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A Plan to Offer Computer Science Classes in All North Carolina High Schools

Technological advances are shifting labor market dynamics to favor applicants with computational skills. For Black, brown, female, and other underserved populations, the full benefits of such technological shifts will require an evolution in computer science (CS) education (as well as broader computing disciplines) and professional training to be more equitable and inclusive. CS education should begin with K-12 and must significantly exceed current calls for overall advancements in science, technology, engineering, and mathematics education. After closely examining how CS is offered in North Carolina's high schools, and why it so often fails to reach Black and brown students in particular, we have outlined a 10-year plan to achieve mandatory provision of CS courses in state high schools.

North Carolina's Research Triangle Park is home to one of the biggest aggregations of technology and start-up companies outside Silicon Valley. The average salary of tech-related jobs in the state is $92,273, which is significantly higher than the average of $53,700 for all jobs. As of 2020, the Raleigh/Durham/Chapel Hill area surrounding the park had roughly 21,000 of the 26,305 open technology positions across the state. Although these numbers are undoubtedly impacted by COVID-19, North Carolina remains a place that requires a wide range of computing talent.

Despite the large number of available jobs, as of 2018, the nonprofit group Code.org reported that there were fewer than 2,000 college CS graduates in North Carolina, and just 25% of them were female. In an effort to understand how low participation in high school CS courses impacts higher education computing graduation rates, one of us (Fay Cobb Payton) and Alexa Busch examined data from the Integrated Postsecondary Education Data System on more than 5,000 CS graduates from the University of North Carolina at Chapel Hill, North Carolina State, Wake Forest, Duke, North Carolina A&T, and the University of North Carolina at Charlotte. The study not only confirmed that there were many more male CS graduates than females and that white and Asians graduated in higher numbers than Blacks and Latinos, but it also showed that little has changed in the number of Black students at any of the schools over the past 10 years.

Investment in early CS education could prepare North Carolina students to enter a rapidly changing labor market, serving as an important tool for closing the wealth gap for Black, brown, female, and other underserved students. Although economic gaps begin in early childhood, and are being exacerbated by the COVID-19 pandemic, providing early CS education could enable pathways to improved personal economic outcomes. Moreover, a pool of highly skilled workers could draw employers to the region, raising regional salaries overall.

At all levels of North Carolina society, there is agreement that more computer science education is necessary. Critical computational thinking skills that can emerge from CS and mathematics education serve students over their lifetimes by teaching them the skills that industry, the higher education system, and entrepreneurship demand. As the former North Carolina governor Jim Hunt put it: "Who knows what technology will emerge in the next five years, let alone 20. The education we provide our children now is supposed to last for decades. We cannot train them for jobs that do not even exist yet, but we can provide them with the minds and tools they'll need to adapt to our ever-changing set of circumstances."

However, when it comes to actually providing CS education, the state's public schools fall short: 49% of them do not provide any CS courses at all. In schools where CS is offered, it is often perceived as an exclusive male-dominant discipline that is unwelcoming to people of diverse ethnicities, races, and socioeconomic backgrounds; people with disabilities; or women. The way this perception depresses the number of students who study CS became abundantly clear when we examined seven years of course data from two public high schools near Research Triangle Park, as we found that underrepresented students are limited not only by curricula but also by bureaucratic structures and policies within schools themselves. In addition, curricula clusters including world languages, language arts, and the arts can enable computational skills development along with the traditional sciences and mathematics.

Based on this research, and other work in this field, we conclude that North Carolina, like other states in similar situations, needs to forgo episodic interventions and instead embrace comprehensive policy reform, making equity and inclusivity a critical part of the process. Cultural context, competency, and relevancy in the teaching of the subject are key, as is recruiting and training diverse teachers. Furthermore, the state will need to address a wide range of long-standing problems caused by segregation and structural inequities—including availability of computers and broadband access in schools and in students' homes.

As the state's schools have switched to remote learning, a troubling gap has been exposed between the resources available to children from low-income families, mostly Black and Latino students, and their peers in wealthier zip codes. These longstanding digital divides have been amplified by the pandemic—with more than 30% of Native American and Black students in North Carolina lacking access to adequate computers and broadband for remote learning, compared with 18% of white students. The penalty of not having a computer or broadband access is significant.

Although there are many programs in North Carolina and the nation aimed at boosting K-12 participation rates in CS education, they are not positioned to create comprehensive change. Some programs focus on job prospects for people with CS skills. Some call for equitable participation in CS education based on race, ethnicity, and gender, while some center on CS teacher training and professional development. These initiatives, however, are not led by the state and cannot replace policy reform that can mandate CS offering in public schools.

Code.org has defined nine policies that a state can adopt to achieve higher computer science educational standards. The options include adopting a statewide plan, setting curriculum standards, providing funding, and adding computer competence to teacher certification, as well as making CS mandatory for high school graduation and having colleges and universities declare it necessary for admission. Of these policies, North Carolina has a state plan, has allocated funding, and started teacher certification, but it has yet to fully implement or explicitly employ the others.

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We propose a policy framework that North Carolina can use as a benchmark. Key elements of this plan are a time frame of 10 years, a state-appointed ambassador responsible for implementation, a regional approach that reaches all school systems, a way of recruiting diverse teachers, a mobile system for training them, and a means to hold high schools accountable for the extent of their CS course offerings.

For a successful policy reform, the state needs to first appoint a CS ambassador who oversees the transition to offering CS in all schools. Segmenting the state into four or five regions based on counties will help state officials and the CS ambassador track and evaluate improvement as they implement the plan. These regions should each hold a mix of counties with the least CS participation and with the most, equalizing the effort required to work with each segment. Student access to technology, school demographics, equity impacts, and the number of available CS/math teachers can also be the basis for the segmentation scheme. Moreover, every segment could include a regional CS champion to manage the process from within.

Across the state, teacher-training programs need to be built, either through undergraduate teacher training or by recertifying existing teachers. Although some of the state's colleges and universities offer undergraduate curricula to help in preparing future CS teachers, more teachers now come from mathematics (and other disciplines) education than from CS departments. Importantly, professional development and education will probably be the key to bringing most new CS teachers into schools, because there is already a national shortage of CS teachers.

The other pathway for teachers who already have a bachelor's degree to be certified in CS would be completing six semester hours of instruction in programming languages. We suggest creating a mobile training program for existing teachers with a budget to make the course and supplies free. In the first two years, the program could create standards and educational material for teacher training to cover the required CS instruction. In years three through 10 of our proposed plan, the new training course could be deployed statewide until every school district has been exposed to the new training, paying attention to the special needs of both rural and urban areas.

It is also important to acknowledge that the state's main competitor for teachers skilled in computer science is industry itself. The demand for CS skills is high and will continue to rise, and hence the salaries will be competitive in the market. To reduce the gap between the CS workforce and demand, CS skill holders need an incentive to choose teaching careers rather than higher-salary industry careers. Since compensation for teachers is low, it is not unusual for them to work an additional "job" during the academic year, the summer, or both. Teacher recruitment and retention efforts can be shared between the state and the counties with input from the regional CS champions and the state-level CS ambassador. This should include efforts to bring teachers of color into CS departments in line with student populations. For example, in Wake County, the most heavily populated county near Research Triangle Park, students of color comprise 53.8% of the school population, but teachers of color make up less than 20% of the workforce.

Finally, school principals and school boards can play a critical role in the adoption of CS curricula. To make school districts accountable for the education provided to students, we propose dividing the school system into four groups based on their CS participation. Schools that continuously offer CS classes, including advanced placement courses, would have the highest rating. The middle ranks would include schools with sporadic offerings of CS, and those not currently offering CS but ready to do so—with high student participation rates in other competitive courses and student-ready computer labs. The lowest designation would be for schools not offering CS and not ready to do so.

These ratings would enable regional CS champions to intervene and address the barriers that prevent schools from achieving the highest rating. In some schools, this might mean providing more teacher training; in others, it might include creating milestones to raise students' educational standards in the core areas of math, science, and English. In any case, each school's relative improvement, or lack thereof, could be easily seen. The CS course offering is a necessary but not sufficient criterion for assessing a school's rating. The rating should also be a function of diverse students participating in CS, course completion, and course success.

This plan to both mandate that high schools provide CS instruction and assist them in carrying it out will provide a minimum threshold so that students are prepared to keep up with an ever-evolving industry and participate in the digital economy. However, even these changes will not be enough. Without comprehensive policy changes that truly promote increased CS participation, there will remain gaps in achievement, skills, and opportunity among Black, brown, and other underserved students.

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