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Broadening Participation
U.S. States Must Broaden Participation While Expanding Access to Computer Science Education

Incorporating equity and inclusion in the effort toward access for everyone.

MAKING SWEEPING CHANGES to education in the U.S. is difficult because of its highly decentralized primary and secondary school system. Each of the U.S. states and territories makes its own decisions about how education is structured. Some of those states push the decision-making to districts and even individual schools. Reforms, such as providing high-quality computer science (CS) education to *all* students, require states to engage every school district, if not every school. In order to broaden participation in computing, rather than exacerbate existing inequities as we expand K–12 CS education to more U.S. schools, explicit attention needs to be placed on how equity is addressed and measured in policy, practice, and professional development.

Many states are making progress on CS education. As of October 2020, 18 states have started or completed statewide plans; 37 states have defined CS standards; 40 states plus the District of Columbia have teacher certification for CS.[2] The Expanding Computing Education Pathways (ECEP) Alliance[a] is one of eight Broadening Participation in Computing Alliances[b] funded by the National Science Foundation. Begun in 2012 (and described a previous *Communications* Education column, "Broadening Access to Computing Education State by State," in February 2016), ECEP focuses on state-level educational systems and now works with 22 states and the territory of Puerto Rico to ensure the goal of *broadening participation in computing* (*BPC*) is a priority.[1] Supported by additional NSF funding in 2018, the ECEP 2.0 leadership team continues to build on the early work of ECEP while scaling the model of state-level BPC work beyond the ECEP states.

ECEP member states are making great strides toward increasing the number and diversity of students who have access to high-quality computing education. But often, there is more pressure to increase the *number* of students who have access than to

a See https://bit.ly/31APN3V

b See https://bit.ly/37h074r

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ensure the *diversity* of those students. It is easier to increase access to computing education in well resourced schools, which tend to be more homogenous. Increasing access, participation, and experience to students who have been historically underrepresented in computing[c] requires broad-based teams who are committed to making change through data-driven strategic efforts.[5]

Why is it difficult to develop and maintain goals for BPC in state education systems? First, such goals are hard to define. How can progress be measured? What data is informing the development of goals? How do we know that changes, be they state education policies or classroom practices, result in engaging a more diverse set of students in CS? Also some goals, while they seem ambitious, are not enough to broaden participation. Ensuring there is a CS teacher in every school is not enough. Many schools are highly diverse, but the computer science classes tend to be mostly White or Asian and male. If the CS teacher offers one small elective class, most students still do not have access. Making computer science classes a requirement is not enough. Many states are enacting a requirement that CS classes be made available in every school, but are not providing funding for teacher professional development nor are intentionally defining what content makes a course a CS course. Schools can often meet this requirement by simply providing access to online classes. However, historically marginalized students face numerous barriers to success in online courses, so the result is still too few students getting access.[3]

The historic inequities embedded in our social systems make the challenges in reaching "CS for All" enormous, but not insurmountable. COVID-19 and the onslaught of virtual educational, professional, and community spaces have brought new awareness to our dependence on technologies and the computer science that is inherent in every aspect of our lives. The pandemic also has magnified the inequities faced by families with limited technology access or literacy and limited skills or time to support their students' online learning. In many communities, parents or guardians do not see technology careers as achievable pathways for their children.

Computer science may be an aspiration, but it is not a priority for many school administrators and principals.[4] School leaders find themselves with a limited understanding of *what* CS is and *why* all students need to learn it. Pressures to address traditional, tested curricula, and a lack of resources and teachers to meet the demand for a new discipline further compound the challenges. The pressures placed on schools, school leaders, teachers and students by standardized testing of reading, writing, mathematics, and science, particularly in schools where large numbers of students struggle with such tests, can result in lower priority for computer science curricula. The "time in the day" for traditional subjects can push CS off as an elective. The pandemic has increased online learning, limiting hours of interactive learning and exacerbating the availability of time CS curricula. CS teachers are hard to find and retain. Too few university programs are training potential computer science teachers. Professional development for in-service teachers is limited. Teachers are often shifted from teaching CS to perceived higher priority subjects such as math or science. The outcome is too often restricted opportunities for students who have had historically limited access to learning the computing skills they need to succeed in any career, much less having been encouraged into computer science pathways. Computer science education must not be seen as yet another burden on schools and teachers. It is beyond time that we flip the educational script and elevate "CS for All" as a priority and see its diversity, equity, and inclusion goals as an opportunity to equip all graduates with the skills they need to succeed in the 21st century.

Several ECEP states are rising to this challenge by putting broadening participation in computing goals at the center of their advocacy and policy efforts. They are creating plans for

c See "Women, minorities (African Americans/Blacks, Hispanic Americans, American Indians, Alaska Natives, Native Hawaiians, Native Pacific Islanders, and persons from economically disadvantaged backgrounds), and persons with disabilities" from https://bit.ly/2Hl0uzZ growing CS education and broadening participation at the same time. A primary focus for ECEP 2.0 is to support states to develop ways to disaggregate and track data that measure BPC goals. Because computing is a new subject for many states, it has been difficult to define computing education and even more difficult to measure the demographics of students engaged in computing. Due to concerns about confidentiality and masking identifiable information when student numbers are small, it has been challenging to disaggregate and report on ethnicity, gender, and disability. As a collective impact network, ECEP is helping state leaders develop consistent, replicable strategies for analyzing state data through the lens of BPC. Two examples, from Rhode Island and Nevada, where state goals and plans explicitly aim to increase the number *and* diversity of students getting access to high-quality CS education, are described here.

Rhode Island

In 2016, Rhode Island Governor Raimondo launched Computer Science for Rhode Island (CS4RI)[d] with the aim of having computer science taught in every public school. CS4RI brought together state government and its education department, K–12 public education, universities, industry and nonprofits. The state provided more than $200,000 per year for the past three years to support staff, events, and teacher professional development. CS4RI's team selected providers of CS educational content, curriculum, and teacher professional development that would support RI's initiative to bring computer science to all students. One of the guiding principles when the state developed CS standards stated: "All students regardless of age, race, ethnicity, gender, socioeconomic status, special needs, English proficiency, or any other demographic will have the opportunity to participate in computer science. The content and practices of the standards will be accessible to all."[e]

Rhode Island's strategy for broadening participation in computing relies on four key actions: identifying a member of the Core Team to serve as the diversity coordinator; requiring that all state-approved CS content providers meet a rubric for culturally responsive and accessible curricula and professional development; offering an online diversity course for all RI CS teachers; and partnering with research projects to identify the level of engagement of students with disabilities. CS4RI also supports districtwide planning workshops for CS educators and administrators that include inclusion and diversity training.

Rhode Island's efforts are showing results. By the end of 2017, the state had reached its goal of having CS offered in every public elementary, middle, and high school in at least one of three modes: standalone courses; CS lessons integrated into existing courses; or access to CS courses during the school day from another Rhode Island school. By the end of 2018, 46% of high schools were offering AP computer science, a 26% increase from 2015. Female students in AP courses rose from 5% in 2015 to 30% in 2018. And the number of female CS major college graduates in the state rose from 17% to 25% over the same period.

Nevada

Nevada's Board of Education vice president Mark Newburn and the STEM Coalition K–12 CS Task Force leveraged membership in ECEP to create a CS coalition that built a cohesive statewide CS education expansion effort. Over two years, NV leaders contributed to the national K–12 CS Framework and also developed a process for writing CS standards for NV. The broad-based team framed a strategy to broaden participation and built statewide support for CS education. Concurrently, the Nevada legislature identified gaps in K–12 CS education instruction and drafted Senate Bill 200. Passed in June 2017, the bill requires all public high schools, charter schools, and university schools for gifted students to offer a state-approved CS course by 2022. Notably, the legislation[f] states: "These schools must also make efforts to increase enrollment of girls, students with

d See https://bit.ly/2T5IYT3
e See https://bit.ly/3m3yjof
f https://bit.ly/3oQcUkR

disabilities, and underrepresented minorities in the field of computer science as identified by the state board." Senate Bill 200 also mandates that Nevada's half-credit Computer Literacy graduation requirement must now include at least 50% of computer science content, thus guaranteeing all students receive some exposure to computer science concepts.

After the bill was passed, NV ECEP leaders and state department of education staff organized a statewide CS education summit at which stakeholders from K–12 and postsecondary education, government and industry learned strategies to support equitable CS education and wrote strategic plans that focused on broadening participation, which were collected and shared. The state education department also followed up with an online seminar series and training for school counselors.

Nevada allocated $1.4 million in state funding to districts and charter schools for teacher and school leader professional development, curriculum, and equipment. Nevada's goal to broaden participation was integrated into how it distributed state funds. Each applicant had to show how funds would be used to increase the enrollment of females, students with disabilities, and underrepresented minorities. Of the 17 districts in NV, 14 applied for funding, and nine charter schools were funded as well.[6]

Nevada's commitment is showing dramatic results. From 2016 to 2019, the number of students taking computer science doubled and the number of high schools offering computer science more than tripled. From 2017 to 2019, Nevada students taking the Advanced Placement Computer Science Principles exam increased by fivefold. Hispanic students' represented 40% of all students in 2019 (a more than eight times increase over 2017), and female students represented 38% of Nevada's CSP exam-takers, up from 30% in 2017.[g]

Nevada continues to focus on broadening participation as it creates a state strategic plan, pre-service and in-service professional development for K–12 teachers, and guidance documents. Nevada's CS team's work has never been about the number of students reached, it has been intentionally and systematically focused on offering high-quality computing education to all students and reaching those underrepresented in computing.

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Conclusion: Getting Access to Everyone

In the movement toward "CS for All," state K–12 education systems often focus on access, but too often equity and inclusion are afterthoughts in policy and strategy efforts. Even mandates to offer CS in every school may not mean that students with disabilities are fully included, or that every girl participates, or that students in schools that offer online CS courses succeed in those courses. As states enact new policies, we recommend the following actions:

- Include people with expertise in diversity and inclusion on the team developing policies and plans. Broad-based teams bring a wide range of perspectives that are vital to serving a wide range of students.
- Tie resources to goals to broaden participation. Provide funding to all districts, not just the well-off schools that are poised to take advantage of competitive grant funds. Ask districts to show how new resources will increase participation by historically underrepresented students.
- Ensure state-approved CS curriculum and professional development incorporates strategies to broaden participation and enable all students to succeed, no matter the tools or delivery mode.

As members of ECEP, Rhode Island and Nevada have developed and shared their approaches to expanding CS education in ways that focus on broadening participation among students underrepresented in computing fields. The 22 ECEP states and the territory of Puerto Rico are working hard to ensure broadening participation in computing remains a top priority and that the policies and resources target that goal.

g See https://bit.ly/2T5IKeF

References

1. Adrion, R. et al. Broadening access to computing education state by state. *Commun. ACM 59*, 2 (Feb. 2016), 32–34.
2. Code.org. State Tracking 9 Policies (Public), (Oct. 2020); https://bit.ly/3dDUq1H
3. Dynarski, S. Online courses are harming the students who need the most help. *New York Times.* (Jan. 19, 2019); https://nyti.ms/3dFnmpX.
4. Herold, B., and Schwartz, S. Principals warm up to computer science, despite obstacles. *Education Week 37*, 27 (Apr. 18, 2018), 24–25; https://bit.ly/31gakKz
5. Ladner, R. and Israel, M. Broadening participation "for all" in "computer science for all." *Commun. ACM 59*, 9 (Sept. 2016), 26–28.
6. Nevada Department of Education. Status Report Senate Bill 200 Computer Science Education. (2019); https://bit.ly/2T7ZIJy

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