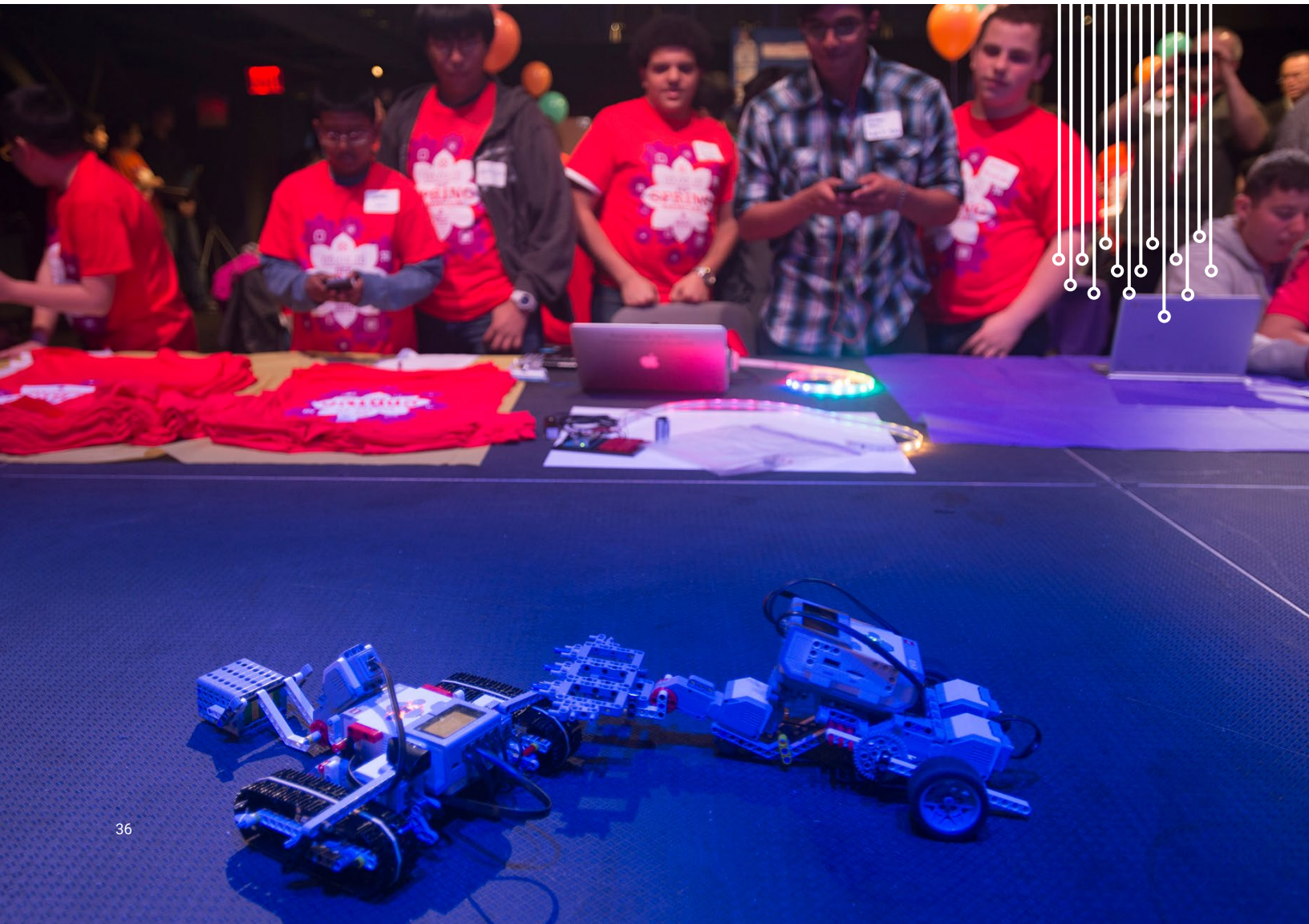
Pairing professional learning initiatives with district strategic planning supports. The alignment approach of providing strategic planning supports, like any other approach, doesn't exist in a policy vacuum. It can be reinforced by other alignment and accountability mechanisms, and, at the same time, weakened by their absence. This phenomenon was seen in the case of the pairing, or lack thereof, of district strategic planning supports with state-supported professional development. Three contrasting cases of state approaches from our data are instructive here.

In one state, a central effort of the state department of education was the provision of professional development related to CS curriculum and pedagogy to teachers, with no support for district strategic planning. In the second, a lion's share of state-led activity focused on providing grant funds for district strategic planning around system-wide CS education initiatives, with little focus on state-led professional development. In a third, a state-established intermediary supported professional development and strategic planning support through grant funds as well as associated planning workshops.

While data collected from district leaders in each of these states provided a limited view into how the efforts played out, they were suggestive of what might occur under these three conditions. In the case of a state focused more exclusively on professional development but without support for district strategic planning, district leaders might only think about implementation in terms of discrete CS courses in their schools and not engage in comprehensive and aligned district-wide strategies. Indeed, none of the district leaders in the state where this was the case mentioned having district-level strategic plans around CS education. In the second case, where these are funds provided for strategic planning without attendant professional learning

opportunities, district leaders might experience a "chicken and egg" tension, where they are tasked with engaging in district-level planning around CS, but members of their district-wide teams feel ill-equipped to make plans, given that they have limited knowledge about CS education learning goals and pedagogies. District leaders in the state that only provided funds for strategic planning confirmed that this was the case for the particular school leadership and central office staff involved in strategic planning. In a third state that combines both approaches, each would likely be mutually reinforcing—state-supported or led professional development for both teachers and administrators would serve to build capacity around CS education in a general way, and then strategic planning supports would create the possibility for the development of implementation strategies that are aligned and coherent across a district, providing the necessary leadership for rigorous, sustainable, and, ultimately, more equitable CS learning in a school system.

District strategic planning as a driver for equity. While the development of district plans around CS education implementation may, on its face, seem like a technocratic exercise, we see it as one that is central to broader equity goals around CS education. Such planning processes provide key moments when values around equity can be



articulated and embedded into district plans (Santo et al., 2019a,b, 2020). These moments provide opportunities to bring a wider array of voices into positions of power and decision-making, acting as a ballast against "top-down" approaches that reinforce existing hierarchies of power and exclude educators on the ground. Critically, in their focus on districtwide systems, they create space in which to deliberate about what it means to reach all students, especially those who are typically excluded from CS education opportunities. Finally, they make it possible to ensure that students not only gain access to CS learning, but that the broader system around these opportunities supports equitable participation, is focused on high quality experiences, and builds capacity for those working with students (Fletcher & Warner, 2020).

3.3 Funding as a Mechanism for Alignment in CS Education

State allocated funding is, naturally, a key ingredient in any state's policy alignment tool kit, used to resource statewide initiatives, staffing, and support programs, among other things. Yet at the time of writing, just over half of states had dedicated funding allocated to supporting CS education, while over 80% had K–12 CS standards in place (Code.org, n.d.). Without funding dedicated to supporting shifts in teaching and learning to meet those standards, it's unlikely that states will reach their intended outcomes, let alone do so equitably. In communities where resources are already scarce, school leaders have little incentive to prioritize a new subject over one on which performance on state assessments could have dire consequences, such as school closures or additional funding restrictions. Indeed, in many states where we held focus groups, district leaders expressed that they felt they were experiencing unfunded mandates: requirements to make substantial instructional changes without the resources necessary to do so, as we will explore shortly.

States that do have dedicated funding allocated to CS education, of course, face the question of how to spend these often limited dollars. Almost all the alignment mechanisms noted on page 26, from having dedicated state staff and state-led professional development efforts to holding state summits, providing grants to districts, and contracting with curricular providers, all require

allocation of funding. While our analysis did not systematically review how state funds are spent, a number of important themes emerged in our focus groups with district leaders that highlight issues and potential directions for how states think about funding for CS education.

District administrators' perception of funding stability for CS education. One theme that emerged from administrators in a state where funding for district strategic planning was in place was the attention they paid to the overall stability of the funding landscape in the state. While the administrators were being asked to develop comprehensive, district-wide plans around CS education, and were given modest planning grants to do so, one administrator expressed that she was closely watching activity at the state level and monitoring what levels of funding were being secured in order to make plans with an appropriate scope. She shared the following:

> *We're frustrated in the fact that we can't really know how much money there's even going to be. In a district like ours where we haven't done much, what I want to do is show the state what it takes to put the [CS education] master plan into place with a big district. What would it take, how much would it cost? It would cost us a lot more money to get ourselves up to a level like [other districts that are further ahead], because we have so far to come. So we look at the money that's out there and we can't really know: Do we just give them sticker shock to show them how much this really costs?*

Later in the conversation, she shared "back of the napkin" calculations of the amount of funding she saw as necessary to put in place a quality implementation that meets state requirements, and noted the discrepancy between that and the amounts of funding that were currently being discussed at the state level. To her, even the more optimistic funding scenarios would still fall short of what she calculated as needed. In essence, she was "reading the policy tea leaves," hedging against possible outcomes, and making more threadbare plans as a result.

This example points to the importance of having clarity around potential funding for district administrators, who, in the face of perceived instability, might be hesitant to invest whole-heartedly in implementation planning. Broadly speaking, we believe funding mechanisms that are institutionalized rather than grant-based or episodic would provide assurances to district leaders that the financial commitment at the state level is sustainable and would encourage them to make similar financial commitments at the district level.

Administrators experiencing CS education as an unfunded mandate. Even in a number of states where funding was allocated for CS education and there was also a requirement that CS be offered at the secondary level, district leaders expressed the reality that when it came down to implementation of new instruction, they felt they were facing an unfunded mandate. These were all states that had a variety of alignment mechanisms in place, such as dedicated state leads, summits, state-supported professional development offerings, and strategic planning support, often including planning grants—all of which pointed to

the somewhat contradictory reality that a state can have funding in place, but administrators can still feel under-resourced. These administrators acknowledged the utility of these supports, but said that at the end of the day, they felt that they faced the simple challenge of not having funding for additional staff, both at the administrative and instructional levels, who would be wholly responsible for ensuring that a district was able to meet those mandates. One CTE coordinator expressed the sentiment this way:

> *I just think that a lot of times, legislation is made and they don't provide the funding to do it, like the size of our curriculum department hasn't changed but [Computer Science has] just been added on. So if they're going to make a bill and they want things done, there has to be something else there.*

While this perspective may not be surprising—indeed, it represents a common experience among those who work in school systems—it is no less important for state leaders to be actively considering the implications of legislating new requirements without providing the resources to fulfill those requirements.

Even when state-level efforts propose to listen to teachers who voice the need for professional development, an administrator and school leader perspective highlights the need for different kinds of resources that can be used to support ongoing professional learning locally. These sentiments point to the fact that when funding exists in a state, this does not mean that school leaders actually experience a substantive difference in the kind of resources they feel they need to provide quality implementation.

Practically, this could mean providing direct funding for full- or part-time positions dedicated to CS education at the district level.

Targeting computer science in state grants to districts. An additional theme related to funding in our data concerned issues of how funding was targeted around CS education. In one state, administrators shared that their state-level funding was inclusive of CS education, and even prioritized it from a narrative perspective in the state's relevant request for proposals (RFP), but that the same "pot" of money and RFP also included funding for general integration of and professional development around educational technology writ large. Some of the administrators from that state shared that they, and many of their peer districts, opted to use those funds for technology initiatives not focused on CS education. Additionally, one administrator noted that due to the structure of the grants, which required districts to apply in groups that would all focus in a similar area of practice, there was somewhat of a "lowest common denominator" effect, where districts that were further ahead found that they were limited in their ability to focus on more advanced work in CS education:

> *Each school district's at a different place, right? So, if you have the learning technology grant, some teachers just need to learn about Office 360 or Google Suite or how to connect to iPads and how to plug them in, right? That's a legitimate need because if you don't know how to do those things, you're not going to be able to do a lot of other things. But then, you have other districts where maybe we've already done those things. So, we're ready to do the next thing, but you still have a lot of different*

skill levels in different places. So, [the grant applications] have to juggle the competing agendas of all their component districts, and then split the difference to get the most folks bought in, on board with ideas and concepts. For us, we might not really care about initiative A that they're working on, and we really need something that is relevant.

In this case, the combination of grants that were oriented towards a broader set of issues inclusive of but not solely focused on CS education with the requirement of collaborative district applications meant that those wanting to pursue CS-related work found it challenging to leverage the grants towards that end.

In a context in which there are needs around both increasing the capacity of schools to integrate educational technologies more broadly as well as engaging in more substantive education focused on technology, as is the priority of CS education, these two priorities shouldn't be set against one another within single funding streams. Doing so can create situations in which administrators who are less inclined towards broadening participation in CS education instead opt to fall back on existing initiatives around technology integration. Generally, such choices should not be either/or—integrating educational technologies and CS education are distinct goals, and as such should each receive dedicated resources and incentives to reach them.

More broadly, funding opportunities like these represent places where state leaders must balance supporting and incentivizing alignment with policy goals with the value and importance of district ownership, a factor that existing research has noted is critical to successful policy implementation (Kaufmann et al., 2016). In line with broader themes we've noted throughout this

report related to school and district leaders having a seat at the table when it comes to policy, we believe that funding should be seen as a tool that promotes district ownership and even local innovations that might be shared as best practices across a state, something that research has noted is critical to establishing successful scale up of education efforts (Coburn, 2003; Morel, Coburn, Catterson, & Higgs, 2019). This might even mean involving representatives of school systems in the development of requests for proposals, or, as noted in the prior section, supporting districts in developing their own strategic plans and associated local visions for CS education in their communities. If done intentionally, this could result in districts that do indeed define what success looks like for them, but do so in a way that aligns with a broader vision of equitable CS education articulated by those supporting them at the state level.

The funding ecosystem. As a final note, it's important to acknowledge that the funding landscape for CS education goes far beyond what state agencies are able to provide, and this adds an additional layer of complexity for those leading CS education policy implementation within state departments of education. Federal initiatives, private philanthropies, industry-led giving, local foundations associated with schools and districts, and others form a somewhat crowded ecosystem of actors that districts may be looking to in order to resource local CS education efforts, each with their own priorities, and with districts both receiving support from, and having to be accountable to, these myriad actors. Some of the priorities held

by such funders may overlap with state-level policy goals, while others may not. Additionally, large districts within states are often able to advance CS education policy and practice, with additional external support that doesn't come from state agencies, in ways that state leaders must contend with. This potentially creates situations in which lessons and approaches can be drawn from various municipalities within a state, but also one in which careful coordination must be done to assure overall coherence within the state.

In this context, one in which such additional resources create risks of misalignment with policy goals, state leaders can attempt to leverage their positions to actively identify and share funding opportunities that they see as well aligned with their state's instructional goals around CS education. Beyond this, they may also attempt to act as conveners of funders that are active in their states in order to help create alignment across multiple efforts and minimize conflicting priorities. This role as a convener is one we address in the next section.

3.4 Statewide Networks as Mechanisms for Alignment and Improvement in CS Education

A key mechanism for policy implementation is the development of local networks associated with a given set of instructional policies. At the statewide level, scholarship highlights the role of networks intentionally designed and fostered by both K–12 system (state agencies, departments, local districts) and non-system (universities, private sector actors, nonprofits, consulting firms, content providers) actors to bring in requisite resources and expertise, facilitate collective action, and effectively structure divisions of labor supportive of policy implementation (Russell et al., 2015).

Within education, statewide networks have been utilized for a number of purposes. They have been developed to actively coordinate state and local reforms (Augustine et al., 2009), connect district educators with external expertise (Perauch, 2011; Wohlstetter et al., 2003), overcome limited capacity and expertise within SEAs (Russell et al., 2015), and provide opportunities for policy sensemaking among district instructional leaders to understand new policies' relationship to existing instruction (Fuhrman, Clune, & Elmore, 1991).

As Russell et al. (2015) note, this move to networked governance within the public sphere, a departure from more traditional approaches characterized by hierarchy, is now common across several sectors, including public health and environmental conservation. Russell et al. also highlight that while such networks are both necessary and effective for knowledge-intensive work like development of innovations and coordinated action, they also face challenges. These challenges are most often associated with ensuring that the necessary organizations and sectors are involved, and, once they are, developing effective participation and coordination structures among them. If these issues are not addressed, the most likely outcome is fragmented, incoherent, ineffective policy implementation on the ground.

Within the context of CS education policy, development and facilitation of statewide implementation networks is a key mechanism supporting alignment efforts. There is likely an especially critical role for state-based networks given limited capacity around CS education within most SEAs. Additionally, CS education's growth across the country as a phenomenon heavily

driven by non-system actors, including nonprofits, field-building and intermediary organizations, national funders, and content providers prior to and now alongside state actors means that there's an important role for SEAs to play in coordinating networks within their states to ensure alignment of these actors with state policy.

Indeed, many existing efforts within the CS education field have included network-driven approaches within specific localities. The ECEP Alliance utilizes a five-stage model to broaden participation in CS education in its work with state-level advocates (ECEPAlliance.org, n.d). This model involves key activities around forming state-level teams and broad networks of allies to coordinate and plan strategic initiatives in a state. CSforALL has itself led and supported numerous network-based regional strategies, including its work forming a public-private partnership to initiate and sustain the New York City Department of Education's Computer Science for All effort, as well as work to provide support for regional networks nationally through its EcoSystemsforCS initiative.

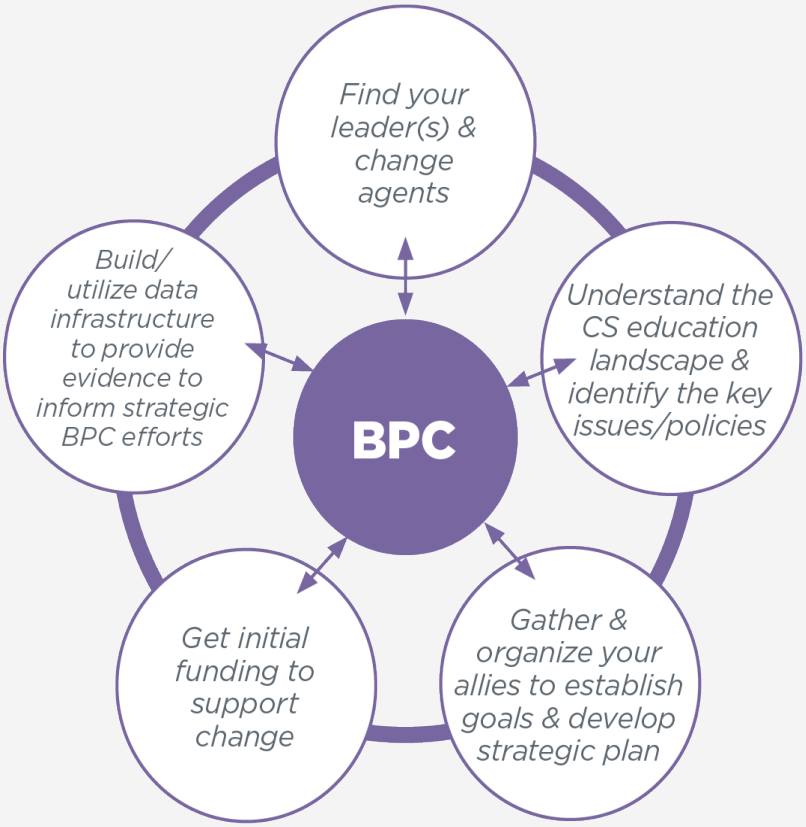
Expanding Computing Education Pathways (ECEP) Alliance: A Potential Coordinating Model for Alignment and Improvement Efforts

The Expanding Computing Education Pathways (ECEP) Alliance, a National Science Foundation Broadening Participation in Computing Alliance, works with broad-based leadership teams in 22 states and the territory of Puerto Rico to develop policy, interventions, and metrics that broaden participation in computing from the state to the student level. ECEP serves as the backbone organization, building a common agenda, facilitating network communications, and supporting mutually reinforcing activities across the ECEP Alliance and in individual states in order to increase capacity, access, participation, and experiences for K–16 students who are underrepresented in computer science education.

The state level work is framed by ECEP's model for state change. This model, designed as five stages, entails a circuitous process of actions and adjustments. State teams start in the stage for which they are most prepared, and step in and out of stages as they pursue strategic efforts such as coordinating broad-based teams of leaders, developing strategic plans at the local or state level, writing landscape reports to better understand the state of CS education in their area, or holding meetings and summits to bring stakeholders together with the intention of advancing CS education in a way that focuses on broadening participation in computing.

Figure 3: ECEP Alliance five-stage model of state change for broadening participation in computing.

The five-stage model allows advocates, educators, department of education leaders, researchers, and government and industry leaders to coalesce around CS education equity work. The formation of a network of leaders from multiple fields is vital to the success of any CS education policy effort. When diverse groups of thought leaders collaborate on policy strategies from the initial stages of problem identification to the pursuit of policy and eventual implementation, there is a greater chance that unintended consequences of policies will be avoided and that the implementation phase will support the recruitment and retainment of diverse students in CS education pathways.



State-led task forces and advisory boards. As we will discuss further in section 6, states have utilized task forces and advisory boards for a variety of purposes, with each including stakeholders beyond SEA staffers in order to widen the circle of actors involved in state-based policy design and implementation. For example, multiple states have put task forces in place to lead development of a state plan for CS education.

Additionally, many states, in line with broader existing state policies on standards development, have put advisory boards in place that include researchers, teachers, district administrators, and other CS education experts to provide feedback and direction on the development of CS education state standards.

State summits. Within the context of state-supported networks, larger convening contexts such as state summits can play a critical role. The ECEP Alliance and NCWIT developed a state summit tool kit, highlighting approaches to planning state-based convenings around broadening participation in computer science. As they note,

> *"Convening a summit is an effective way to coordinate state-level computing education reform efforts. [...] Gathering the various stakeholders at an event creates an opportunity to explore the unique challenges within the state, assess the resources available, create buy-in and a shared message, and energize the various constituents to become advocates for change."*

Summits create key moments when state-based actors can connect with and discover experts, both external and within their state, collectively articulate needs and goals, provide opportunities for voices that haven't been at the table to participate, and clarify key questions about emerging education policy.

Cross-district administrator and teacher convenings. As noted in the prior section related to policy communication, some states have put in place more targeted and regular meetings at which district leaders and state actors convene to discuss, make sense of, and clarify emerging CS education policies. Our data also contained cases in which these contexts were used to clarify alignment between CS education policy and other areas of state education policy that administrators were already focused on. For example, in one state, meetings of this sort were used by district and state leaders to identify overlaps between new CS education standards and existing standards in math and English language arts, an activity administrators expressed as valuable in supporting their planning for local implementation as well as their communication efforts with teachers in their districts.

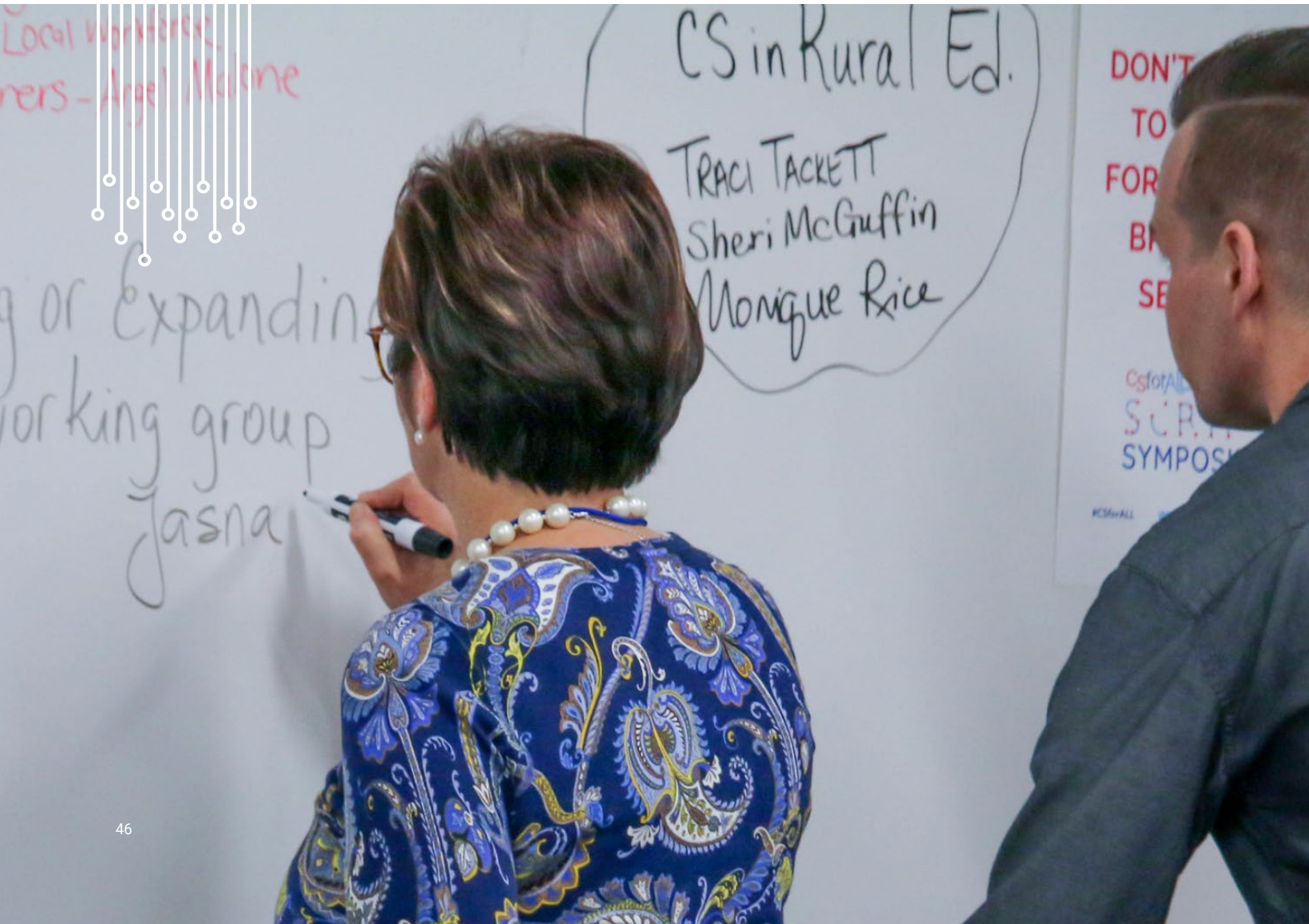
Additionally, some district administrators we spoke with discussed putting in place structures like these, independently of state actors, in order to bring together teachers and coordinators across multiple districts in a region to collaboratively develop lesson plans and plan professional development, noting that "It just makes life easier when you can share the load." Such approaches are ones that state actors can also encourage and support, even if state representatives can't always be present in them. As one state leader who did facilitate these types of meetings around CS regionally in her state put it:

> *Administrators will be like, "Well, we're doing this, what are they doing?" That's like their sister or brother kind of thing. So there's a lot of that, but it's also that they know that they [districts] can compare notes but then they still can go back and do what they want, but they do like to reach out and see.*

A number of teacher and administrator CS education convening models exist in both the regional and national arenas. CS for ALL Teachers, run by the American Institutes for Research, and other online discussion boards support learning among educators around classroom instruction in CS. Regional teacher networks provide teachers with communities centered around a particular organizational membership,

such as the Computer Science Teachers Association (CSTA) or groups focused on particular curricular efforts. While these nationally led convening contexts play important roles, they also complement, and should be reinforced by, state-based cross-district working groups that can coordinate strategic planning, professional development, and implementation efforts.

District improvement cohorts. Another network-centric approach is the development of statewide district improvement cohorts supporting CS education policy implementation and professional learning. In such approaches, the organizing body (e.g. SEAs, state-authorized intermediaries, state-contracted professional development organizations) often engages in various forms of technical assistance for districts (for example, the kind of strategic planning support discussed earlier) or professional development for teacher leaders, but also creates a cohort context whereby district leaders and/or teachers can, in an ongoing way, share lessons, collaborate, and take inspiration from one another. One key feature of improvement cohorts that makes them distinct from more general convening and learning contexts such as those described previously is their focus on *highly specified and shared problems of practice* (e.g., recruitment of female, Black, or Latinx students, or integration of CS education into existing



disciplines) and attendant *utilization of shared measurement* around these challenges that can serve to shed light on what is and isn't working across a cohort.[4] Grounded in models of continuous improvement that are increasingly common in districts, a networked improvement approach expands beyond work in a single district to leverage the power of a collective that is focused on shared goals.

State actors as brokers in CS education networks. A final theme that emerged around networks was the role that state actors played in brokering, both within and beyond state-based networks. State leaders shared both formal and informal ways that they connected district leaders to one another for advice, to potential partners within the state, such as universities or content providers, or to those in the broader, national CS education field. We see it as important that states understand these roles as, among other things, explicitly being about the process of connecting otherwise disconnected actors through brokerage practices.

3.5 Conclusion

This section shares successes and challenges around a variety of alignment mechanisms. It highlights how, in CS education policy communication, state leaders at all levels should be aware of potential misconceptions both around policy specifications (e.g. required course offerings) as well as policy focus (e.g. what does and doesn't "count" as CS education), along with models for approaching policy communication in non-traditional ways. It explores what support for district strategic planning around CS education can look like and lead to, noting the importance of pairing such supports with broader capacity building around instructional approaches and learning goals of CS education. It outlined how funding must not only be present generally, but must also be intentionally configured so that it can be used to make progress on CS education efforts in districts. Finally, it elevates the importance of statewide networks as a key mechanism for organizing, coordinating, learning, and improving CS education efforts.

However, these are far from the only mechanisms of alignment—support for pre-service CS education initiatives, the development of CS education standards, aligned efforts around curriculum and professional development, and, critically, a strong state-level supervisor are additional alignment mechanisms that cut across the issues explored in this section, and have their own particularities and challenges. Most importantly, we want to emphasize the importance of understanding such mechanisms not in isolation but as part of a larger, reinforcing tapestry of support for equitable CS education in schools. And, as we'll explore in the next section, these alignment efforts must be configured in relation to accountability mechanisms in a way that supports equity goals around CS education.

[4] See Bryk et al., 2011 for examples of Networked Improvement Communities that utilize this approach.

4

Accountability: Mechanisms for Monitoring, Enforcing, and Incentivizing Implementation of State CS Education Policy at the District Level

As noted earlier, existing scholarship on education policy predicts that solely focusing on alignment supports will likely result in an uneven and inequitable implementation. Even if institutions that have been sites of historic disinvestment are provided with the funding and capacity-building they need, actors inclined towards a reform will likely be able to implement it well, but actors who are not personally attuned to the goals of the reform could effectively ignore such policy with little consequence. Policy goals that have associated accountability mechanisms, then, incentivize all school system actors to orient towards shared north stars.

As noted in section 2, within the context of CS education, state-level goals that might be subject to accountability mechanisms include mandated CS standards (as opposed to voluntary standards)[5], course offering requirements at secondary or elementary levels, high school graduation requirements, and licensure or endorsement requirements for those teaching CS courses. And, of course, there are broader stated goals that don't take the form of mandates, but where accountability mechanisms can still spur action. One example, especially relevant to CS education, is the need for guidance and recommendations to actively focus efforts on recruiting low income, female, Black, and Latinx students who have historically been underrepresented in computing into elective courses. Accountability mechanisms may be used to orient district and school leaders towards these goals, as in the case of reporting requirements to include disaggregated enrollment data. Requiring that such data be reported might incentivize schools to focus on questions of representation within their elective CS courses.

In order to ensure accountability to goals and mandates, states generally utilize two interdependent sets of mechanisms: monitoring mechanisms and enforcement/incentive mechanisms. Monitoring can sometimes be public and included in data dashboards (as discussed later), or private within the policy implementing body. Ideally, monitoring mechanisms effectively and clearly document progress on and adherence to policy goals.

In this section, we share a broader perspective on accountability as collective responsibility for student learning, explore themes regarding accountability that emerged from interviews with district and state leaders, and outline the nature of monitoring, enforcement, and incentive mechanisms states are currently employing. We offer these themes as they are, and encourage readers to consider the implications within their own contexts as well as engage community groups before implementing any accountability measures.

4.1 Accountability as Collective Responsibility for Learning

Prior to exploring themes around and approaches to accountability that emerged in our study, it's important to set some additional context on this often contentious issue and explicitly state the perspective we take in this report. Broadly, we view accountability through three intertwined lenses: collective responsibility, transparency, and balances of internal and external accountability.

Accountability is often fraught in discussions of education policy, as historically it has too often been used punitively, as a tool to defund, deprioritize, or critically undervalue important work done in educational institutions that serve the most marginalized communities. Accountability that triggers high-stakes enforcement mechanisms can often act counter to the very equity goals policy-makers are seeking to enforce, even if they have good intentions (Jones, 2007). For example, the removal of financial resources from schools designated as "failing" based on their performance on standardized testing has caused many under-resourced schools that started out with less funding to receive even less resources, making it increasingly difficult for them to provide the supports for student learning needed to close the performance gaps that triggered enforcement in

[5] For more detail on the nature of mandated as opposed to optional standards in CS education, see the Code.org brief: Every State is a Local Control State: A Look at the Intersection of CS Standards and Accountability.

the first place (Baker, Farrie, & Sciarra 2016). More broadly, evidence also points to curricular narrowing in the face of such sanctions (Dee, Jacob, & Schwartz, 2013), effects on teacher morale (Finnigan & Gross, 2007), and social fragmentation of low-income communities following sanction-based school closures (Kirshner, Gaetner, & Pozzoboni, 2010).

Accountability mechanisms that remove alignment supports have, unfortunately, been common in education, and research has shown them to be counterproductive and damaging to communities that have the greatest need.

Accountability mechanisms that remove alignment supports have, unfortunately, been common in education, and research has shown them to be counterproductive and damaging to communities that have the greatest need (Heilig, & Darling-Hammond, 2008, Lipman, 2013; McDermott, 2007). This is why we emphasize, throughout this report, the importance of attending simultaneously to resource issues, through alignment mechanisms, while also understanding that without some measures of external accountability, past experience demonstrates that inequitable outcomes are likely (Coburn, Hill, & Spillane, 2016; Forum of Educational Accountability, 2007; McLaughlin, 1987) .

Given this history, we take a particular view on how to think about accountability in the context of CS education, and center this view on three themes: accountability as collective responsibility (Whalan, 2012), transparency as a key mechanism for accountability to the public (Read & Atinc, 2017), and the importance of both internal and external accountability (Fullan, Rincon-Gallardo, & Hargreaves, 2015).

Understanding accountability as collective responsibility for student learning shifts from a more classic view of accountability as simply based on “sticks and carrots” determined by governmental bodies to one in which the full body politic associated with education—families, teachers, administrators, policy-makers, and many others—engage in a mutual commitment to educational goals around equity and public goods, and cooperatively support achievement of those goals. The emphasis we’ve made across this report to simultaneously attend to both resourcing school systems while also holding to high expectations around equity is reflective of this collective responsibility view of accountability. Within it, policy-makers set goals informed by multiple stakeholders, and are responsible for ensuring that schools have the resources they need to achieve them.

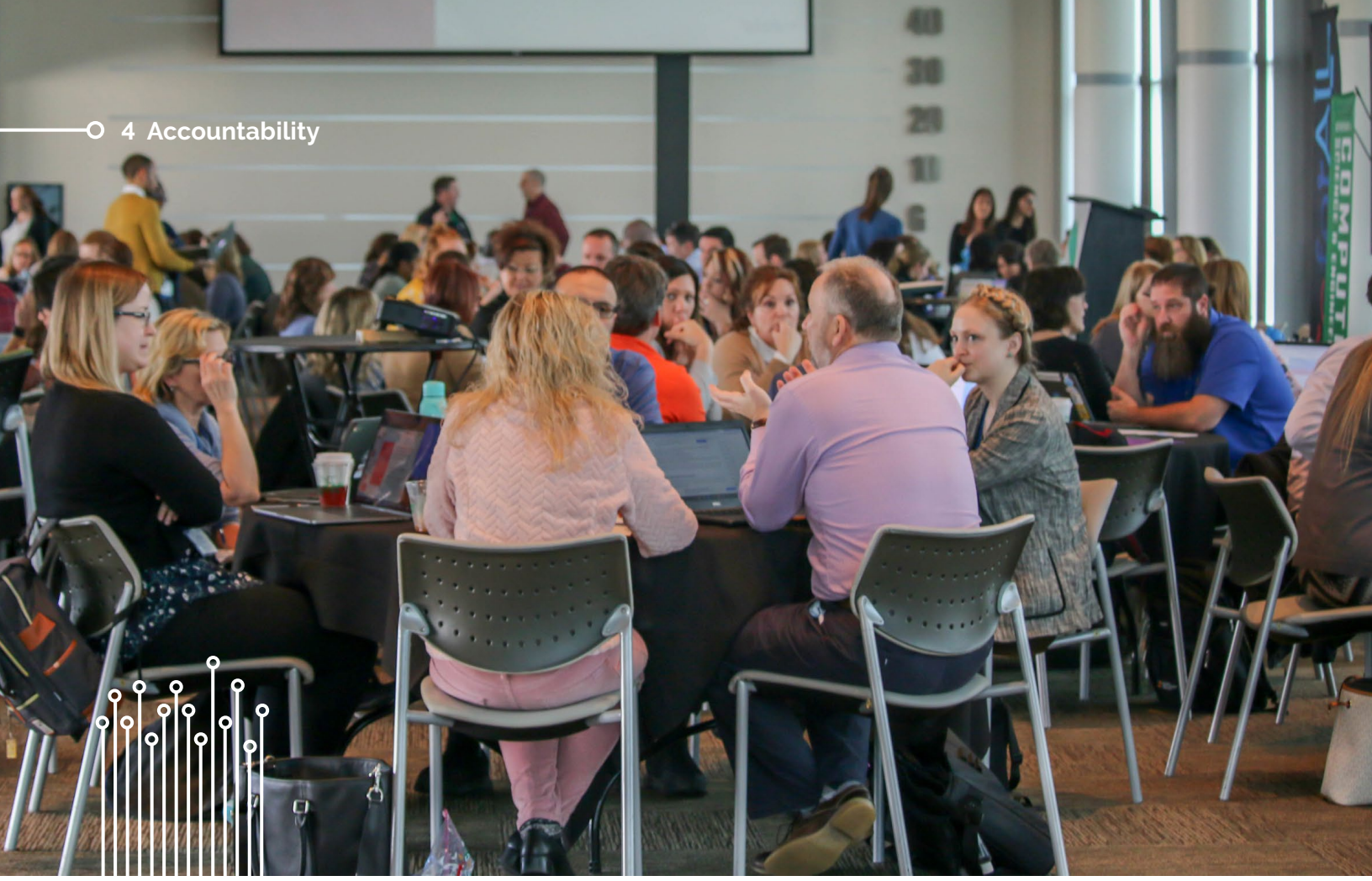
Understanding accountability as collective responsibility for student learning shifts from a more classic view of accountability as simply based on "sticks and carrots" determined by governmental bodies to one in which the full body politic associated with education—families, teachers, administrators, policy-makers, and many others—engage in a mutual commitment to educational goals around equity and public goods, and cooperatively support achievement of those goals.

Collective responsibility as a frame for accountability naturally links into the other themes in this report—support for internal accountability while also including external accountability, and the centrality of transparency. External accountability is generally understood as "the control by an external authority to achieve school goals" (Kim & Yun, 2019), while internal accountability "occurs when individuals and groups willingly take on personal, professional and collective responsibility for continuous improvement and success for all students" (Hargreaves & Shirley, 2009, as cited in Fullan et al., 2015, p. 4). Put simply, while external accountability sets goals from the "outside" of school systems, internal accountability results from processes of planning and ownership from within them.

Fullan et al. (2015) argue that those in policy-making positions should lead with supports for the development of internal accountability first, stating that such strategies will lead to greater accountability overall. Various alignment mechanisms noted in the last section—from support for professional development to offering contexts in which districts can set their own strategic plans for CS education to building strong networks around implementation—are constitutive of an approach that supports internal accountability. Through building capacity and maintaining local determination over many of the questions around how CS education is rolled out, those within school systems are positioned to take ownership over policy goals and systems of accountability.

External accountability is not absent in this overall view. As Fullan et al. (2015) note, external accountability should act as a mechanism by which "system leaders reassure the public through transparency, monitoring and selective intervention that their system is performing in line with societal expectations and requirements" (p. 4). We view mechanisms of transparency as being particularly salient here, and, as such, actively highlight examples of what this might look like in CS education throughout this section, and touch further on this theme in section 5, which focuses on the relationship between data, equity, and state policy.

As we share findings in this section, we encourage readers to understand them within the context of accountability as collective responsibility outlined above.



4.2 "There Are No Consequences": District Administrator Perceptions of Limited External Accountability in CS Education

As noted earlier, for this report we intentionally chose to speak to leaders in states that had differences in terms of the current CS education policy configurations in place—ones with both lower and higher alignment, and weaker and stronger accountability around CS education. Unsurprisingly, district leaders from states with weaker accountability mechanisms shared about tensions associated with not having clearer incentives. It is notable, however, that we heard some similar sentiments in states that we had considered as having stronger accountability mechanisms in place, with some noting the unevenness of monitoring mechanisms that might promote accountability both internally and externally. In this section, we share from across states that were in very different places when it came to accountability around CS education policies, noting the particular policy contexts they were situated in as we highlight different examples.

Not surprisingly, in one state that was both at a relatively early stage in its process of policy implementation and had few mechanisms for either alignment or accountability (and no mandates around offering CS courses, for example), one administrator described the situation around CS education like this:

> *[The state] is trying to do something, but they haven't figured out how to put any teeth behind it.*

In that same state, another administrator highlighted what she saw as a gaps between the "ideals" concerning equitable CS education learning and the current policy landscape in her state:

> *One of the things I've been experiencing is a disconnect between the ideals of, well, yes, of course everyone should have CS, of course every child. This is going to be that great equalizer. We're going to teach them all. All these kids, if they're coming from really impoverished homes, are going to have this equal access. We're going to really do it and they're going to really be able to fly. This is going to be the thing that's going to fix the future. Well then, what are you doing? Until there are individuals within districts that are demanding it, that's going to cause that to happen, because* ***we don't have a state structure right now that will demand that****. (emphasis added)*

Even in the case of a state with a mandate to offer multiple CS courses, an administrator in that state noted that there were no implications for districts that did not do so:

> *There is a clause in our education code that says a school district must offer computer science courses. However, there are no consequences to a district for not offering them. The worst you can get is a slap on the hand from the state for not offering it. But, there's not really any financial consequence or other consequence for not offering it.*

Although the administrator mentioned financial consequences, we acknowledge that as a common accountability mechanism it was likely the one most easily on hand to bring up in a discussion, but was not one advocated for by this administrator or this report. Later in this chapter, we offer a description of incentives and accountability mechanisms around CS education state policy, none of which include reductions in school funding.

A district CS education coordinator in another state, one that had a much more robust range of accountability mechanisms in place, including funding implications for districts that didn't offer CS at the high school level, echoed these sensibilities, though somewhat more tentatively:

> *I mean, to be honest, we probably have some educators in our district that it's really not even on their radar. So it's probably too little accountability.*

In the same state, another district leader noted variability in how much leaders and their colleagues felt accountable to following the state's CS education mandates, based on what he saw as uneven monitoring:

> *Because we are close to [the state capital], we have eyes on us all the time, so we get inspected more than the average district. So we're very accountable to the standards and what we do. But I know I've got colleagues that live in more rural areas and they don't do some of the same things that we do.*

Of course, respondents were also attendant to not wanting accountability mechanisms that were unnecessarily high-stakes. As one state leader put it, in her state, they were seeking a balance between alignment and accountability, stating that "In education, if we can keep the pendulum from swinging too far either way, we usually do pretty well."

These examples highlight the inconsistency of CS education accountability at the district and state levels. These inconsistencies can be linked to systemic issues, not necessarily unique to CS education but with greater ramifications for a new subject attempting to scale with a focus on equity. While clear alignment mechanisms help individual institutions see the intended outcome and be supported to reach it, administrators are not making decisions about inclusion of efforts around computer science in a vacuum: they must weigh budget, staffing, and instructional time in parallel with all other disciplines. Without some form of accountability mechanisms, we see it as unlikely that administrators will be able to prioritize CS education when other subjects have more stable systems of accountability. At the same time, this reality must be balanced against the sentiments expressed by some district leaders, noted in section 3.3, around feeling like they were facing unfunded mandates around CS education, and were likely not looking for repercussions around goals they didn't feel like they had appropriate resources to meet.

4.3 Monitoring and Evidence of District Progress on State CS Education Policy Goals

As with all other areas of education policy, in order to understand whether a district or school is making progress on state-level goals and its degree of compliance with mandates around CS education, a state needs a way to monitor or otherwise gather evidence of progress for fair

implementation of accountability mechanisms. This involves, in one way or another, data collection related to these mandates and requirements. As we have discussed earlier, and as we will continue to describe, any monitoring or evidence must be rigorously aligned with not only the execution requirements of the policy, but also the underlying goals, in order to determine if the policy is having the intended effect. For example, if the goal is to broaden the participation of young women in computing, simply monitoring the offering of courses without checking sub-group enrollment data may not produce evidence of progress towards broadening participation goals.

Equally important for goals regarding equity is to measure the variability of implementation across locations—if state policy mandates that schools offer a single course at the high school level, are some schools offering sequences leading up to a capstone like an Advanced Placement course, thereby creating the structural support for higher pass rates, while other schools may just offer the capstone, and may, as a result, have lower success rates? Such forms of monitoring create the possibility of not simply compliance, but improvement, and thus, equitable outcomes that should be at the center of any education policy initiative.

We found a number of methods of monitoring and evidence gathering employed by states, and will outline them here in brief. Many of the monitoring and enforcement approaches in this and the next section are noted in the Code.org policy brief, *Every State is a Local Control State: A Look at the Intersection of CS Standards and Accountability* (2019). In the next section, we explore questions of data and its relationship to equity and school systems change more broadly.

Letters of assurance. Also known as "letters of attestation", these are letters provided by district central offices to state education agencies that assure the state of district compliance with mandated CS education standards, and, in some select cases, voluntary standards (Code.org, 2019). As such, they are technically a form of "self-monitoring"—we did not hear of cases of state education agencies validating these letters in terms of their veracity, and this form of evidence gathering was not brought up by any district leaders in discussions about accountability. However, one state leader noted that in his state, anybody is able to report non-compliance to their state accreditation body around any area of mandated standards, which links to enforcement mechanisms around standards of accreditation violations that we explore in the next subsection. In some cases, such letters of assurance are required to include evidence of compliance in the form of documentation such as unit and lesson plans.

District site visits by state agencies. On-site visits were also noted as another approach to monitoring. Such site visits are, in some cases, impromptu on the part of state agencies, and in others are part of the broader, more formal accreditation process that may be conducted by state or external agencies. The nature of site visits and what they aim to document also varies by case.

Data reporting requirements. While we will explore more fully both the nature of reported data as well as ways in which it is represented in section 5, it should be noted here that general requirements around reporting various forms of data are a central mechanism of monitoring employed by many state education agencies. Such data, which most often relate to courses offered and student enrollment, have a range of issues associated with them that we will explore further in section 5. Ideally, these data should provide a state with a clear picture both of which courses containing standards-related CS content are currently being offered in a given school, and which students are enrolled in such courses by sub-group. However, high variability both in the definition of course codes and in their application by district staff means that such data can often be fraught with validity issues. Courses may be misclassified or not sufficiently specific, with those that do not relate to CS learning but rather areas like computer applications often being included under the same course code. Additionally, accurate course code application relies on the availability of district staff who are sufficiently knowledgeable about the courses in order to avoid misclassification.

4.4 Approaches to Developing Accountability to State CS Education Goals through Enforcement and Incentive Structures

Among the uses of evidence gathered through monitoring mechanisms noted in the previous section, a central one is to provide state education agencies with a way of understanding whether

and to what degree districts are in compliance with existing state mandates, or are making progress more broadly towards state goals. It should be noted, again, that such mandates and goals vary widely across states. For instance, while 38 states have K–12 CS standards in place at the time of writing, they are only mandated (as opposed to voluntary) in 18 states, meaning that if a school offers CS instruction, it is required to be aligned with those standards. This can likely be attributed to the desire to avoid resistance and foster a more collaborative approach to reaching policy goals. Similarly, only 18 states mandate that a CS course is offered at the high school level, and only eight require CS content to be offered at the K–8 level, which most often translates into either integrated instruction or "pullout" courses at the middle school level. Such examples are provided for consideration, and are not necessarily endorsed as best practice.

But even with such mandates in place, what can happen when districts are unable to comply with implementation mandates? What resources do they require to be in compliance? What is causing the gap? What incentives are they offered if they do reach various state goals? Our analysis did find that a range of mechanisms meant to develop and incentivize accountability around CS education are being put in place across some states,

each with different degrees of consequence. The choices of monitoring, incentives, and consequences can communicate the priority of initiatives as well as influence the variability of offerings between resourced districts, or districts with at least one highly engaged teacher, and those without.

Data transparency. As noted in section 4.1, a central approach to enforcement focuses on creating transparency around school district data related to CS education through publicly accessible data systems. The examples we found most often centered on making data related to CS course offerings available, with the viability of such approaches reliant on states having existing public data infrastructures in place through which such data could be published.

The visibility of computer science offerings through public data systems does not have an immediate and direct consequence to the school. When coupled with alignment mechanisms meant to engage parents and community members around the importance of computer science, however, the visibility of offerings could drive some aspects of parent choice of schools. Additionally, district administrators being able to see how their offerings differ from those of their peer districts can itself motivate change. As one district leader put it during a discussion of his state's public data system, which did include data on CS course offerings:

> *It's just another layer of visibility that the public and the state has into what's going on in these districts.*

During the same conversation, another administrator noted that this approach was also reinforced by the broader education policy environment in his state related to school choice:

> *For good or bad, our state does allow school choice. So the fact that they publish all that out there and a parent every year can decide, I want to move my kid from district A to district B or district B to district C, or whatever other town. It is another piece to say, "Okay, [in our district] we want to be one of the top with computer science classes at our high school, so we can try to get more kids to want to come to our school systems." I guess that's an accountability piece as well.*

In a limited number of cases, public data included not only whether CS courses were on the books in a school or district, but which students were participating in them in terms of demographics and sub-groups. This additional layer of data is important, as it informs stakeholders not only about whether there is equitable access to, but also participation in, CS learning opportunities.

Finally, in states where CS education is situated within policy on career and technical education, the numbers of students earning industry-based credentials may also be integrated into publicly available school ratings.

Community-based awareness and advocacy. As noted in section 3.1, some states have aimed to create more widespread communication campaigns that raise awareness within communities and families around districts and state CS education initiatives. Again, while an approach like this does not represent a "formal"

mechanism for accountability, it creates the conditions whereby parents and other stakeholders might come to expect and advocate for student learning opportunities around CS education in their district.

Monetary rewards for students, teachers, and schools. Some policies offered direct rewards for making progress on policy goals. In at least one state, teachers were offered monetary incentives if, following participation in state-led professional development, they offered localized professional development around CS education in their schools. In that same state, teachers were compensated for seeking CS licensure, with costs associated with the licensure process covered by the state, and students that achieved a score of 3, 4, or 5 on AP Computer Science exams received monetary rewards, as did their school, on a per student basis. Monetary incentives like this may serve to motivate progress towards state goals on the part of schools, teachers, and students, though there is not currently evidence of the efficacy of these incentives.

School distinctions on state report cards. Similar to some of the other approaches noted so far, some states make it possible for schools to have distinctions associated with school-level computer science efforts on publicly accessible state report cards. For instance, in Oklahoma, computer science is included as one of seven areas that constitute offering a well-rounded curricula, with schools being able to self-identify as being at gold, silver, and bronze levels in terms of their computer science work (Ok.gov, n.d.). It should be noted that in that case, districts are guided by the state to conduct a committee-based review process involving external stakeholders, in conjunction with state-provided rubrics, in order to determine whether or not they meet various levels of distinction around their computer science efforts. While the state education agency does not verify each school, it does conduct random audits in order to highlight examples of strong or weak examples of evidence used by schools in their self-evaluation and self-identification process. These self identifications are then visible on a school's profile within the state data dashboard.

Linkage to federal policy and ESSA STAR ratings. Related to the above approach, one mechanism of accountability did come up in multiple conversations with district leaders that they felt had more "teeth," and this was public ratings linked to federal compliance with federally-mandated Every Student Succeeds Act (ESSA) plans in their state. A small handful of states have incorporated priorities around CS education in their state ESSA plans (Code.org, n.d.), which require reporting on schools through public reports, often in the form of school report cards. It should be noted that in these cases, states were receiving funding through ESSA, serving as a system of accountability. ESSA funding and Perkins IV funding for career and technical education both have very specific reporting systems tying funding to data and end of year reports.

In one state that had included teaching computational thinking at the middle school level in its ESSA plan as part of what counted as a "well rounded curriculum" for schools, administrators noted it as something they saw as motivating to them and their colleagues, regardless of commitments to equity in CS education:

> *I feel like these Star Ratings definitely lit in a fire under the schools who are not offering those courses. Schools were definitely like, "Why are we getting dinged on this and how can we get a better score?" The ratings have really helped to put some teeth into Computer Science. Schools get dinged when they don't offer any Computer Science now. So for them to get some boosting in their ratings, they're starting to kind of scramble to get some sort of Computer Science offerings. So that's helped us get closer to where we want to be but by no means are we there.*

As in other cases, the repercussions of public transparency were noted by these administrators, who themselves saw this as positive in terms of promoting equity in CS education and advancing towards state goals:

> *It's a public rating that you're getting and that parents and communities are looking at, so I think it's just a nice transparent way to show what's being offered in our schools. Anything that can get more exposure to courses like Computer Science for me is a plus. It's now going to become more obvious to the public if you don't have it.*

One district leader in this state did, however, note that in the state's current rating system it was not clear why a rating around access to a well rounded curriculum might be low. She shared that if a report card had five stars "they are probably offering computer science," but that it did not directly indicate whether or not computer science was offered. This may suggest that great clarity on how computer science offerings affect such public ratings may improve this accountability mechanism.

Weighted funding formulas. In at least one state where CS education is designated as part of career and technical education (CTE), associated funding formulas represent an incentive to offer and enroll students in CS. In that state, for CS, as with all CTE courses, schools receive approximately $300 in additional funding per student enrolled, on top of Perkins IV federal funds associated with CTE. Career and technical education programs are also more carefully monitored to ensure appropriate fund distribution, and the clearly defined courses and sequences that count as CTE coursework are an example of accountability and alignment being closely tied.

Linking state-level grant funding to implementation progress. In some cases, states with targeted funding opportunities around CS education required district applicants to show evidence of progress around adhering to state CS standards, or around other CS-related activities, as in the case of creating strategic plans noted in section 3.2, as part of the application process. The use of such evidence in funding decisions creates a direct incentive for districts to make progress around policy goals.

Standards of accreditation violations. The most high stakes form of enforcement around state CS education mandates found in our analysis was standards of accreditation violations. Such violations are only possible in states where, for example, offering CS at various levels is required legislatively, with state-funding formulas tied to those requirements. One state leader described the nature of the repercussions around such violations like this:

> *Our school funding formula is based on a [set of required credits], because of our accountability cases and statutes. So schools are now receiving funding to implement computer science. So if they do not do it with validity or within the regulation, they have received funding to do so. We can bring them up under standards of accreditation violation, and we have. [In that case] a principal of a school that is brought up on a probationary standards of accreditation violation, [and] unless they have a really good reason, they're not the principal the following school year.*

As noted earlier, it is possible for any actor to notify state education agencies of accreditation violations, including teachers, parents and other community members, making this an avenue of accountability that has broad access where it's applicable. However, we did not examine how likely it is for schools to be brought up on such violations, and did not find evidence in discussions with district leaders where it is applicable that it is something they are oriented towards or concerned about, suggesting that it may be an enforcement mechanism that is less likely to be utilized by states, even when it is an option.

4.5 Conclusion

In this section, we explore in more depth questions of accountability as a component of state CS education policy systems. Rooted in an acknowledgement of the deleterious effects of punitive, high-stakes accountability policies in education, we first offered an alternative perspective on accountability based in policy scholarship that views it through the lens of collective responsibility for learning, one that aims to center support for internal accountability within school systems while maintaining external accountability through monitoring, transparency, and selective intervention. We then explored perceptions of district administrators that noted their experience of external accountability in CS education as limited, both in states we determined as having stronger external accountability, as well as those we saw as having weaker external accountability. The final sections explored current mechanisms for developing accountability around state CS education goals through monitoring, incentive and enforcement mechanisms.

Overall, we encourage those responsible for state policy to approach questions of accountability with a high degree of care given the history of accountability's role in education. Central to doing so, and a theme we will explore in section 6, is the involvement of school-based actors in the process of determining the nature of all aspects of CS education policy, including those related to alignment and accountability. Although mechanisms for accountability can be important for relative prioritization of initiative goals, the design and execution of those goals and eventual accountability measures without critical representation from the most underserved communities can easily lead to unintended consequences.

5

Data, Equity and State Policies on CS Education

Data plays a critical role at the intersection of accountability and alignment in the implementation of state CS education policy. As seen in figure 2, section 2, data, along with other forms of monitoring, serves to shed light on what progress is being made, but also acts as a feedback loop to improve policy mechanisms, and, in some cases, trigger accountability actions. But the term "data" itself is broad, and just like an artist can use the same underlying components (e.g. paint, canvas, brushes) to construct different images, so too can data "paint different pictures" at the hands of those who collect, represent, and communicate with it. When viewed, data is represented through the lens of the aggregator. Choices of what data to include, how to disaggregate it, and how to display it makes a critical impact on the way teachers, school and district leaders, and advocates understand local CS education implementation and the goals they should be pursuing within implementation support efforts.

The use of data has become an important part of understanding any policy or implementation reform effort in education. It serves as a critical tool and resource in any implementation that has equity or broadening participation at its core, ideally shedding light on existing inequities and pointing to schools and districts that need more resources. Essentially, it is impossible to understand if a particular implementation is reaching intended goals and driving change without measuring the system against a metric critically aligned with desired equity outcomes.

Data has been used in education both to motivate new policies, and to implement them. Consider the trajectory of subject-based assessments in Math and ELA in the United States over the last 30 years. First, SAT and NAEP[6] scores showed regional inequities in student academic achievement, and the U.S. Department of Education instituted the "No Child Left Behind" Act in order to promote the use of research-based practices and hold states accountable for a minimum bar of education—to strive for equity. Although the law was enacted with a desire to reduce inequities in educational outcomes, there were significant flaws in the gap between policy and implementation and the stated goals of the policy, most notably few resources with which to support alignment and implementation on the ground. Additional efforts aimed at regional equity in educational outcomes include continued data monitoring (ESSA) and attempts to standardize learning outcomes in different states (Common Core). The assessments, and subsequent data, have been criticized for prompting "teaching to the test" in an abandonment of the very research-based practices advocates hoped to promote (Koyama, 2011).

Clearly, the history of education reform shows that data and data-based policy can have unintended consequences.

Although in other subjects there is a movement in education reform centered on the use of data to inform practice and implementation (Marsh, Pane, & Hamilton, 2006), CS education still lags behind in both readily available data or even accepted instruments used to measure the quality of implementation (McGill, Decker, McKlin & Haynie, 2019). Currently, the most often used metric of CS equity and participation at the national level is student participation and pass rates of the Advanced Placement Computer Science Exams (Collegeboard.org, n.d.; Ericson, 2019). Yet data-related participation in an elite, advanced exam is destined to be flawed in its representation of the full picture of access and participation. States, districts, and even schools are struggling to identify measures that will produce consistent, reliable, meaningful data to inform the question of whether computer science education is being implemented with equity.

Recent national reports, including the 2018 NAEP Technology and Engineering Literacy assessment, the 2018 International Computer and Information Literacy Study (ICILS) study, and the National Survey of Science and Mathematics Education, which included computer science in 2018, highlight the inequities in educational outcomes between students of color and their White peers (NCES, 2019, Yuquin, 2017), between students in more and less affluent schools (NCES, 2019), and availability of CS coursework and well prepared teachers in under resourced schools (Banilower et al., 2018). These studies, while helpful at a national level, are delivered to representative

[6] National Assessment of Educational Progress

samples of students in the United States and make regional monitoring difficult. They offer policymakers insight into what problems may exist, but cannot pinpoint individual schools or districts who are not reaching equity goals regarding CS education.

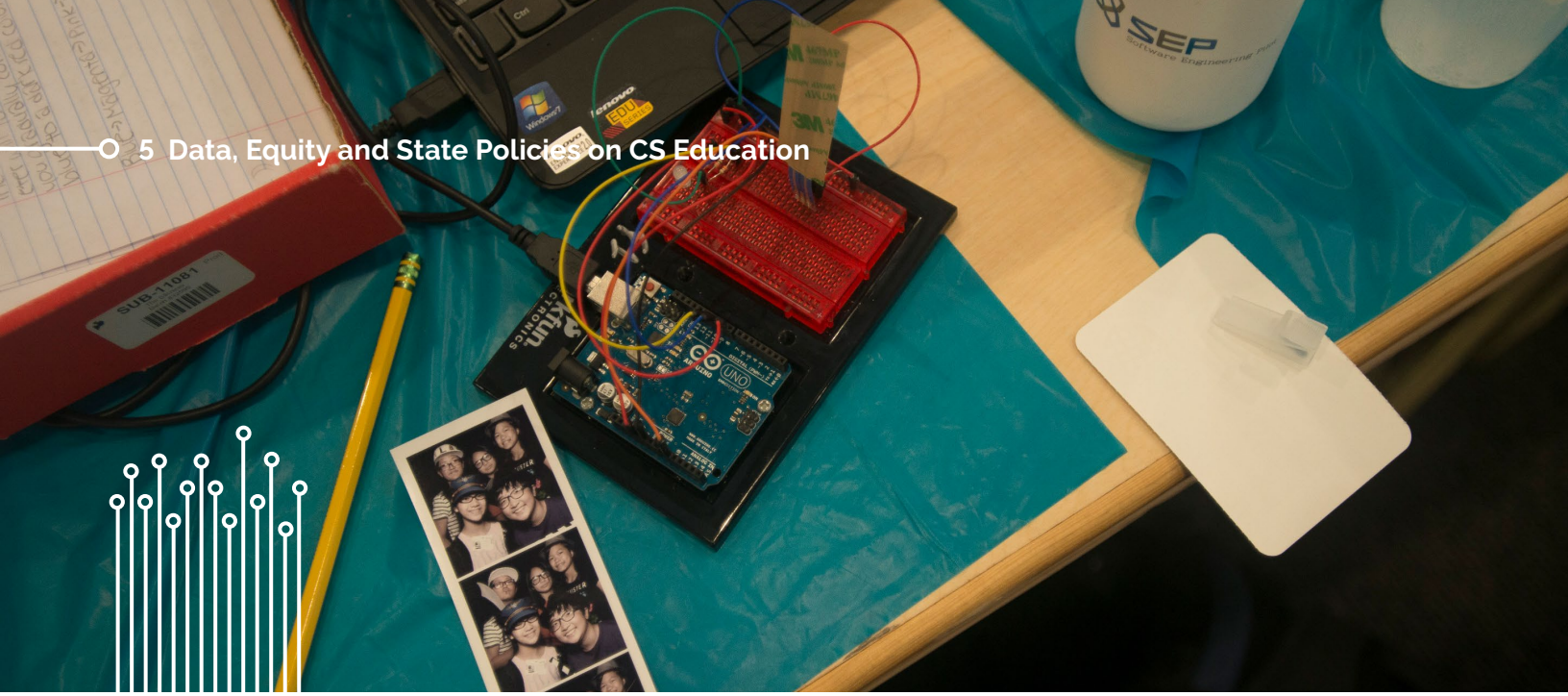
In this section, we explore how data is collected in the context of state CS education policy and for what purpose, how it can be used to evaluate different facets of equity in the implementation of CS education, what types of data we can collect, and the opportunities that data hold for policy development. This section highlights how regional data as well as state data can inform state-level teams, as well as how local data can provide important cues to schools about how to improve.

5.1 Multiple Measures, Multiple Purposes

Within broader research on education policy implementation, a widely held perspective is emerging that data and measurement efforts should not simply be used as a form of accountability—with high-stakes tests being the quintessential example of this—but should rather encompass a wider range of possible purposes and designs, most notably as a support for improvement processes at both state and local levels.

We noted in sections 4.3 and 4.4 various accountability mechanisms in state CS education policy that are data-related. However, as many leaders in improvement science within education note, data gathered for improvement purposes is likely to take different forms than those gathered for accountability purposes (Bryk, Gomez, Grunow, & LeMahieu, 2015). Additionally, improvement data should also be decided on and used in different ways from accountability data. As such, in order to act as a support for improvement, instead of solely accountability, both the "what" and the "how" of state data must look different.

In terms of "what" data is needed, we will explore more deeply in section (5.3) forms of data related to CS education, but we can take inspiration from other areas of education policy. One prominent idea emerging within education policy scholarship and practice is that of "multiple measures"—focusing on collecting a wider range of data about schools that tell a more complete story about the nature of school quality and students' learning experiences (Bae, 2018). Outside CS education, such approaches advocate collecting data on areas like student engagement, socio-emotional learning, citizenship, opportunities to learn, graduation rates, career readiness, transition to post-secondary opportunities, school climate, attendance rates, and teacher qualifications (Bae, 2018, Schneider, 2017). These multiple measures can be seen in the data collection efforts of the National Center for Education Statistics, including the National Assessment of Educational Progress, Early Childhood Longitudinal Studies, Common Core of Data survey, and the Schools and Staffing Survey. Each of these instruments collects national information regarding a variety of educational outcomes. Additionally, there are an increasing number of national assessments, such as the National Survey of Science and Mathematics Education, which include CS as a part of their instrument, allowing for representative data about CS course taking and outcomes (Banilower et al, 2018). However, the application of multiple measure approaches to state and district level policy data can allow for more effective efforts around improvement and equity.



If the idea of "multiple measures" speaks to the "what" of state education policy data, another emergent approach speaks to the "how support for and use of both state and locally determined indicators, ones decided upon by school districts themselves. Rather than measurement regimes that are purely top down, this mixed paradigm within state education policy creates opportunities for local education agencies to determine and identify their own measures. This allows for greater flexibility and responsiveness to local need and context as well as greater ownership among districts, while also maintaining the viability of states being able to see how policy is playing out equitably through state-required indicators. Locally determined indicators are an important component of diagnostic data that can be specifically tuned to the implementation approach chosen by local school and district leaders, allowing them to align their own locally determined indicators with the particular outcomes they are focusing on. Broadly, the approach of states supporting inclusion of local indicators within reporting again creates more avenues for those within schools to have "a seat at the table" in policy contexts, a theme we explore deeply in section 6.

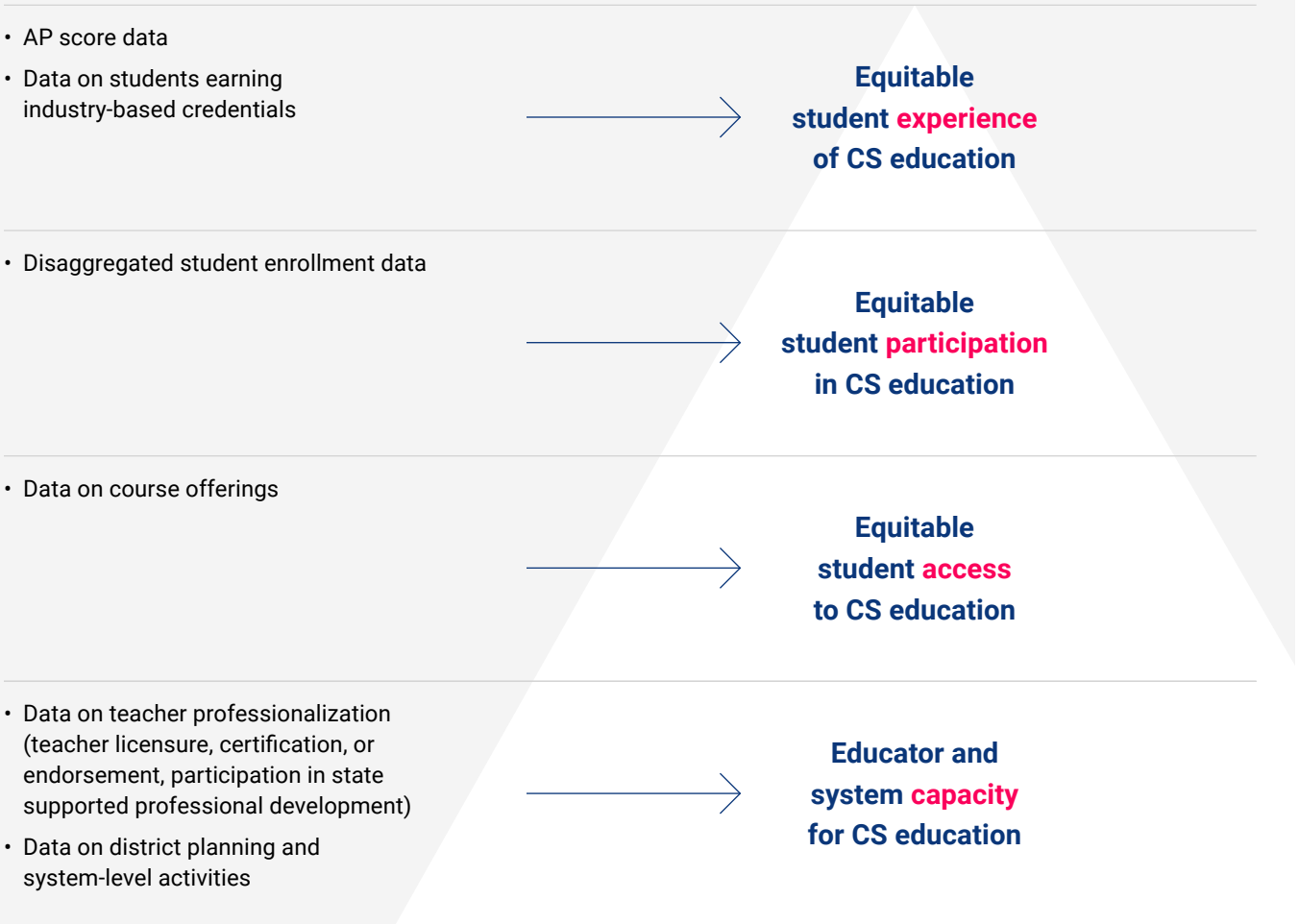
All of the above—shifts in both the "what" and the "how" of data—aim to serve purposes of *improvement*, not simply accountability. Such formative uses of data to help districts positively change their approaches to meet learning goals are again reflective of contemporary policy scholarship that emphasizes a balanced approach that includes both accountability and alignment and support mechanisms in order to meet equity goals.

Shifts in how we think about both the "what" and the "how" of CS education policy data aim to serve purposes of ***improvement****, not simply accountability.*

5.2 What Should State CS Education Data Tell Us About?

If current policy scholarship, noted previously, points to the importance of gathering multiple forms of data in order to understand policy implementation in schools and districts, then emergent work within the CS education field points us towards what this might look like around computing education. In this section, we share how the CAPE framework (Fletcher & Warner, 2020)—focusing on issues of capacity, access, participation, and experience—can guide states in terms of possible data sources that can support equitable CS education implementation. Figure 4, below, provides an overview of what these data might look like.

Figure 4: Application of CAPE equitable policy framework (Fletcher & Warner, 2020) to possible state-level data collection around equitable Computer Science education.



Data on student experience in CS education. There are two critical components to student experience in CS education—content knowledge and student interest and engagement outcomes. Stated simply, content knowledge is what students learn in a course, and can often be measured by content assessments such as the AP Computer Science exams or career and technical education end of sequence exams. Student interest and engagement outcomes are the way a student perceives their participation in the class, belongingness, and importantly for CS education programs, their desire to persist or take future coursework.

Data on student content knowledge outcomes is difficult to collect at scale due to the distributed nature of education in the United States as well as its lack of standardized assessments for CS education. Currently, the most widely used assessment of student content outcomes is the Advanced Placement Computer Science exam, which has broad reach as a nationally administered exam. As stated previously in this report, there are challenges with using an elective and highly selective course as an indicator of educational equity. Other opportunities to collect broad content outcome data are CTE industry-based certifications, which may vary significantly from school to school, as well as federally funded research projects for specific curriculum (e.g., Exploring Computer Science, Goode & Chapman, 2018) which also are not universal in implementation or participation.

Data on student experience related to interest and engagement is even more difficult to obtain at scale. Researchers who collect such data often use self-created instruments that do not allow for multi-state comparisons, and depending on the goals of the funded research may not explore the same constructs. Enrollment data for students (discussed further below) might be applied to understanding student experience in CS education by offering indicators that show where more focus is needed by looking at participation in sequences of courses, drop out rates, enrollment in electives after required courses, or even the relative declaration of post-secondary majors. These participation data, taken together, might be used as lagging indicators of student interest and engagement in CS courses.

Data on student access to CS education. Data on student access is typically gathered via course codes that districts submit related to their offerings. While ideally these data should provide a state with a clear picture of what courses related to CS are currently being offered in a given school, high variability on both the definition of course codes and their application by district staff means that such data can often be fraught with validity issues, as noted in section 4.3. In section 6.2, we explore a case of how a state dealt with this issue using a participatory process with district and school-based faculty to create more consistent course codes for CS.

Data on student participation in CS education. While having general numbers about how many students are participating in the CS education learning opportunities available within schools is an important starting point for states, equity priorities mean that states must move beyond this to collect more granular data related to sub-group enrollment in CS education courses. Existing policy advocacy by Girls Who Code

(Girls Who Code, 2019) has recommended that reporting requirements by states include mandates on reporting sub-group enrollment data related to CS education participation, aiming to actively and accurately chart progress and challenges around reaching groups that have been historically excluded from CS education.

The definition of underrepresentation in computing is often understood to include students of color (Black, Latinx, and indiginous students) and young women. The National Science Foundation and other organizations, including CSforALL, recognize that groups that have been historically marginalized within computing cultures and career sectors not only exist by broad ethnicity and gender-identity lines, but also include students from rural communities, students of low socio-economic status, micro-populations within larger ethnic groups, and students with disabilities.

For example, Asian-americans as a broad group are not perceived as being underrepresented in technology careers or STEM majors in post-secondary education; however, micro-populations, including Asian-Pacific islanders, often lack access to courses or degree programs at the same rate as other students in the communities where they exist in the United States. Individual municipalities may have different population density of ethnicities or subgroups that are not participating in elective computer science classes at a rate equal to their community representation, and, therefore, individual states and regions should consider the local meaning of subgroup data on CS course enrollment, in addition to the large national populations mentioned when discussing representation in CS careers and post secondary education pathways.

Data on teacher and system capacity for CS education. In order for high quality learning experiences to happen, courses to be offered, and students to equitably take advantage of them, districts must build capacity not only of teachers but their broader instructional systems. Data related to capacity can vary, but states do have a number of starting points that have been charted through existing work.

In focusing on teacher capacity, data should be able to speak to how well teachers in a state are becoming professionalized with regards to CS education. This can of course mean having accurate data, in states where it's applicable, on teacher licensure, certification, and/or endorsement related to CS education. But beyond this, given that many states directly offer or support intermediaries to offer professional development around CS education, participation data on these opportunities can provide an additional lens on what professionalization around CS education looks like in a state.

Questions of measuring "system" capacity at the district level, going beyond teachers, becomes somewhat more complicated. For states that offer or support district strategic planning processes, as explored in section 3.2, such processes provide an opportunity to not only gather data on which districts are participating and potentially which actors within a district are part of planning teams, but also to gather data on what forms of visions and goals are set around CS education locally.

In contrast to course code and enrollment data, which more centrally speak to outcomes in terms of student access and participation, interviews we conducted with state leaders show that some

are gathering various forms of documentation and data around district planning and early stage implementation, areas that can surface early indicators of progress. While submission of strategic plans themselves is one form of such documentation, some state leaders indicated that they were in the process of collecting survey data related to district planning and early stage implementation work. In these surveys, they were aiming to gather evidence on indicators like CS leadership team formation, vision development, utilization of external resources, and self-efficacy around CS education implementation of those involved in planning. Broadly, much work remains to be done when it comes to creating consistent metrics around systems-level capacity for CS education, and we encourage states to work collaboratively, alongside researchers focused on CS education district change processes, to develop and test viable measures.

5.3 Forms of Data Documentation in State CS Education Policy

Just as there are many forms of data on CS education policy implementation that might be collected, as noted in the previous sub-section, state-level actors have many options available to them when it comes to communicating these data to stakeholders and broader publics. We explore a number of these approaches in this section, including landscape reports, regional data profiles, and data dashboards.

Landscape reports. In its work with state-based teams, the ECEP Alliance has encouraged and supported the practice of developing state landscape reports, which aim to document the state of CS education capacity, access, and participation, with a particular focus on making transparent any disparities in representation for groups traditionally excluded from computing education such as women, students of color, students with disabilities, students from families dealing with socio-economic challenges, or other underrepresented populations specific to a state.

Landscape reports often also address issues such as current CS education offerings, state policies impacting CS education, availability of teacher professional development, current teacher certification approaches, and other areas germaine to the CS education agenda. These reports are often developed in partnership with actors outside of government agencies, such as higher education and nonprofit researchers, as well as the government employees. The shared work of producing such reports can foster clarity around definitions and goals, mutual understanding of desired outcomes, and then, once released, offer a critical basis for decision-making around policy and implementation.

The ECEP Alliance sees landscape reports as a critical step in their five-stage model for changing a state. Landscape reports tend to take a view that's broader than simply reporting on student participation or instructional outcomes; they also include community factors such as regional employers, graduation requirements, internship opportunities, and post-secondary institutions with appropriate programs. Critically, ECEP emphasizes that landscape reports should not be a "one and done" form of documentation. Instead, the creation of landscape reports should be done in an ongoing way, providing a way to pull back, assess progress and challenges within a state, and set a direction for future work that addresses current and projected needs.

Regional data profiles. Although states are a useful fiscal and policy unit of disaggregation, they often encompass regions that are very different from each other. Regional data profiles around CS education are an effective means with which to identify challenges to implementation within particular geographic areas in a state. For example, a rural region may have difficulty connecting to reliable WiFi in multiple classrooms at once, but recommended curricula all involve video lessons or stable internet connections. This challenge may not be the same as one faced by an urban center. By providing regional data profiles, like the ones in Texas (see case example below), policy actors and CS education advocates can identify targeted strategies to increase participation in computing that meet the needs of particular localities.

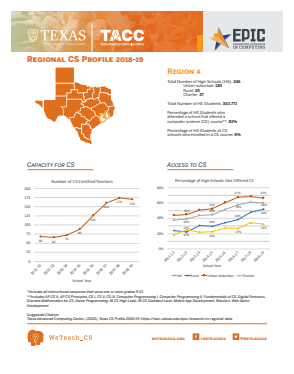
Case example: Texas

Creating Regional Data Profiles to Support Targeted Improvement and Accountability

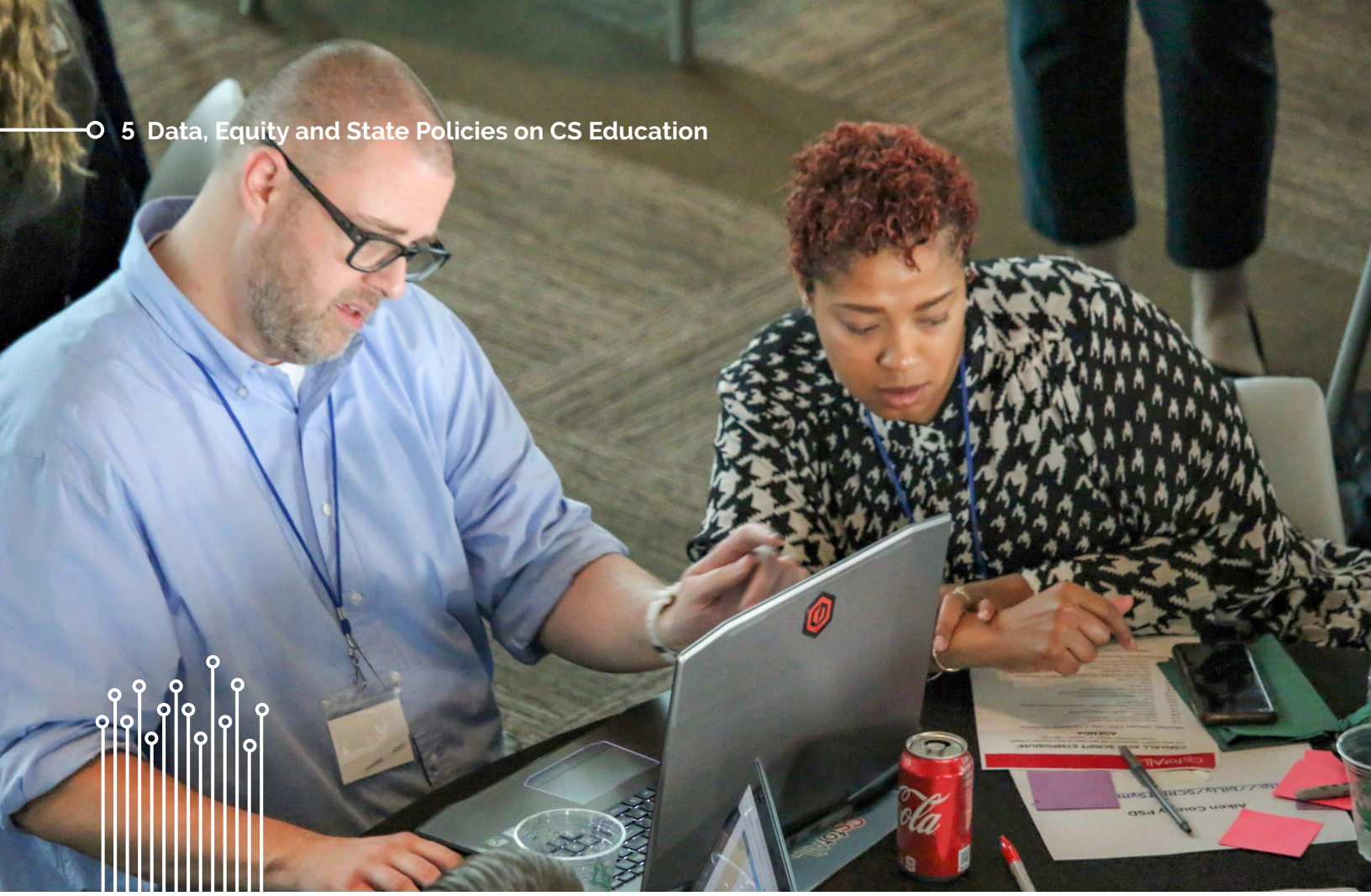
In Texas, the Expanding Pathways in Computing (EPIC) initiative at the University of Texas-Austin supports a range of projects aimed at advancing equity in CS education within the state, as well as nationally.

As part of these efforts, it's created CS profiles for the entire state, broken down into 20 regions. Within each profile, an overview is provided (see right), which includes general descriptive data about the region, including numbers of districts, high schools, and high school students. It then brings in data on CS education access and participation in the region, how those numbers have changed over time, and the region's percentages of students from low socio-economic backgrounds, female students, and Black, Latinx, and Native American students who, historically, have been marginalized in computing. Additionally, the profiles include the proportions of students with disabilities. All the data collected is up-to-date as of the 2018–2019 school year.

Beyond these overviews, each regional profile also includes related data on each district and associated high schools in the region in terms of student participation in CS courses.



Forms of data documentation that provide this level of granularity, both in terms of access and participation, but also by region, support the goals of improvement and accountability, making clear where progress has and hasn't been made, so that greater resources can be targeted where they're needed while also providing public transparency that can spur action by those working in schools and districts.



Data dashboards. In addition to static reports or profiles, some states are implementing data dashboards, common in many other areas in education. Well designed dashboards not only support prepared visualizations or data tables, but also the ability to manipulate the data. Dashboards provide a way for the user to create individual perspectives on the data and answer questions at both a macro and micro level. Data dashboards in education are not new, and have been used for school report cards, to monitor the progress of schools against statewide goals, and to help communicate priorities. As described in section 4.4, state and district leaders felt the ability to compare data with neighboring districts was an important accountability mechanism.

5.4 Crosscutting Challenges and Opportunities in State CS Education Data

Data and "what counts" as CS. One notable issue related to state and district data around CS education is the challenge of accurately defining what constitutes a CS education offering, and how existing data collection infrastructure and routines can support validity in data collection in areas such as course offerings. Processes of applying appropriate course codes, and building capacity of district and state level staff to identify CS courses based on state standards are currently areas of attention in multiple states (see the example in section 6.2). This challenge is not only related to the reality that many computing-related instructional areas—teaching computer applications, keyboarding, and digital citizenship—often get conflated with CS education (as noted

in section 3.1), but also that many approaches to teaching CS focus on integration with existing subject areas in addition to creating "stand-alone" courses, creating categorization issues. Additionally, questions of whether areas like robotics, web development, or courses that address a subset of core concept areas laid out in the K–12 CS framework add further complexity to the question of what should "count" as a CS course. The rigorous alignment of state standards to course descriptions or course codes can help ensure data accuracy.

This is another example in which data and policy intersect with the need for clear communication and equity-aligned goals and values. What counts as computer science for the purpose of assigning course codes is only the first part of an equity conversation around access to and rigor of computer science learning. For example, early in the movement to bring computer science to all students, many teachers and administrators said they "taught" computer science in the school, but upon further questioning indicated that they were referring to Microsoft Office tools, using the Internet, or keyboarding skills. While these are fundamental skills that cannot be ignored if we hope to close the digital skills gap, they do not represent computer science instruction (Seehorn & Clayborn, 2017). Because computer science is a relatively new discipline, there is a well documented misunderstanding as to the difference between instruction in technology (keyboarding, word processing software) and computer science. Until recently, there were very few state standards for CS education (Wison, Sudol, Stephenson, & Stehlik, 2010), and many current teachers did not receive computer science instruction themselves as a part of their schooling. The growth of state standards in CS is important, since some states use standards to assign course codes, while other states may rely on more narrative course descriptions or even course titles to align instructional content with course topics.

During interviews, state leaders referenced state course codes and data systems, with a common theme surfacing that codes themselves didn't provide transparency to a deeper understanding of what was being implemented or the nature of CS being taught. As one state leader put it:

> *This was all about high quality, so what is high quality as opposed to just CS? And what does that mean, and how do we define it? And so the first definition piece of it, which again, wasn't really a rubric, more of a decision tree, is: Does it align to our standards in general? Does it fit in with the standards that we have that are passed in our state?*

Without clarity on which course codes align to computer science content, it is impossible to identify the capacity, access, or experience of school systems or students.

Teacher quality and capacity data. In order to effectively support implementation, it's important that state-level CS education collection efforts do not solely focus on students (course participation, sub-group enrollment, etc.) but also on areas like *opportunities to learn* (course offerings, out-of-school time opportunities), *opportunities for teacher professional development*, and *overall teacher preparedness*. This is important, given that many states have opted to not mandate teacher certification or endorsement in CS. Although the components used to set the minimum bar for

teacher certification often are associated with impact on student achievement (Sykes & Martin, 2019), there is not yet enough research on the elements of teacher certification for CS to determine a viable minimum bar for a certification pathway that will lead to equitable student outcomes. Additionally, as many teachers are retraining from other subject area specialties, there is also a need for data regarding both the *background* and *CS-specific preparation* of teachers.

The Every Student Succeeds Act, also known as No Child Left Behind, created a notion of "highly qualified" teachers. These teachers were expected to have had academic preparation for both the content they were teaching and specific pedagogical approaches for that content. Despite the changes prompted by that legislation, we know today that students of color, and students with low socio-economic status, are more likely to be taught by a teacher with a "shortcut" alternative certification (Darling-Hammond & Podolsky, 2019). CS education needs not only policy initiatives supporting the notion of certification, but also research to determine the necessary components of high quality teacher preparation in CS and the resulting impacts on equity and student outcomes.

Need for state level data coordination and capacity building. The five-stage model of state change from the ECEP Alliance (ECEP, 2020) specifically includes "Build and utilize data infrastructure to provide evidence to inform strategic broadening participation in computing (BPC) efforts" as a key component of state efforts to broaden participation in computing. Without centralized leadership at the state level when it comes to data, there are two potential challenges that impact local school systems' ability to meet policy goals. First, without centralized measures, it is difficult to make

comparisons across school districts and even state regions. We discussed in section 3.4 how state networks can increase their alignment with BPC goals for CS education, and those networks should have common measures to work with in network activities. Secondly, without centralized leadership, smaller or less resourced school systems may lack the human resources necessary to collect, analyze, and interpret data aligned to state goals.

Local education agencies see the importance of data, but often are hampered by the inaccessibility of data about where and how CS is taught. Because scheduling, course assignment, and course codes are assigned at the school or district level, state leaders are often left trying to understand what is being taught in each course and how individual courses or sequences align to policy goals. As one state leader put it:

> *Sometimes we just were not sure. We would get a little blurb description and that would be it. And we could look through some of their catalogs, especially the high school level, they have catalogs for students to go through, and we would be looking at that. And so we, myself and my data analysts that I also work with, went through all of that and we had a spreadsheet of so many across the entire state.*

CSforALL has also observed that many district leaders also do not have access to high quality data about what is being taught in their own schools. From 2017–2018, CSforALL collected over 1,000 goals set by district teams, and,

upon analysis, approximately 10% of the goals referenced the need to gather data on the landscape of CS in each team's district—surveying teachers or spending time collecting information about what was being taught and in what grade bands (DeLyser et al., 2019). As noted earlier, complicating the data is the integration of CS instruction into other disciplines, which will not always be apparent in course codes or labeling.

With decisions being made at the local level, data is sometimes inconsistent from school to school, and often hard to aggregate at the state level to understand the relative landscape of implementation. A key policy that may not seem to be connected to data, but was mentioned by a few interviewees, was the state-level position devoted to computer science. Having a single person or team responsible for the state-level definition of computer science and ensuring the curation and accuracy of the data ensures alignment from institution to institution and can allow for explicit goals around equity to be reflected consistently in all the data. As one state leader in a dedicated position around CS education shared:

> *Now, my team, whenever we go out and we meet with a principal, or a superintendent, and try to grow their program, we will have this information… I build out standards reports year after year, the same report that I see, and it has the data that I want.*

Envisioning data for improvement in state CS education policy. In the best cases, data that is collected carefully, accurately, and in alignment with equity goals makes the situation on the ground transparent. Additionally, data can be an important part of an ongoing improvement cycle, providing feedback for both policymakers and school leaders about ways to improve (Means, Padilla, Gallagher, 2010).

Even with the difficulty described above of obtaining clear information about how and what is being taught, data is perceived as a critical element of self-assessment and feedback for new implementation. Data is also necessary to justify ongoing spending by policymakers to support initiatives that promise to broaden the pipeline of students preparing for high-paying industry jobs. Unfortunately, the goal of a diverse workforce is often years, if not a decade, away from being realized from interventions at the K–12 level. Data can also be used to make decisions about what investments are high quality, and how to choose between available options.

In addition to providing transparency and feedback, data can also create pressure for schools and districts, as noted in section 4.4. Comparisons of data from different schools or districts can incentivize action, and, in some cases, integrating computer science into state level accountability systems can even encourage action by decision makers. When the data also includes a clear focus on broadening participation or equity, it helps guide decision makers to prioritize implementation that will make change responding to those numbers. For example, the data profiles from Texas shown previously allow for comparison between regions and allow individual schools to see how they're doing within a region, and Oklahoma's Champions of Excellence program creates visibility through acknowledgement on public report cards. The focus on BPC helps teachers and school leaders

understand that diverse participation is an important component of high quality CS education, that a specific focus on enrollment is important, and that being able to compare progress on this front is critical. As one state leader put it:

> *It goes back maybe on some level to the scorecard thing of what's public or available… I hear from plenty of districts that I've worked with that they just want to see where they stack up really, in relation to other districts, what they're offering, what their student involvement looks like.*

Data systems are an important part of the policy and implementation environment. How the data is collected, verified, disaggregated, and communicated can have important implications for whether equity-driven CS education policies are effective in moving state outcomes towards goals. Data is necessary for both alignment- and accountability-based policies and requires attention and investment for accuracy, consistency, and utility.

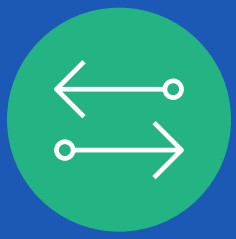
5.4 Conclusion

Data can play an important role in supporting both accountability- and alignment-based initiatives for equity in CS education. When considering how data can help inform policymakers, advocates, and implementers, understanding the definitions of what is being measured is just as important as understanding the numbers themselves. CS education is often difficult to measure directly due to a lack of prior integration into state data systems, lack of standardized assessment of student learning, and often misunderstanding or disagreement regarding what counts as CS.

The capacity to gather, aggregate, clean, and understand data needs to be invested in and built in order for individuals at the school, district, and state level to make the most use of data. Data can take many different forms, and each form needs to be aligned to the intended outcome of the policy implementation in order to provide feedback about the impact on students. In the collection of data, we should be sure to use multiple analysis and levels, such as the Capacity, Access, Participation, and Experience levels from the CAPE framework, to ensure that data is providing a full picture of the equitable implementation of CS.

6

Bidirectional Policy Development: Giving School Systems a Seat at the Table in CS Education Policy Conversations



Equity is an explicit focus in the CS for All movement, and is a core value that should, and in many instances, does, guide CS education policy. But equity is not only something that can be viewed as an *outcome* of policy, but also something that should be present in the policy *process*. How decisions are made and who has a chance to be involved in decision-making is itself an equity issue. We strongly believe that equitable policy development in CS education should give those in school systems a seat at the table, a perspective rooted in democratic ideals that value the participation of broad publics in co-determining how education can meet its aspiration to be a public good.

Instead of taking a down-top approach, CS education policymakers and implementers should take one that is bidirectional between policy and practice.

Within the context of policy development this means that instead of taking a down-top approach, policymakers and implementers should take one that is bidirectional between policy and practice. Concretely, this involves creating structures for participation, feedback, and collaborative decision- making. Such processes should involve those working within local education agencies, including administrators, teachers, coaches, and building leaders. And while, in this report, we only focus on participation by school system actors, the broader democratic ethos driving such approaches also means that states should attend to including all stakeholders—including families, community- based organizations, and, of course, students themselves.

Existing research on participatory approaches to policymaking in education note that doing so is not a simple task, and doing so well requires a great degree of intentionality. Marsh, Dhaliwal, Hall, and Polikoff (2020), in looking at efforts to involve broader publics in policy decision-making, highlight the need to invest in active communication, targeting of stakeholders, and capacity building for policy deliberation as key for equitable involvement in policy development.

Taking such bidirectional, inclusive approaches is not only important from the standpoint of "equity in process," but also "equity in outcomes"—school actors have lived experiences that inform perspectives on how policy and its implementation might go wrong, how it can effectively support teachers and students, and ways that it can balance the needs of state agencies with the realities of classrooms and school buildings. As one state CS leader we spoke with put it, "The more we can include those that are in the classroom and those that are the content specialists, the better off and the stronger all of the policies will be."

"The more we can include those that are in the classroom and those that are the content specialists, the better off and the stronger all of the policies will be."

6.1 Approaches to Inclusion of District Voices in CS Education Policy Development

Within the context of CS education policy, the use of statewide task forces, advisory groups, and community-based standards review processes can all be leveraged to elevate school-based faculty voices within processes of policy development. We note a number of those structures in section 3.4, which focuses on state-based network development as a strategy for alignment. However, the mere existence of these structures does not ensure that such voices will be at the table—there needs to be active and intentional outreach to those who might not otherwise be present.

We heard a number of perspectives from state leaders who reflected on the importance and value of involving district leaders in decision-making related to policy design and implementation.

Inclusion of dissenting voices. One state leader, in a broader discussion about various task forces and committees she convened around CS education policy, noted the importance of including district administrators who might challenge policy approaches:

> *Even those that won't necessarily agree, those are the ones that in particular, you want to make sure they're there. So I know sometimes when people pull these things together, they think, "Oh, well, we don't want to have that district or that person or whatever." But that's exactly who you do want because you do want to be able to work through those types of issues and get their feedback and have all of that upfront and in the process, rather than after the fact.*

She took the perspective that addressing concerns and adjusting plans by including those with dissenting perspectives was more productive in the long term, and would result in less course correction once implementation structures were put into place.

Open communication channels and strong relationships. State leaders noted the importance of having a variety of modes of communication, both formal and informal, as well as a strong set of relationships with districts in order to facilitate feedback and honest conversation. One state leader spoke about some of this relational infrastructure, such as an email listserv that he put in place, where districts could share not only questions but perspectives:

> *I would say our district leaders, and especially our teachers, do give a lot of feedback. That's one reason we started up our CS listserv, and I allow others to answer a lot of questions. I will go on there and answer questions. I use it kind of as a push out tool. But it's an active listserv—I also watch it for what kind of questions [are there], pulse, etc. My team is also responsible for going out to districts and bringing back information from them.*

This state leader also spoke about the importance of having more informal check-ins with district leaders when he was considering putting in place new supports and programs, ones that he didn't see as requiring something as formal as a task force or committee:

> *I'm going to have a video call with a small group, I'm just going to pick up the phone and call this superintendent or that principal. I'm going to call one of these superintendents that I know—they have a strong program, they're going to tell me the truth, and they'll let me know how it's going to positively or negatively affect them, and they're going to often make suggestions that I haven't thought about.*

One district leader also noted the importance of having relationships with state representatives during the process of policy design and legislation, with those relationships serving to act as avenues for feedback on policies that are under consideration:

> *We have a representative who's very active in education. I've known her for years, so I can feel free if there's a policy that's coming up, I'll talk with her about it.*

She noted that this kind of relationship worked in concert with more formal mechanisms for feedback on legislation, with her state department of education keeping her and other district leaders informed about potential policies that might impact her work, and associated public comment periods for new bills they might want to provide feedback on.

Avoiding "low value" participation structures. State leaders did note, however, that they took quite a bit of care when setting up participation structures such as committees that involved district leaders and educators, wanting to avoid situations in which people felt like their time was wasted. One state leader noted that in their experience, more broadly in education, some groups, once set up, had a tendency to spend time on trivial issues, with those involved then seeing participation as futile and time poorly spent.

Multiple state leads mentioned that they only moved to put in place these more formal structures when it was clear that there was a high-leverage problem that needed to be solved through a group process. As one shared:

> *It's not always easy to find the right person or the right fit for who needs to be there, and it sometimes slows down the process a little bit, but in the end, it strengthens those processes, because if you don't have those voices at the table to speak up, then you don't have that as part of your design process. You have to make sure that you're pulling in those people that are really going to truly help have these very rich discussions to be able to move forward in a way that you wouldn't have if you didn't have them as part of your process.*

Creating opportunities for school-based actors to participate in policy development, then, should not be done for its own sake. If structures are not high value, and, especially, if those involved don't see ways that their participation ends up actually being consequential in shaping policy development and implementation, these processes can result in less, rather than more, trust among those involved. And if such structures operate well and meet their goals of including the voices of school leaders in ways that substantively shape eventual policy, these policies themselves are likely going to be more effective, creating solutions that may more readily be embraced on the ground and thus help make progress on core policy goals. Finally, administrators who participate in shaping policies can, in turn, become advocates for those policies within their own peer networks of school and district administrators. A well informed district superintendent can help correct misconceptions of other superintendents or school leaders and explain the decision making and goals behind policy choices, creating another opportunity for alignment through communication mechanisms.

6.2 Examples of CS Education Policy Shifts through Inclusion of District and School Leaders

The impact of having school and district leaders involved in CS education policy development was evident across our data collection. Some of the examples we found were around substantial areas of policy implementation and decision making, while others can perhaps be seen as minor, but consequential in terms of supporting school systems to engage students in CS learning opportunities.

Development of a flexible CS credit in response to school discussions. One of the more consequential instances of school and district leaders being involved in policy development was Arkansas' design and adoption of a "flexible" computer science credit, which allows students to fulfill graduation requirements in a number of areas such as math, science, and technology by completing CS courses (Code.org, 2016). In sharing about how this solution came into place in his state, Anthony Owen, Arkansas' State Director of Computer Science Education, shared how school leaders shaped the decision:

I think the flexible CS credit is a good example of feedback that we got from the real world. Because the issue that we had prior to adopting the credit is the same issue that the vast majority of states out there are having—that it creates a rift when you're talking about CS as a math, versus a science, versus a CTE, and really that's what it is, it's versus. It creates a rift between those departments within the schools, it creates ownership, siloing, and everybody wants to say, this is mine, or no, it can't be this, because I'm a traditional math teacher and you're not going to water down what I've done. So really, the flexible CS credit was created because of a lot of the discussions we had with our schools, the real world implementation of it, and what it looked like, and us trying to find a solution to overcome those fears, those siloing of efforts and just that ownership piece that people had. Now, it's everybody's. And it doesn't matter what your previous background was.

The kinds of institutional realities related to departmental siloing and ownership are precisely the kinds of factors that can come to the surface through active engagement and involvement of district- and school-based leaders, who are able to see how things like credit policies are playing out on the ground, and can inform ways to address tensions.

School leader involvement in defining "high quality" computer science courses. Another consequential instance of policy development and specification came up in discussions around one state leader's process of defining what counted as a "high quality" computer science course. Conversations around "what counts" as CS are a central issue in CS education policy, and are reflected in broader, national challenges around data collection (e.g., Code.org, N.d.), and each state must contend with this question when it comes to issues of course classification codes (see section 5.4).

In this case, the state leader convened a task force around the issue, bringing together teachers and content specialists such as coaches, district leaders, and school principals to tackle the classification challenge.

> *Each member of the task force went off, after clearing up some of those definitional type things, and went through a spreadsheet of all of these course codes that have been submitted across the state and then took a look and said, "Okay, what do you think now counts?" Yes or no, zero or one, as a high-quality CS course? And then we looked across that, aggregated them, and then to see those that had made our cut score. So anything that was really low, we didn't start with and debating over what should be counted or not. And then we went through every single one of them together to figure out whether it should count.*

She went on to reflect on the ways that having this kind of involvement created opportunities to develop shared language, but also fill in her own knowledge gaps that likely would have otherwise been baked into the state's course classification scheme:

> *It's always interesting to go through that kind of process because if you didn't have them there, you just made the assumption based on the little short description that's given with the course code and you say, "Okay, that's it." And again, any local [district] can develop their own local codes and align it to any state-level course code, they still have the autonomy to do that. So you can very much just spend an hour talking about all of those kinds of examples, so you try to streamline that conversation and understand, "This is what the course code description is, this is how we're thinking about it." And you might realize that a given course really shouldn't be aligned to that code. What you're describing actually should go into this other bucket.*

Again, we see an example here of how the viability of coming up with policies that reflect and take into account local realities is contingent on direct involvement of those on the ground.

Shifting policy mandates around course requirements. In a final example, policy participation on the part of district leaders shifted to the nature of a state's mandate around high school CS course

offering requirements. In this case, rural districts raised concerns that proposed legislation was initially phrased in a way that meant that not only would a CS course have to be offered each year, but that it would have to "run" each year. A state leader recounted the situation:

> *They were going to be mandated that every high school had to have, not just offer, but they actually had to have a computer science course every year. That was changed because of rural districts. The representation of rural school districts said, "We can't. We can't get a whole classroom full [to run a course every year], so we have to rotate every other year in order to have cohorts of students come through." And that was something that wasn't even on our radar even though we know that and we can think through that, it wasn't something that we thought about until the policy was going through all those subcommittees and that's when it was changed. It was during the legislation session and during the subcommittee, and it was from those rural school districts' representation, who said this cannot go through as is.*

She went on to note that there was a trade-off that came with accommodating what those in rural districts saw as an inequitable policy design, resulting in what some might see as a less robust policy around CS course offerings across the state:

> *You, on the one hand. are trying to be equitable to make sure that they can meet the standard and be able to enact the policies, but on the other hand, your other districts now only have to offer [as opposed to implement].*

The concerns raised by the state leader around the shift in the policy mandate do echo some of the broader questions about the nature of accountability discussed in section 4 of this report, and highlight the challenge of designing policy mandates that are simultaneously viable and equitable in a wide range of school systems. Indeed, there may have been other possible policy solutions that could have addressed both concerns while maintaining a broader policy mandate around CS course offerings that promoted equity goals across the state. However, the instance does highlight what kinds of issues can surface, and ideally, be addressed, when district stakeholders have opportunities to voice feedback on emerging policies.

6.3 Conclusion

Throughout this report, we put forth the view that CS education policy is not only something that must focus on equitable outcomes, but also something that must see empowerment at all levels as an aspect of equitable state policy—the view of collective responsibility. In this section, we highlight how this applies to the policy process itself, arguing that policy development should be a bidirectional process and one that gives those within schools and district offices a "seat at the table."

As the examples we shared show, such participation spans both the legislative aspects of the policy development process, as evidenced in the examples shared around input from rural districts and the creation of a flexible CS credit, and the policy specification process, as evident in the example of a collaborative process determining what counted as a "high quality" CS course.

Involving those within schools in policy development is an end in and of itself: an expression of both the values of equitable process and the broader ideals of democratic participation that are at the heart of education. And beyond that, it also yields important outcomes in terms of policy implementation. Policies will ideally be stronger and more equitable as a result, communication about policy can occur through participatory policy development structures, and those involved are more likely to become advocates who can share the rationale behind state policy decisions and know the specifics of what they entail.

Overall, while taking such an approach might take more time and effort up front, we see participatory policy development approaches as likely to contribute to the long-term success of CS education policies at the state level.

7

Conclusion: An Opportunity for Policy Learning and Improvement in CS Education

Education policy around computer science has made significant progress in recent years. And, as many in the movement have acknowledged, the work to establish equitable CS education will be a marathon rather than a sprint. Given this, the field has a unique opportunity to not only learn quickly, but learn deeply about the ways it might structure policy in a way that is equitable in both its outcomes and its process.

The work to establish equitable CS education will be a marathon rather than a sprint. The field has a unique opportunity to not only learn quickly, but learn deeply about the ways it might structure policy in a way that is equitable in both its outcomes and its process.

This report offers a particular perspective on state CS education policy, one that aims to step back from seeing particular policies in isolation from one another or as simply items on a list of necessary supports, and seeks to instead view instructional policy as a coherent and aligned system with the whole being greater than the sum of its parts. Grounded in lessons from existing policy scholarship, the framework of balancing alignment and accountability aims to offer a broad view through which CS education policies can be considered in relation to one another, a view we hope will allow policymakers, advocates, and those in implementation roles to ask critical questions about how particular configurations of policies support their goals. By exploring how district and state leaders experience emerging policies of alignment and accountability, this report offers a view into the intentionality required to develop and implement effective CS education policy.

Central to the view offered in this report is the relationship between how data is collected and measured and the development of equity in state CS education policy. Data and measurement infrastructures provide the transparency that is necessary for continuous improvement and external accountability, and we highlight the importance of data with regard to both these purposes.

More broadly, we argue for the central importance of involving and listening to those who do the work within school systems as part of the CS education policy development process. In its own small way, this report attempts to not only argue for this, but, in highlighting the voices and perspectives of administrators we spoke with, to index this value itself.

The other central value we hope readers will leave with is the possibility of seeing CS education policy as a space of learning and improvement. In offering a conceptual framework through which to analyze policy, we hope to develop shared language that can be used to compare notes, share lessons, and debate and discuss the work happening in this area across the United States. Indeed, little progress will be made if the field doesn't have both an intellectual as well as an institutional infrastructure for doing so. The work done by our colleagues in the ECEP Alliance, in the Code.org Advocacy Coalition, in CSTA chapters across the country, and in dozens of partnerships between researchers, policymakers, teacher leaders, administrators, and many others is part and parcel of that intellectual and institutional infrastructure.

Our hope is that this report can play some small role in advancing broader discussions in our field about what equitable and effective CS education policy looks like at the state level, knowing that this is something that no state agency, administrator, or researcher can accomplish alone.

References

Amrein, A. L., & Berliner, D. C. (2002). *An Analysis of Some Unintended and Negative Consequences of High-Stakes Testing*. Education Policy Research Unit, Education Policy Studies Laboratory, College of Education, Division of Educational Leadership and Policy Studies, Arizona State University.

Au, W. (2007). High-stakes testing and curricular control: A qualitative metasynthesis. *Educational Researcher*, 36, 258–267.

Augustine, C. H., Gonzalez, G., Ikemoto, G. S., Russell, J., & Zellman, G. L. (2009). *Improving School Leadership: The Promise of Cohesive Leadership Systems*. Rand Corporation.

Bae, S. (2018). Redesigning systems of school accountability: A multiple measures approach to accountability and support. *Education Policy Analysis Archives*, 26, 8.

Baker, B. D., Farrie, D., & Sciarra, D. G. (2016). Mind the gap: 20 years of progress and retrenchment in school funding and achievement gaps. *ETS Research Report Series*, 2016(1), 1–37.

Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). *Report of the 2018 NSSME+*. Horizon Research, Inc.

Barron, B., Martin, C.K., Takeuchi, L., & Fithian, R. (2009). Parents as learning partners in the development of technological fluency. I*nternational Journal of Learning and Media*, 1(1), 55–77, https://doi.org/10.1162/ijlm.2009.0021.

Blikstein, P., & Moghadam, S. (2019). Computing education literature review and voices from the field. In S. Fincher & A. Robins (Eds.), *The Cambridge Handbook of Computing Education Research* (Cambridge Handbooks in Psychology, pp. 56–78). Cambridge University Press. https://doi.org/10.1017/9781108654555.004.

Bryk, A. S., Gomez, L. M., & Grunow, A. (2011). Getting ideas into action: Building networked improvement communities in education. In *Frontiers in Sociology of Education* (pp. 127–162). Springer.

Bryk, A. S., Gomez, L. M., Grunow, A., & LeMahieu, P. G. (2015). *Learning to Improve: How America's Schools Can Get Better at Getting Better*. Harvard Education Press.

Chiang, H. (2009). How accountability pressure on failing schools affects student achievement. *Journal of Public Economics, 93*(9–10), 1045–1057.

Ching, D., Santo, R., Hoadley, C., & Peppler, K. (2016). Not just a blip in someone's life: Integrating brokering practices into out-of-school programming as a means of supporting and expanding youth futures. *On the Horizon*, 24(3), 296–312.

Cobb, P., Jackson, K., Henrick, E., & Smith, T. M. (2020). *Systems for Instructional Improvement: Creating Coherence from the Classroom to the District Office*. Harvard Education Press.

Coburn, C. E. (2003). Rethinking scale: Moving beyond numbers to deep and lasting change. *Educational Researcher, 32*(6), 3–12.

Coburn, C. E., Hill, H. C., & Spillane, J. P. (2016). Alignment and accountability in policy design and implementation: The Common Core State Standards and implementation research. *Educational Researcher, 45*(4), 243–251.

Coburn, C. E., & Russell, J. L. (2008). District policy and teachers' social networks. E*ducational Evaluation and Policy Analysis, 30*(3), 203–235.

Code.org, Computer Science Teachers Association, & Expanding Computing Education Pathways Alliance (2019). *2019 State of Computer Science Education.*. Retrieved June 14, 2020 from https://advocacy.code.org/.

References

Code.org, CSTA, & ECEP Alliance. (2020). *2020 State of Computer Science Education: Illuminating Disparities*. Retrieved November 13, 2020 from https://advocacy.code.org/stateofcs.

Code.org. (2016). *Issue Brief (December 2016 update): Computer Science Flex Credit*. Retrieved April 27, 2020 from https://docs.google.com/document/d/1ksKYCmYVK7cNS6Pfc7OL9Cre2SsFsWW-TyvW7faPPIZc/edit#

Code.org. (n.d). *Putting Computer Science Into State Plans for the Every Student Succeeds Act*. Retrieved April 25, 2020 from https://code.org/files/CS_and_ESSA.pdf.

Code.org (2020). *Every State Is a Local Control State: A Look at the Intersection of CS Standards and Accountability*. Retrieved April 27, 2020 from: https://docs.google.com/document/d/1vLQL-VU5gqvoNEyvAP0ERYWweRB0gx5fxoi7bAG_t_hI/edit.

Code.org. (2019). *Nine Policy Ideas to Make Computer Science Fundamental to K–12 Education*. Retrieved April 7, 2020 from https://code.org/files/Making_CS_Fundamental.pdf

Code.org. (n.d.). *Defining a Foundational Computer Science Course*. Retrieved April 27, 2020 from https://docs.google.com/document/d/1i8CTNtn7hgzCtMw1x_zV14IDnS5LuA22JcVTwQyShoI/edit

Code.org. (n.d.). *State Tracking of 9 CS Education Policies*. Retrieved April 30, 2020 from https://docs.google.com/spreadsheets/d/1YtTVcpQXoZz0IchihwGOihaCNeqCz2HyL-waXYpyb2SQ/pubhtml

Cohen, D. K., & Hill, H. C. (2001). *Learning Policy: When State Education Reform Works*. Yale University Press.

Computer Science Teachers Association. (2005). *Computer Science K–8: Building a Strong Foundation*. Computer Science Teachers Association and Association for Computing Machinery, Inc.

Cottom, T. M. (2017). *Lower Ed: The Troubling Rise of For-Profit Colleges in the New Economy*. The New Press.

Darling-Hammond, L., & Podolsky, A. (2019). Breaking the cycle of teacher shortages: What kind of policies can make a difference? *Education Policy Analysis Archives*, 27, 34.

Dee, T. S., Jacob, B., & Schwartz, N. L. (2013). The effects of NCLB on school resources and practices. *Educational Evaluation and Policy Analysis, 35*(2), 252–279.

DeLyser, L. A., & Wright, L. (2019, July). A systems change approach to CS education: Creating rubrics for school system implementation. In *Proceedings of the 2019 ACM Conference on Innovation and Technology in Computer Science Education* (pp. 492–498).

DeLyser, L. A., Wortel-London, S., Wright, L., & Bora, A. (2019, July). Understanding our human resources: district leadership efforts at understanding CS education implementation in their own buildings. In *Proceedings of the 2019 ACM Conference on International Computing Education Research* (pp. 297–297).

DeLyser, Wright, Wortel-London, & Bora. (2020). Evaluating a systems approach to district CS education implementation. In *The 51st ACM Technical Symposium on Computer Science Education (SIGCSE '20), March 11–14, 2020, Portland, OR, USA*. ACM. https://doi.org/10.1145/3328778.3366898.

Ericson, B. (2019, February 20). *AP CS Report for 2018*. Retrieved June 14, 2020 from https://cs4all.home.blog/2019/02/28/ap-cs-report-for-2018/

References

Expanding Computing Education Pathways. (2020, March 04). *ECEP Releases New 5-Stage Model to Broaden Participation in Computing*. Retrieved December 02, 2020 from https://ecepalliance.org/news/ecep-releases-new-5-stage-model-broaden-participation-computing

Finnigan, K. S., & Gross, B. (2007). Do accountability policy sanctions influence teacher motivation? Lessons from Chicago's low-performing schools. *American Educational Research Journal, 44*(3), 594–630.

Fletcher, C.L. and Warner, J. R., (2020). *Summary of the CAPE Framework for Assessing Equity in Computer Science Education*. Retrieved May 26, 2020 from: https://www.tacc.utexas.edu/epic/research.

Forum on Educational Accountability. (2007). *Assessment and Accountability for Improving Schools and Learning: Principles and Recommendations for Federal Law and State and Local Systems*.

Fuhrman, S., Clune, W., & Elmore, R. (1991). Research on education reform: Lessons on the implementation of policy. *Education Policy Implementation*, 197–218.

Fullan, M., Rincon-Gallardo, S., & Hargreaves, A. (2015). Professional capital as accountability. *Education Policy Analysis Archives*, 23(15). http://dx.doi.org/10.14507/epaa.v23.1998.

Girls Who Code (2019). *The State of Girls in K–12 Computer Science Classrooms: Making the Case for Gender-Specific Education Policies*. Girls Who Code.

Goode, J. & Chapman, G. (2018). *Exploring Computer Science* (version 9). Retrieved October 1, 2020 from: https://www.exploringcs.org/curriculum

Google Inc. & Gallup Inc. (2016). *Trends in the State of Computer Science in U.S. K–12 Schools*. Retrieved from http://goo.gl/j291E0.

Gordon, E. M. & Heck, D. J. (2019). *2018 NSSME+: Status of High School Computer Science*. Horizon Research, Inc.

Hargreaves, A. & Shirley, D. (2012). *The Global Fourth Way*. Corwin Press.

Kaufman, J. H., Thompson, L. E., & Opfer, V. D. (2016). *Creating a Coherent System to Support Instruction Aligned with State Standards*. RAND Corporation. Retrieved June 15, 2020 from https://www.rand.org/content/dam/rand/pubs/research_reports/RR1600/RR1613/RAND_RR1613.pdf

Heilig, J. V. & Darling-Hammond, L. (2008). Accountability Texas-style: The progress and learning of urban minority students in a high-stakes testing context. *Educational Evaluation and Policy Analysis, 30*(2), 75–110.

Jones, B. D. (2007). The unintended outcomes of high-stakes testing. *Journal of Applied School Psychology, 23*(2), 65–86.

Kim, T. & Yun, J. T. (2019). Logics of accountability: Cross-national patterns in school-level controls. *Education Policy Analysis Archives*, 27(119). https://doi.org/10.14507/epaa.27.4597.

Koyama, J. P. (2011). Generating, comparing, manipulating, categorizing: reporting, and sometimes fabricating data to comply with No Child Left Behind mandates. *Journal of Education Policy, 26*(5), 701–720.

Kirshner, B., Gaertner, M., & Pozzoboni, K. (2010). Tracing transitions: The effect of high school closure on displaced students. *Educational Evaluation and Policy Analysis*, 32(3), 407–429.

Lipman, P. (2013). Economic crisis, accountability, and the state's coercive assault on public education in the USA. *Journal of Education Policy, 28*(5), 557–573.

References

Marsh, J., Dhaliwal, T. K., Hall, M., & Polikoff, M. (2020). Civic Engagement in Education: Insights from California's Local Control Funding Formula. *Education Finance and Policy*, 1–33.

Marsh, J. A., Pane, J. F., & Hamilton, L. S. (2006). Making sense of data-driven decision making in education: Evidence from recent RAND research. Retrieved November 23, 2020 from https://www.rand.org/pubs/occasional_papers/OP170.html.

McLaughlin, M. W. (1987). Learning from experience: Lessons from policy implementation. *Educational Evaluation and Policy Analysis*, 9(2), 171–178.

McDermott, K. A. (2007). "Expanding the moral community" or "blaming the victim"? The politics of state education accountability policy. *American Educational Research Journal*, 44(1), 77–111.

McGill, M. M., Decker, A., McKlin, T., & Haynie, K. (2019, February). A Gap Analysis of Noncognitive Constructs in Evaluation Instruments Designed for Computing Education. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (pp. 706–712).

Means, B., Padilla, C., & Gallagher, L. (2010). *Use of Education Data at the Local Level: From Account ability to Instructional Improvement*. U.S. Department of Education. Retrieved November 23, 2020 from https://files.eric.ed.gov/fulltext/ED511656.pdf.

Morel, R. P., Coburn, C., Catterson, A. K., & Higgs, J. (2019). The multiple meanings of scale: Implications for researchers and practitioners. *Educational Researcher, 48*(6), 369–377.

National Center for Educational Statistics (2019). *U.S. Results from the 2018 International Computer and Information Literacy Study (ICILS) Web Report*. U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics. Available at https://nces.ed.gov/surveys/icils/icils2018/theme1.asp.

National Research Council. 2015. *Guide to Implementing the Next Generation Science Standards*. The National Academies Press. https://doi.org/10.17226/18802.

Oklahoma State Department of Education. (n.d.) *Champion Excellence*. Retrieved November 13, 2020 from sde.ok.gov/ChampionExcellence.

Peurach, D. J. (2011). *Seeing Complexity in Public Education: Problems, Possibilities, and Success for All*. Oxford University Press.

Read, L. & Atinc, T. M. (2017). Information for accountability: Transparency and citizen engagement for improved service delivery in education systems. Brookings. http://hdl.handle.net/11540/7252.

Russell, J. L., Meredith, J., Childs, J., Stein, M. K., & Prine, D. W. (2015). Designing inter-organizational networks to implement education reform: An analysis of state Race to the Top applications. *Educational Evaluation and Policy Analysis*, 37(1), 92–112.

Santo, R., Ching, D., Peppler, K., & Hoadley, C. (2017). *Participatory Knowledge Building within Research-Practice Partnerships in Education*. SAGE Publications Ltd.

Santo, R., Vogel, S., & Ching, D. (2019). *CS for What? Diverse Visions of Computer Science Education in Practice*. CSforALL. Retrieved November 23, 2020 from https://www.csforall.org/visions.

Santo, R., DeLyser, L. A., Ahn, J., Pellicone, A., Aguiar, J., & Wortel-London, S. (2019, February). Equity in the who, how and what of computer science education: K12 school district conceptualizations of equity in CS for All initiatives. In *2019 Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT)* (pp. 1–8). IEEE.

References

Santo, R., Vogel, S., Ryoo, J., Denner, J., Belgrave, C., Moriss, A., & Tirado, A. (2020, February). Who has a seat at the table in CS education? Rethinking equity through the lens of decision-making and power in computer science education initiatives. In *Proceedings of the 51st ACM Technical Symposium on Computer Science Education* (pp. 329–330).

Santo, R., DeLyser, L. A., & Ahn, J. (2020). Negotiating equity priorities within systems change: A case study of a district-level initiative to implement K12 computer science education. *Computing in Science & Engineering*, 22*(5), 7–19*.

Schneider, J. (2017). *Beyond Test Scores: A Better Way to Measure School Quality*. Harvard University Press.

Seehorn, D., & Clayborn, L. (2017, March). CSTA K–12 CS standards for all. In *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education* (pp. 730–730).

Stephenson, C., Gal-Ezer, J., Haberman, B., & Verno, A. (2005). The new educational imperative: Improving high school computer science education. *Final Report of the CSTA Curriculum Improvement Task Force*.

Sykes, G., & Martin, K. (2019). Equitable access to capable teachers: The states respond. *Education Policy Analysis Archives*, 27, 39.

Tyler, B., & Britton, T. (2018). Developing district plans for NGSS implementation: Preventing detours and finding express lanes on the journey to implement the new science standards. *Evaluation Report #4*. WestEd.

Villavicencio, A., Fancsali, C., Martin, W., Mark, J., & Cole, R. (2018). *Computer Science in New York City: An Early Look at Teacher Training Opportunities and the Landscape of CS Implementation in Schools*. Research Alliance for New York City Schools. Retrieved November 23, 2020 from https://research.steinhardt.nyu.edu/research_alliance/publications/cs4all_nyc.

Weintrop, D., Holbert, N., & Tissenbaum, M. (2020). Considering alternative endpoints: An exploration in the space of computing educations. In *Proceedings of the Constructionism 2020 Conference*. Retrieved November 23, 2020 from http://www.constructionismconf.org/wp-content/uploads/2020/05/C2020-Proceedings.pdf.

Wilson, C., Sudol, L. A., Stephenson, C., & Stehlik, M. (2010). Running on empty: The failure to teach K–12 computer science in the digital age. *Association for Computing Machinery*, 26.

Whalan, F. (2012). *Collective Responsibility: Redefining What Falls Between the Cracks for School Reform*. Springer Science & Business Media.

Wohlstetter, P., Malloy, C. L., Chau, D., & Polhemus, J. L. (2003). Improving schools through networks: A new approach to urban school reform. *Educational Policy, 17*(4), 399–430.

Yuqin, Y.. (2017). Review on technology and engineering literacy assessment of NAEP. *Studies in Foreign Education*, 08.

Appendix A: Methodology

The methodology for this report followed a theoretically driven approach to gathering and analyzing a range of qualitative data on state computer science efforts, including focus groups, interviews, and reviews of documentation provided by states or publicly available. The theoretical and analytic framework is rooted in existing literature on education policy design and implementation, in particular scholarship on alignment and accountability synthesized by Coburn, Spillane and Hill (2016).

Empirical data drawn on for the report was gathered in a multi-stage process. First, based on the guiding theoretical framework, the authors categorized existing state instructional policies related to CS education in terms of whether they could be seen as policies of alignment, or policies of accountability. For example, the policy of requiring course offerings in all high schools was categorized under accountability, and the policy of providing support for pre-service computer science programs was categorized under alignment.

With categorization of policies in place, in collaboration with Code.org, all 50 states were categorized in terms of the existing policies of alignment and accountability they had in place at the time of analysis (November 2019). This analysis yielded a loose categorization in terms of whether a given state had strong or weak accountability policies overall, and high or low alignment policies overall.

Based on this categorization, to guide further data collection the authors purposively sampled a subset of states that represented variation in their policies (i.e., weak accountability/low alignment, weak accountability/high alignment, strong accountability/low alignment, strong accountability/high alignment). At least one state in each of the four categories was selected.

The authors then engaged in qualitative data collection focused on the sampled states. These included five administrator focus groups of 1.5 hours each with 15 total administrators participating, spanning five different states. These included CS coordinators, superintendents, assistant superintendents, career and technical education directors, and principals. Administrator focus groups focused on their experiences of their state's computer science education policies, as well as their perspectives and opinions on those policies. One on one interviews of 1.5 hours were conducted with four state leaders representing four states, as well as one focus group of 1.5 hours that included four state leaders representing an additional four states. These state leaders were all involved in policy design and/or implementation in their states, and included a mix of state education agencies employees as well as state authorized or contracted intermediaries. Interviews and focus groups with state leaders focused on the nature of the policies and policy implementation in their states. Finally, a 4.5 hour interview was conducted with leaders of the ECEP Alliance and SageFox Consulting to gain further context on the process that focal states, as well as other states, had taken towards establishing and implementing computer science education policy in their states.

In most cases, we de-identify both states and individuals in the main body of the text to address tensions with more candor. In case examples, placed in 'call-out' boxes, we identify states, actors, and organizations engaged in promising approaches in order to elevate these practices and allow others to more easily draw off their work.

csforall.org
@CSforALL

CsforALL