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California Computer Science Education Policy

Contributing Factors to Success and Opportunities for Further Progress

MARCH 2021

Joel Knudson | Candice Handjojo | Ashley Sunde

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Executive Summary

Computer science (CS) education in California has grown substantially in the last decade. Early grassroots efforts have evolved into a broad coalition of educators, industry leaders, and other members of the CS community known as Computer Science for California (CSforCA). At the same time, developments in multiple aspects of state policy reflect an increasing commitment among Sacramento policymakers to expanded CS education. Nevertheless, troubling disparities in CS access and success continue to exist between traditionally advantaged students and their historically underserved peers. If California is to create an environment in which all students have opportunities to thrive in CS, further policy action will likely be part of the process. By drawing on interviews with 20 individuals involved in the CS education policy process—from people directly involved in creating policy to members of a CSforCA working group—this report explores the contributing factors to recent CS education policy successes and considerations for achieving further progress.

Policy Developments in California CS Education

Interviewees drew attention to some of the most consequential policy changes that have promoted the expansion of CS education in California. Requirements for admission to the California State University and University of California systems now incorporate CS coursework, which helps create new incentives for districts, schools, and students to pursue CS classes. The adoption of state academic standards provides a framework for high-quality courses while validating CS as a priority in the state's approach to K–12 education. California's Computer Science Strategic Implementation Plan identifies CS education priorities and outlines opportunities for future policy progress. Finally, programs and positions articulated in Governor Gavin Newsom's January 2020 budget proposal would have committed resources toward additional CS initiatives before the COVID-19 pandemic forced significant funding reallocations.

Contributing Factors to California CS Policy Success

Several factors emerged from the interviews as facilitators of California's recent policy successes. Foremost among these was support from influential stakeholders, both within policymaking institutions—in the form of policy "champions" for CS education—and from the outside—including the value of education practitioners, industry representatives, and others working collaboratively as a coalition. The interviewees described the importance of educating policymakers about the benefits of CS education and problems that require policy attention. Policy progress also occurs when advocates for CS policy tap into the priorities and values of influential decisionmakers. As CSforCA coalition members and other stakeholders in the CS education landscape pursue policy change, their ability to provide useful information, develop

relationships with policymakers, and develop resources that are easy to consume and understand have been helpful.

Priorities for Further California CS Policy Development

The interview responses did not reveal any strong consensus about the top priorities for California CS education policy moving forward. However, three general topic areas emerged consistently. First, building teacher capacity by preparing, placing, and supporting teachers in CS classrooms will play a critical role in expanding CS education and its ability to reach students who are historically underrepresented. Second, given persistent disparities in access to CS knowledge, skills, and opportunities, nearly half of the interviewees emphasized the need to prioritize equity in CS policy. Third, the interviewees advocated for stronger connections between CS education and workforce needs in California.

Lessons Learned About Influencing California CS Education Policy

The report concludes by highlighting three lessons learned that might influence ongoing efforts related to shaping CS education policy. First, the availability of funding for CS education can play a powerful role in supporting or inhibiting policy progress. Bipartisan support for the issue, underscored by early commitments in the 2020 state budget, suggests that the state is willing to commit resources to CS education. However, the financial strain and adjusted priorities that resulted from the COVID-19 pandemic create uncertainty about the prospects for support in the short term.

Second, the COVID-19 pandemic disrupted priorities and progress for CS education, but it also presents opportunities for progress. One possible silver lining from the pandemic is that expanded access to devices and broadband connections—combined with increased awareness about the digital divide—could create a foundation for further discussion about emphasizing CS in schools. At the same time, misconceptions about what CS entails could lead educators, parents, and students to falsely equate computer literacy with CS. Consequently, they may erroneously believe that efforts to distribute laptops and tablets during the pandemic appropriately addressed disparities in the development of knowledge and skills in areas such as computational thinking that are the bedrock of effective CS education.

Finally, work to build and sustain stakeholder support for CS education policy efforts will shape the future success of those efforts. CSforCA has achieved great success in identifying champions for CS education and developing relationships with influential stakeholders. Maintaining these relationships while also strategically partnering with other important stakeholders could help position the CS education movement for continuing growth.

Introduction

Supporting Computing Access, Leadership, and Equity in California (SCALE-CA) was formed to ensure the equitable, scalable, and sustainable implementation of computer science (CS) education across California. To achieve this goal, SCALE-CA focuses attention on interlocking systemwide interventions at the (1) classroom level through professional development for teachers; (2) district/county level through capacity building for school, district, and local education agency leaders; and (3) state level through activities that inform policymakers. As a partner in the SCALE-CA project, the American Institutes for Research (AIR) is facilitating Plan-Do-Study-Act cycles to inform progress on these interventions. This report summarizes findings about the third dimension of SCALE-CA activity: state policy that helps expand and improve the quality of CS education in California.

A coalition of stakeholders, including members of the K–12 and higher education communities, tech companies, and nonprofit organizations, has engaged in a multipronged effort to inform policymakers about the need for CS education progress and advocates for policy changes that support it. Originally convened as the Alliance for California Computing Education for Students and Schools (ACCESS) in 2012, the group launched Computer Science for California (CSforCA) in 2017 as a campaign that aligns with the nationwide CSforAll movement and seeks to expand CS education across California. CSforCA has collaborated to organize informational hearings and webinars, develop infographics, share data about access to CS in California, and mobilize its members to provide testimony in Sacramento.

This report describes developments in CS education in an effort to inform the ongoing work of CSforCA and its partners. It uses interview data from 20 stakeholders closely involved with policy developments in Sacramento—either as policymakers themselves or as members of a CSforCA working group—to provide insights about the conditions that have enabled progress to date in advancing CS education, as well as considerations for engaging in effective advocacy moving forward. Because CSforCA's membership heavily overlaps with that of SCALE-CA and because their policy goals closely align, the findings here also can feed the activities of SCALE-CA and its work to leverage the influence and expertise of local educators to advance more equitable CS opportunities and experiences across the state.

Methods

This report draws on information collected through interviews conducted between October and December 2020. The research team identified an initial interview sample through consultation with the CSforCA codirector, who recommended individuals who had been most closely engaged in discussions and actions to advance policy with the California legislature, the California Department of Education (CDE), the California State Board of Education (SBE), and the state's systems of higher education. The team continued with a snowball sampling approach in which members of the research team asked the interviewees for their recommendations of individuals who have high levels of understanding or involvement with California CS policy developments. The final sample comprised 20 interviewees who fall into two general categories. Nine interviewees have played policymaking roles as elected or appointed officials or as members of these officials' staffs. Eleven interviewees have actively sought to inform or influence state policy in their primary professional roles and as members of the CSforCA policy working group.

A member of the AIR interview team spoke to each person in the sample, using a semistructured interview protocol in conversations that were roughly 1 hour in length. AIR researchers used qualitative analysis software to code interview transcripts according to the main topics addressed in the interviews. By analyzing the responses associated with each code, the study team identified emerging themes, examples, and illustrative quotes to characterize the evolving CS education policy landscape in California. Some themes were consistent across interviewees. However, we recognize that the lenses through which different people view the policy process may differ based on their role in that process. In cases where perspectives were particular to one group of individuals (policymakers vs. CSforCA working group members), we offer that clarification in the text.

Policy Developments in California CS Education

In the last decade, policy support for the implementation and expansion of CS education has grown noticeably. Building on a sustained and growing grassroots effort, a sequence of notable policy developments beginning in 2014 have enhanced and advanced state-level supports for CS education. In this section, we highlight a selection of key changes that the interviewees most frequently identified as consequential for advancing support for CS education in California.

Aligning CS Coursework With Postsecondary Admission Requirements Incentivizes Participation in CS

The interviewees saw the incorporation of CS coursework into the mathematics and science components of the state's A-G requirements as a major impetus for increasing involvement in and access to CS education. The A-G requirements specify the minimum expectations for coursework completion to achieve eligibility for California State University (CSU) and University of California (UC) admissions. Historically, CS only counted toward the elective course ("G") component of A-G. In an environment where pressures have increased for schools to prepare students for postsecondary success, the sparse attention to CS in higher education guidelines offered limited incentives for districts, schools, and students to prioritize CS coursework in schedules.

A series of policies and initiatives in the past 7 years has collectively contributed to "making CS count" in considerations for K–12 academic progress and transitions to postsecondary education. In 2014, Assembly Bill (AB) 1764[1] allowed CS to count as a third- or fourth-year mathematics course when it included extensive mathematic components, making it the first step in incorporating CS as a core academic content area. Although this development represented an important step in clearing the pathway toward increased participation in CS courses across the state, the actual number of courses the UC Board of Admissions and Relations with Schools (BOARS) initially approved for the mathematics requirement was quite low—only 11 out of more than 1,500 courses (Noguchi et al., 2015). Advocacy efforts, including an Oakland-based teacher's petition garnering more than 18,000 signatures[2] and a high-profile coalition letter signed by numerous policy and tech leaders,[3] worked toward getting UC BOARS to reconsider and reclassify its categorization of many CS courses (Noguchi et al., 2015). These efforts led to a UC BOARS announcement in February 2019 that it will allow CS classes meeting certain specifications to count for the lab science ("D") component of A-G (ACCESS, 2019). Advocates hope the change in making CS count will increase participation in and access to CS courses, particularly for young women and students of color (Johnson, 2019).

Development of Statewide CS Academic Standards Promotes a Higher Number of Quality Courses While Signifying Importance of the Subject in California

Another key CS education policy initiative launched in 2014 when AB 1539[4] called for the creation of statewide K–12 CS content standards. Development activities began in fall 2016 and

[1] See https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1764 for the language of the bill.
[2] The petition is available at https://www.change.org/p/make-computer-science-count-in-california-csinca-makecscount.
[3] Members of CSforCA played key roles in this effort, helping garner support, oversee efforts, and sign the letter itself. The full letter is available, courtesy of the *San Francisco Chronicle*, at https://www.sfchronicle.com/file/135/0/1350-BOARS%20Letter%20-%20Computer%20Science.pdf.
[4] See https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB1539 for the language of the bill.

concluded in fall 2018 when the SBE adopted the standards.[5] Policymakers and standards developers intended to have the standards model key CS concepts and practices for educators and, in doing so, increase the number of quality CS classes in schools across the state. The CDE has developed content standards for 12 subject areas, most of them representing traditional core academic content.[6] The incorporation of CS as one of these subjects validates it as a priority in the state's approach to K–12 education. One policy representative suggested that this success was particularly noteworthy given the scope of the challenge involved in developing an entirely new set of standards:

> The adoption of computer science standards was the most important because we had never had computer science standards before. Next Generation Science Standards [were] a vast improvement over the old science standards, but at least we had science standards before. . . . The computer science standards [were] starting from scratch.

Computer Science Strategic Implementation Plan Lays Groundwork for Future Policy Developments

In September 2016, progress with incorporating CS into the state's K–12 education system continued when AB 2329[7] called for the development of a Computer Science Strategic Implementation Plan (CSSIP). The CSSIP was to set out strategies and recommendations for increasing access and supporting implementation of CS across the state. AB 2329 specified that an advisory panel consisting of educators, researchers, and policymakers was to collaborate to form the CSSIP recommendations. The CSSIP task force began meeting in March 2018 and presented a set of recommendations to the SBE in September of that year.[8] Eight months later, the SBE approved the panel's recommendations after requesting a series of adjustments. The final recommendations were presented as a report to the California State Legislature in July 2019 and included suggestions such as integrating CS into other subject coursework and providing more professional learning opportunities in CS, as well as more specific state-level recommendations, such as the creation of a CS supervisor (CDE, 2019).[9] Although the CSSIP did not directly create new policies, the plan represents an important effort to articulate and establish support for guide future policy objectives. One working group member described the

[5] Additional information about the CS Content Standards, including downloadable components of the standards themselves, is available at https://www.cde.ca.gov/be/st/ss/computerscicontentstds.asp.
[6] Other subject area content standards include English language arts, mathematics, English language development, career technical education, CS, health education, history-social science, model school library, physical education, science, arts education, and world languages.
[7] See https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB2329 for the language of the bill.
[8] Notably, multiple CSSIP panel members played a prominent role in CSforCA. The complete list of panel members is available at https://www.cde.ca.gov/pd/ca/cs/cssipmembers.asp.
[9] Additional information, including a downloadable file of CSSIP's report, is available at https://www.cde.ca.gov/pd/ca/cs/cssip.asp.

importance of the CCSIP by saying, "I'd say that was probably the biggest thing because it's not just a big policy, but it sets the groundwork for future policy."

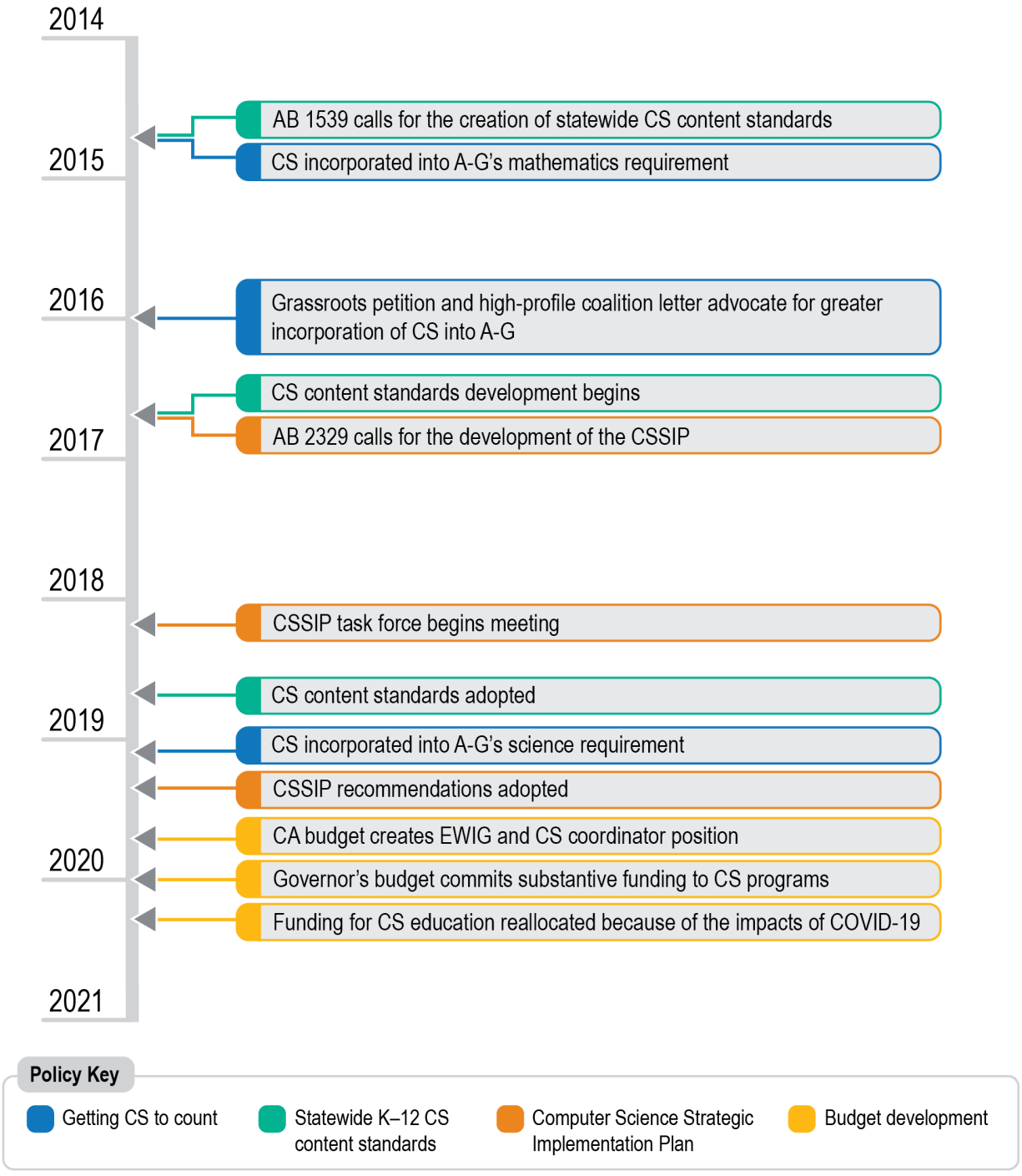
Devotion of Financial Resources to CS Education, Though Hindered by COVID-19, Signals Broad Support

State budget allocations in 2019 and 2020 built on some of the early policy successes by devoting significant financial resources to support CS education. These commitments symbolically affirmed the importance of CS education for the state and provided tangible resources to support it. When the legislature approved the state budget in 2019, it established the Educator Workforce Investment Grant (EWIG), which created grants for selecting professional learning activities, including professional development in the CS domain. EWIG represented a direct response to portions of the CSSIP recommendations that called for increased professional development opportunities. Following another recommendation from CSSIP, the 2019–20 budget also included funding for the creation of a California CS coordinator—a supervisor position meant to enact the implementation plan and related education initiatives. Together, the budget allocations for these commitments totaled $38.1 million.[10]

Building on this momentum, Governor Newsom's initial budget proposal in January 2020 committed funding for multiple additional CS education initiatives. These allocations were to support grants for teachers to obtain supplementary authorization for teaching CS, funding for compiling and sharing CS education resources, and the development of a UC subject matter project in CS. One participant who has engaged in CS education advocacy efforts in multiple states even noted, "When the governor put his proposal out for the . . . January 2020 budget, it was the single largest recommendation of computer science in any state that we've tracked." Unfortunately, funding for EWIG, the CS coordinator position, and other preliminary budget commitments were reallocated in spring 2020 because of the pressing demands of COVID-19. Figure 1 provides a timeline of activities.

[10] See https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB75 for the language of the bill.

Figure 1. Timeline of Consequential CS Education Policy Developments in California



Contributing Factors to California CS Policy Success

The interviewees identified several contributing factors to recent policy successes in California. In some cases, these factors were directly attributable to the actions of CSforCA. More frequently, the interviewees described the general characteristics of actions and resources that helped shape policy progress. Among these were support from influential stakeholders, policymaker exposure to important information, and alignment with policymaker priorities and values. This section concludes by outlining some key considerations in efforts to influence policy.

Support From Influential Stakeholders

Policymakers and CSforCA working group members consistently attributed policy developments in California CS education to support from key stakeholders, including champions within policymaking bodies, a coalition of support from outside, and the specific roles that leaders from practice and industry have played.

Champions for CS Education

Most frequently, the interviewees pointed to the importance of having a "CS champion" in a policymaking role. When an influential policymaker is willing to take up an issue and shepherd it forward, it can significantly shape that issue's prospects for policy success. Effective advocacy efforts, then, may be those that enlist the support of individuals who both share an interest in CS education and have the standing in policy spaces to motivate forward progress. A policymaker explained how the power dynamics operate in this situation:

> It's about your reputation, your influence, and the level of trust you have with their peers. . . . Most champions could take on any issue, frankly, because it's about the relationships, if people respect and trust you. . . . It's about targeting and finding that right person who has that sphere of influence.

A working group member suggested that in part because of the tech industry presence in the state, the California context makes it easier to find champions.

> There's definitely an interest, and that grows year by year. We have no issues with staff reaching out to us asking for [help with writing] legislation. That doesn't happen in other states. I think part of it is who these legislators are representing and who their stakeholder groups are.

The specific individuals who can serve as effective champions may vary by policymaking body and the specific policy change that advocates are targeting, but some names emerged repeatedly in the interviews. Governor Newsom is one such champion. "He made a pledge to

computer science when he was lieutenant governor that all high schools should offer a computer science course," one working group member explained. "It's sort of a commitment he's made, and I think that there is also a certain level of accountability from the community to his office." Indeed, multiple interviewees attributed the prominence of CS education in the initial 2020 budget to the governor's commitment. Policy and working group interviewees alike also described former SBE member Trish Williams as a champion for CS education. As one working group member reflected, "Having somebody in that position who is constantly keeping computer science as part of the conversation was particularly helpful and somewhat unique in terms of content area." Multiple interviewees noted, however, that since the end of Williams' term, no comparable advocate for CS education has emerged on the SBE.

A Broad, Diverse Coalition of Support

Nearly all interviewees expressed the belief that having diverse perspectives represented in a broader coalition for advancing equity in CS education was instrumental to achieving policy success. Several interviewees noted that policymakers are responsive to advocacy efforts that represent a wide range of constituencies. For example, interview responses suggested that the incorporation of CS into the state's A-G requirements happened in part because of a coalition letter to UC BOARS. In describing that letter of support, one working group member observed, "To see the nonprofit industry, K–12, universities, it's impressive, and it holds power. And it also shows that the work is being done with or without the support of legislation at the moment, which can be very powerful." Broad-based collective action can both underscore the importance of an effort while providing political cover to policymakers who can act with the assurance that their support will not invite undue controversy or political risk.

A coalition consisting of stakeholders from multiple perspectives also enhances the quality of the coalition itself by incorporating a range of experiences and areas of expertise—which in turn enhances its outward effectiveness. The unique perspectives, experiences, and skills that the broad range of CSforCA members bring to the table can inform other coalition members. One working group member described ways in which the network "cuts across the county offices, higher ed, policy folk—all kinds of folk are represented on CSforCA. That just makes it easier for us to do things in a well-informed way." Although the interviews conducted for this report focused on the role of CSforCA in shaping policy, some interviewees described ways in which their participation was personally rewarding. Indeed, when asked to name the individuals they turn to for advice on matters related to CS education, nearly all the working group interviewees listed at least one other member of CSforCA.

Coalitions can engage in a distribution of responsibilities that leverages each member's particular strengths. By drawing individuals together from a range of professional roles, CSforCA features members with different areas of content expertise, relationships with key policy

actors, and understanding of the systems that craft and implement CS education policy. Turning to members with the knowledge, skills, and connections appropriate to a given group action allows a group such as CSforCA to spread out the workload while also maximizing the effectiveness of its actions.

Coalition members also have the opportunity to expand and draw on other members' networks in service of group and individual goals. Because members have their own network of colleagues, peers, and other connections, outreach can happen on a broader scale and at a quicker pace. As one working group member explained,

> Once we get a bill introduced, because CSforCA and all of the members of CSforCA were part of the initial conversation, it's so much easier and faster to then get them to do the things that need to happen when a bill is at risk of being lost. So that's calling members, it is testifying before committees, it is potentially disagreeing privately but supporting something publicly.

Input From Education Practitioners and Technology-Focused Industries

Given the value that the interviewees found in a coalition that supports CS education, they yielded further insights into the value that various CSforCA participants and partners bring to the collective policy-focused efforts. Their remarks focused on the roles of educators and representatives of the technology-based business community.

Incorporating practitioner perspectives into coalition efforts resonated with nearly all interviewees as useful. The voice of local educators plays a key role, for example, in informing policymakers about what can be feasibly implemented in schools and districts. "The process is always smoother," one policy actor observed, "when you're working directly with practitioners, especially at the front end." A working group member added, "Having that engagement and involvement allows you to say, 'Okay, what do you need in order to implement it within the district?' as opposed to just sort of requiring them to do it, which is very difficult in California." Practitioners also can offer compelling narratives that can sway policymaker opinions. According to one CSforCA participant, "Some of the most memorable testimony that I have heard . . . has been hearing directly from the teachers and some of the students about the impact [that] having access to computer science courses has had in their lives, in their school, in their community."

The interviewees also reflected on the importance of having advocates from the technology industry engaged in the policy development process. Industry voice can help articulate the connections between classroom and career in CS. One policy representative, for example, explained as follows:

> It really helps us understand the future goal that we're trying to achieve: to have more students exposed to computer science, and if that's what they choose to have a career in, then they just have a whole range of options for careers and industry.

Other interviewees commented on the ability of the technology community to bring wider recognition to the CS education cause. "I can't imagine that this work would have the same success if we didn't have industry pulling," one working group member reflected. "I think that that has been a very influential part of what's happening in Sacramento is industry affirming just so much of what we do on a very basic level." In addition, some interviewees believed that industry plays an important role in providing funding streams to launch and sustain CS education programs, initiatives, and policies.

Despite these positive impressions, roughly one third of the interviewees expressed reservations about the role that the tech industry plays in the education policy process. Although the education and business communities have found an area of common interest, they still operate in response to different sets of priorities and incentive structures. Members of the education community sometimes worry about the feeling of having "strings attached" to receiving industry support for their CS efforts, even as they depend on outside funding in the resource-constrained realm of public K–12 education. Consequently, one working group participant explained, "Sometimes it feels more economic or industry driven, as opposed to being student focused. We absolutely need the stakeholders at the table, but I think it really needs to be balanced, and not an outsized voice."

Exposure to Information for Policymakers

A second contributing factor to policy developments in CS education has been the ability of advocates to provide useful and actionable information to policymakers. An interviewee with a long history of developing policy in Sacramento offered this overview of the dynamics that legislators and their staffs must navigate to create responsible legislation:

> One of the most problematic realities of serving in a state legislature like California is your lack of access to information and the fact that you are making enormous decisions on a drip feed of information. Anyone with any sense of conscience or responsibility starts to feel very nervous at some point that you are casting votes on things you know very little about, so there is a thirst among most responsible legislators to actually understand issues so that they can feel confident and their conscience can be quelled that they are doing the right thing. . . . So the way to present the education of a legislator is really to say, "I have a solution for you. I have a solution for the families in your district, your constituency."

Interviews with policy actors suggest that CSforCA has been effective in addressing this thirst for information by educating stakeholders about the need for expanded CS education policy and offering solutions to help get there. Data and evidence about current levels of CS education access and success appear to have been especially useful in this regard. As one policy interviewee explained, "A lot of the research that [the] Kapor Center has done around showing that inequity between ethnicities and poverty levels . . . has been very helpful in advocating for a lot of needs to increase access to the different communities throughout the state." Another policymaker directly credited the CSforCA and the Kapor Center's *Computer Science in California's Schools* (Scott et al., 2019) report, plus the demographic breakdown of CS education, for informing the development of the Computer Science Access Initiative, AB 1932.[11]

Alignment With Policymaker Values: Growing the Economy and Enhancing Equity

Another contributing factor to policy success has been the alignment between CS education and values that many California policymakers already prioritize. Chief among these are growing the economy and enhancing equity.

One of the compelling arguments for policymakers to support CS education builds on the recognition that quality jobs are available, and preparing students for those jobs serves the state's economy. One CSforCA member referred to a report developed by Microsoft in 2012 (*National Talent Strategy*) as an influential early push to raise the profile of CS education in California and recalled, "A big focus of [the report] was this issue on computer science education and how the current job market had a huge demand for these skills, and our education system across the US was just not meeting this demand." Another working group member succinctly echoed the point by saying, "There's just so many jobs available; it's almost impossible to argue."

Given the progressive nature of politics and priorities in California, some interviewees also suggested that policymakers see CS education as an opportunity to advance goals related to equity. "People care far more about equity than they care about computers," one policy actor argued. "I think it was largely an equity issue and an economic issue, and a realization that the only way to tackle this pervasive and growing issue of poverty is to equip our children more effectively."

Characteristics of Effective Approaches for Influencing Policy

In their reflections on policy-focused efforts emerging from CSforCA, the interviewees also offered insights about effective approaches for influencing policy in general. A majority of the interviewees were familiar with at least some of the resources that CSforCA had produced.

[11] See https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200AB1932 for the language of the bill.

Among these, the Kapor Center report[12] (mentioned more frequently among policy interviewees) and the CS Equity Guide[13] (mentioned more frequently among working group members) garnered the most recognition. The interviewees shared their observations about aspects of these policy-focused efforts that are most effective: the ability to provide useful information, develop relationships with policymakers, and create easily understandable resources.

Providing Useful Information

Echoing observations about the value of CS education advocates providing useful information to policymakers, several interviewees described ways in which resources affiliated with CSforCA had played this role. One policy actor pointed to the value of illustrating problems by "starting off with that baseline of having really solid data to be like, 'Ah, this is a problem,' because we don't have time to work on things that aren't a problem." This interviewee continued to explain that it also is important "to have an idea of targeting if we know enough about the problem to understand where the solutions are, where the potential solutions, or where the breaking points are. That's super-duper helpful." Another policy representative described ways in which data from the Kapor Center helped in this regard: "What's really helpful about their data is they bring in data that you can't really find on other places." For the office in which the interviewee worked, "it was always a matter of equity for communities of color and low-income disadvantaged communities, and there wasn't a lot of data out there that was showing the details of the disparity between these communities and other more affluent communities."

Developing Relationships With Policymakers

The interviewees also highlighted the importance of CSforCA working group members developing relationships with policymakers. One policy actor referred to an informational hearing organized through CSforCA, noting that it "exposed me to all of the different organizations that were really trying to advocate for CS education. So, it actually helped me to talk to them, introduce myself, and to continue working with them as well." Another policy representative further explained the value of developing relationships with legislators' offices to bring important issues to policymakers' attention: "If you have a good relationship and you've worked on an issue before. . . [an advocate might] reach out and say, 'Hey we're looking at this bill idea.'" This interviewee continued to describe the way in which this kind of connection operates in a symbiotic relationship: "We might reach out as well and say, 'Hey, do you have any ideas for legislation this coming year?' It really is that type of partnership." Interviews with policymakers suggest that CSforCA has been effective in forging these kinds of relationships. Nearly all interviewees, including the majority of those in policy roles, specifically

[12] See https://csforca.org/wp-content/uploads/2021/02/Computer-Science-in-California-Schools.pdf.
[13] See https://csforca.org/csequityguide/.

named CSforCA or specific individuals who are part of the coalition as the place they turn to most frequently with questions about CS education policy.

Creating Easily Understandable Resources

Finally, the interviewees emphasized that creating usable resources—from easily understandable written materials to tangible policy proposals—enables groups such as CSforCA to be maximally effective. "For legislators, succinct and concise is best," one policy interviewee explained. "It's always helpful to have some type of synthesized high-level document that I think can be the first place folks can see and understand very quickly. And then they can dig into the report if they want more." Another policy actor emphasized the value of offering solutions that address problems of importance to policymakers: "What everyone would love to see is, 'Here's the problems and here's our top five solutions of how we're going to fix these.'"

Priorities for Further California CS Policy Development

When asked to identify the top priorities for California CS education policy moving forward, no strong consensus emerged among the interviewees. Nevertheless, three general topic areas emerged consistently across multiple interviewees: teacher capacity building, equity in student learning opportunities, and alignment between education and the workforce.

Teacher Capacity Building

More than half of the interviewees identified teacher capacity building as a CS education policy priority, pointing to the importance of preparing, placing, and supporting teachers in classrooms as a catalyst in the process of expanding CS education and its access. In particular, interviewees described the potential value of formal teacher preparation pathways into CS that include CS certificates, other forms of credentials, and in-service supports such as CS professional development and training. These opportunities may create and/or strengthen CS teacher pipelines, building teacher capacity across grade levels, content areas, and the PK–12 and higher education system. A range of supports can benefit from policies that commit resources and establish guidelines to enhance the quality and supply of CS teachers.

The prioritization of teacher capacity building in CS education has been reflected in recent legislation, AB 1932,[14] otherwise known as the Computer Science Access Initiative. Introduced to the California legislature in January 2020, this bill would expand the CS teacher education workforce through supplemental authorization to teach CS and professional development for CS credentials using grant funding.

[14] See https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200AB1932 for the language of the bill.

Similarly, AB 2309[15] sought to implement the Computer Science Preparing Educators Grant Program to award competitive grants to higher education institutions with preservice credential CS programs when it was introduced in February 2020. The bill would have created, according to one interviewee, an "incentive grant program for institutions of higher education to prepare current and future educators to teach computer science" and contributed to the creation of CS teacher pipelines. Both legislative efforts fell victim to resource constraints that resulted from the COVID-19 pandemic in spring 2020. Nevertheless, they offer examples for what potential capacity-building policies might look like.

Equity

Nearly half of the interviewees, including a majority of working group participants, voiced the need for equity to be a continued priority in CS education and forthcoming policy developments. According to one interviewee,

> Equity has always been a core value of every aspect of the policy battles; . . . it's the equitable access to computer science, whether it's making computer science count, or giving the correct teaching credential. Whatever the policy piece is, the goal has consistently been the equitable access to computer science.

Given the persistent disparities in access to CS courses, initiatives, and programs, these interviewees argued that equity-focused policy should target marginalized and underrepresented students and communities. Interviewees drew particular attention to students from low-income families, students with disabilities, and African American and Latinx communities in California. One interviewee highlighted the need to explicitly address systemic racism as a barrier to access and success:

> When we think about actual solutions to increasing students' access, like meaningfully increasing access, we have to take those hard looks at the institutional racism that exists within all of our institutions but seem to be particularly kind of profound in the STEM [science, technology, engineering, and mathematics] fields.

To help place equity at the forefront of CS policy developments, one policy interviewee suggested financially incentivizing districts and schools that serve higher populations of underrepresented students to provide access to CS education. In the same way that the Local Control Funding Formula provides supplemental and concentration grants to districts based on their student populations, a similar model could be used to create systems of resource allocation and accountability to ensure that targeted student populations have access to CS

[15] See https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200AB2309 for the language of the bill.

education. In addition, this interviewee described the possibility of creating a variable that measures the population of these communities and their access to CS—the interviewee referred to this hypothetical variable as an "equity measurement"—to inform CS equity policy. Although this idea represents the perspective of a single interviewee, it illustrates the kinds of approaches that members of the CS education community might consider for promoting equity across the state.

In the continuing effort to expand CS equity for students who are historically underrepresented, policy and working group interviewees pointed to CSforCA as playing an instrumental role in elevating equitable policy considerations in CS education. According to one working group interviewee,

> CSforCA puts equity to the heart of what they do. And I feel comfort in knowing that when I go into a meeting with CSforCA and policymakers on the other side of the table, I know that because they're in the room, either they or I, or one of our other partners, will bring the conversation back to the importance of equity and diversity at some point in the conversation and have that be a crux of the argument.

CS Education and Workforce Alignment

A third topic that emerged frequently in the interview responses as a policy priority is strengthening alignment between CS education and the workforce. High-quality CS learning opportunities can help students develop skills in mathematics, computational thinking, and analytical problem solving that are highly desirable to employers. Students armed with these skills prepare themselves to be competitive in the job market and offer the versatility to succeed in a variety of settings both within the STEM field and in areas like media, education, and urban development (Microsoft, 2012).

Currently, there are not enough graduates with CS skills and degrees to meet workforce demands for individuals with those skills. California's STEM field is growing, with more than one million STEM positions expected to be available within the next decade; 75% of those positions will require a bachelor's degree or higher (Byrd & Shorette, 2016). The interviewees noted how critical these endeavors were, especially for marginalized and/or underrepresented student communities. According to one policy interviewee,

> Teach people how to use what they've been given [in CS courses], and to elevate that skillset, so that way they can have more successful futures, so they can have careers in tech that pay like really good paying jobs and can move themselves out of poverty.

Despite the emphasis on CS education and workforce alignment, insights in this area did not necessarily point to concrete policies to pursue. Rather, the interviewees highlighted workforce preparation as a key area of attention in CS policy-focused activities.

Lessons Learned About Influencing California CS Education Policy

Funding for CS Education Plays a Powerful Role in Supporting or Inhibiting Policy Progress

Like many other developments in the policy world, funding plays a critical role in CS education policy. New policies may call for personnel changes. For example, the statewide CS coordinator role has been established through legislation, but resources have not yet been allocated to fill the position. In the area of teacher capacity, preservice training and certification programs and in-service professional development can play an instrumental role in preparing the teaching workforce to meet student demands for CS education, but large-scale professional development and training programs are costly. For many of the policy priorities that the CS education community has identified, financial investment is necessary to design, staff, and implement promising ideas.

There are reasons for hope that policymakers will allocate the funding necessary for some critical areas of CS education policy progress. Unlike other policy issues that promote partisan conflict, computer science is typically a bipartisan issue supported by members across party lines. One policy interviewee explained, “Computer science is really interesting because Democrats, Republicans, everybody loves it.” Another working group representative echoed, “Everybody’s on board; everyone’s supportive of computer science.” In addition, the commitments from the governor’s preliminary 2020 budget included funding for a statewide CS coordinator, CS professional learning, and other CS priorities. These commitments, according to one policy interviewee, allowed for “increased investment in computer science and continued progress in across policy areas that don’t happen often.” The fact that the governor was willing to allocate resources for CS education suggests that the political will exists to make it a priority.

Despite these reasons for optimism, constrained resources present a formidable obstacle to CS education policy progress. Indeed, half of the interviewees pointed to funding as a barrier to new developments. When the COVID-19 pandemic forced school buildings to close in spring 2020, policymakers reallocated resources originally intended for CS professional learning and other priorities to meet more immediate basic needs. Continuing struggles to navigate crises that include the pandemic, statewide fires, and the prospect of an upcoming recession have

since diverted policy leaders' priorities and funding commitments in other directions. It remains to be seen whether the CS education community can secure the kinds of financial commitments moving forward that the governor was willing to make in early 2020.

COVID-19 Disrupted Priorities and Progress for CS Education and Presents Opportunities for Progress

The COVID-19 pandemic has profoundly reshaped the education world. Although the resulting challenges are immense and will likely resonate for years, the interviewees also highlighted the opportunity to take advantage of this moment in time and make waves in CS education. For example, although the digital divide has been a long-standing barrier to equity within CS and the broader education system, the pandemic brought disparities in access to devices and broadband connections front and center and prompted educators in many communities to address a fundamental need so that students could participate in distance learning (Chandra et al., 2020). Now, with expanded access to devices, school systems may have a stronger starting point for students to build interest in CS. Indeed, improved connections to devices and the internet can create a foundation for further discussion about emphasizing computer science in schools.

At the same time, expanded access to devices could potentially contribute to community misunderstanding of CS among educators, parents, and students who incorrectly equate the use of computers, tablets, and even phones—essentially, computer literacy—with CS. One policymaker explained the potential backlash of COVID-19 and access to devices:

> In the public's mind, there's no difference between using a computer and learning about a computer. It's all screen time, it's all virtual. [The public doesn't] understand that the real goal here is to equip students to understand computer science and become the designers, the programmers, the engineers, the thinkers behind this tool.

This misconception may lead some stakeholders to mistakenly believe that responses to COVID-19 have appropriately addressed the disparities in access among students and communities, without recognizing the vast divide that continues to exist in students' abilities to develop skillsets in computational thinking that are the bedrock of effective CS education.

As districts and schools manage their transitions back to in-person schooling, the interviewees argued for members of the CS education community to seize a rare window of opportunity for progress. Simultaneously advancing policy priorities with governing bodies and educating the public may be critical to ensuring that CS education priorities are at the forefront of policy developments. As one working group interviewee described the path forward,

> As the immediate crisis evolves into more long-term planning, ensuring that computer science education is part of that mix of policy conversations. . . . And so that CS isn't just a limited, narrow conversation about devices or hotspots, but it's a broader conversation about the skills and the trainings and the digital access and what that means.

Work to Build and Sustain Stakeholder Support for CS Education Policy Efforts Will Shape the Future Success of Those Efforts

The key roles that champions for CS education play in supporting its growth, along with findings that members of CSforCA have successfully developed relationships with many influential policy actors, suggest that the continued engagement of these partners will be important for ongoing progress. Among the possible facilitators of future policy success in CS education, the interviewees identified a range of policymakers who can promote progress, including the governor, legislative leaders, SBE, and institutions of higher education.

Beyond the high-profile champions for CS, other individuals and groups in positions of influence also shape progress toward CS policy expansion, and these stakeholders also merit attention in plans for moving forward. Among these are parents and families, community organizations, and the California Teachers Association (CTA). Families and community organizations, by representing the "on-the-ground" experiences of CS education participants and beneficiaries, can play a powerful role in contextualizing problems and articulating specific needs worthy of policy intervention. From a more Sacramento-focused perspective, one working group interviewee described the influence of CTA by saying,

> The California Teachers Association is a factor in any education policy in California. . . . When they were willing to stay quiet on our policy agenda, we were able to move it forward. If they were opposed to it, that was usually a deal breaker.

CSforCA and other groups advocating for CS education policy developments may therefore need to think strategically about the role that CTA plays their policy efforts.

Overall, it is the maintenance of a coalition of members across these stakeholder groups that may be most influential in sustaining CS education policy progress. As previously mentioned, a coalition comprising diverse stakeholders adds value to multiple actors in the policy process. According to one policy interviewee, a coalition is influential because the group is

> able to bring together all these different entities, to really push that same goal to make it all fused together. It's going to take a lot of effort, and then, all great things I've

> noticed in policy take like decades . . . in order to come together and create a plan, create goals, and really find those next steps that need to take place.

Furthermore, a coalition can effectively distribute responsibility based on member strengths and expand and draw on other member's resources and network, thus creating a coalition with resources, support, and influence in policy. Given the varying priorities for moving forward that emerged from the interviews, it may be important to develop consensus among coalition members about the highest policy priorities and the sequence of policy actions most likely to advance the group's goals.

Conclusion

In less than a decade, the state of California has seen tremendous progress in state policy that promotes and facilitates the expansion of CS education. This progress has been enabled by a combination of interlocking factors, including a set of policy "champions" committed to prioritizing CS, a coalition of advocates committed to collaborating and leveraging their combined strength in service of a shared goal, and a body of resources that can educate policy actors and focus their attention on concrete solutions to persistent equity and access challenges. The growth of CS in the policy landscape is encouraging and even promising, but it is also sobering: Policy is a long game that can take years to unfold, and promising developments often stall when they encounter barriers within the political system or external crises that reshape priorities and possibilities. As CSforCA continues its work moving forward, it builds on a strong foundation of relationships within the coalition and with influential policymakers. The group's ability to navigate dynamics related to funding; to take advantage of the disruption and possibility introduced by the COVID-19 pandemic; and to maintain, strengthen, and grow a coalition of support are likely to shape its prospects for continued success in advancing the CS for all movement.

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