How South Africa implemented its computer science education program

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October 2021

B | Center for
Universal
Education
at BROOKINGS

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Summary

Computer science (CS) education helps students acquire skills such as computational thinking, problem-solving, and collaboration. It has been linked with higher rates of college enrollment ([Brown & Brown, 2020](#); [Salehi et al., 2020](#)), and a recent randomized control trial showed that lessons in computational thinking improved student response inhibition, planning, and coding skills ([Arfé et al., 2020](#)). Since these skills take preeminence in the rapidly changing 21st century, CS education promises to significantly enhance student preparedness for the future of work and active citizenship. CS education can also reduce skills inequality if education systems make a concerted effort to ensure that all students have equitable access to curricula that provide the needed breadth of skills, regardless of gender, ethnicity, or socioeconomic status.

Based on prior analyses and expert consultations, we selected 11 CS education country, state, and provincial case studies that have lessons that can broadly apply to other education systems and lead to successful implementation. These cases come from diverse global regions and circumstances and have implemented CS education programs for various periods and to different levels of success.

This case study focuses on the advancement of CS education in South Africa. As a developing country with a history of apartheid, South Africa faces unique challenges in offering quality and equitable CS education. While the education system lacks the infrastructure typically used for CS education, the government is working alongside NGO partners to make the subject accessible to more students.

An overview of CS education in South Africa

The South African government has installed information communication technologies (ICT) and internet connectivity in some schools, but most still lack computing infrastructure—particularly in low-income and rural areas. This is a

major obstacle to offering quality CS education. Yet, many teachers have circumvented the problem by using smartphone and analog learning activities.

A lack of qualified teachers further constrains CS education quality and scale. There are few efforts to solve this problem, even as South Africa considers a new curriculum that would greatly increase the need for quality CS instructors within the next few years.

Lessons learned

- Teacher training should be the top priority when initiating CS education.

- An absence of reliable broadband connectivity and ICTs is an obstacle to implementing CS education in South Africa. Analog or smartphone-based lessons can make CS more accessible to students whose schools lack adequate computing infrastructure.

- Now in the post-apartheid era, the government should focus on making computing infrastructure and qualified teachers available in all schools so that students of color, rural students, and girls can access CS education.

Inclusion

South Africa's apartheid regime (1948-1994) divided the country along geographic, economic, and social lines, making education equity a challenging prospect. Some of the most prevalent issues include a geographic divide between urban and rural schools, racial segregation, and gender inequality.

The [Department of Communications and Digital Technologies (DCDT) and Department of Basic Education (DBE](#)) have tried to prioritize disadvantaged communities to bridge the digital divide between rural and urban schools. Working with private sector partners, the two departments spearheaded a drive to increase the [number of computers](#) and [internet connections](#) in South African schools in the mid to late 2010s. In 2007, only 22% of schools had computer labs ([Isaacs, 2007](#)). Today, that number has risen to 40% ([SAPeople, 2020](#)). Thus, despite notable progress, low accessibility in computing infrastructure is still prevalent in South Africa, especially in rural schools ([Jantjies, 2020](#)).

Even though analog lessons are a viable way for students to learn CS and computational thinking ([Harris, 2018](#)), it is still ideal for classrooms to have access to digital devices for CS education, particularly for more advanced CS topics ([Lockwood & Cornell, 2013](#)). As such, inequalities between urban and rural in-school computing infrastructure contribute to the disparity in access to CS education to a significant extent.

Boys and girls also have unequal access to CS education, as traditional gender roles in South Africa discourage girls from developing an interest in technology or CS. Even in rural communities, South African boys traditionally have more access to technology at home, giving them more resources to pursue technology education ([Dlodlo, 2009](#)). To counter these trends, several initiatives attempt to reduce these inequalities. For example, [Black Girls Code](#) introduces young girls of color to skills in computer programming and technology. Likewise, [Girl Code](#) runs a national network for weekend coding clubs that helps upper-secondary school girls develop a strong foundation for learning programming skills. Additionally, this volunteer network runs weekend coding bootcamps that provide

in-person workshops for both students and teachers that want to learn CS and integrate coding into their lessons (Girl Code, n.d.).

CS curriculum

Today's curriculum does not provide adequate opportunity for primary and lower-secondary school students to learn about CS. However, the government is introducing a new curriculum to bring CS education to all students, giving them a chance to develop an interest in the subject from an early age.

At the primary-school level, the mandatory subject "natural sciences and technology" includes computational thinking skills such as designing and making products, for example, using paper-based projects. At the lower-secondary school level, students take "technology" as a standalone course a dedicated two hours per week. Yet, both courses mainly focus on engineering concepts and mechanical systems like electric circuits with no regard for digital technologies (Department of Basic Education, Republic of South Africa, 2011). Thus, the curriculum through these grades may include elements of computational thinking but does not provide a foundation for students to develop an interest in CS.

At the upper secondary level, the DBE offers "Information technology" (IT) as one of four optional subjects. The course focusses on CS topics, including algorithms and coding languages (Department of Basic Education, Republic of South Africa, n.d.). However, access has become highly unequal by socioeconomic divisions since many schools lack the requisite equipment and software to offer the course (Jantjies, 2020).

The DBE is considering a new curriculum that may change this course structure as early as 2022. If the department moves forward with the proposal, kindergarten through third grade students would focus on analog activities that teach the basics of coding and algorithms. In grades 4 through 6, students would use block-based programming tools, like Scratch. In grades 7 through 9, students would use line-based coding platforms. As such, CS lessons like programming and robotics skills would become gradually more rigorous as students advance through each grade level.

In February 2021, President Ramaphosa announced that 200 primary schools and 1,000 secondary schools would pilot the new curriculum in the following school year under the DBE's direction (Khoza, 2021). The President said that his administration designed the new curriculum for "equipping learners with knowledge and skills for a changing world. Not only must (South Africans) adapt to new ways of learning, but (their) curricula has to respond to the changes in the world of work" (Khoza, 2021). Indeed, if implemented properly, the new curriculum would give many more students opportunities to learn CS.

Alternative learning strategies

Yet, there are practical considerations that could complicate widescale implementation of the new curriculum. For example, Professor Jean Greyling at Nelson Mandela University Computing Sciences worries that the government's plan to universalize CS education across South Africa is problematic because many students cannot access a computer (Ellis, 2021).

To address his concern, Greyling helped enable computerless CS education by co-creating Tanks, a game that uses puzzle pieces and a mobile application to teach coding to children (Ellis, 2021). This is an especially useful concept, as many households and schools in South Africa have smartphones and analog lesson materials, but not necessarily laptops or desktop computers (McCrocklin, 2021). To date, over 20,000 students have used these lessons in both classrooms and coding workshops across the country (Ellis, 2021), suggesting that they may be used on a larger scale.

Teacher training

Teachers are the most important school-side factors in student learning in core academic subjects (Chetty Friedman, & Rockoff, 2014; Rivkin, Hanushek, & Kain, 2005). Yet, despite the government's intentions to include CS in the standard curriculum, it has not initiated meaningful professional development programs to train teachers for CS. Meanwhile, the private sector has only recently begun to fill this need.

In 2020, a private education company, [Code School Finland](#), started to train teachers from select schools in South Africa to teach CS. The company cooperates with South African partner [Contextualize](#) to help educators integrate CS concepts into the curriculum, including coding, robotics, and artificial intelligence. The program plans to train teachers from a wider range of schools—both private and public. Though this is a good first step to piloting teacher training, it would have to be scaled for South Africa to offer CS education to the broad student population.

Conclusion

[Amnesty International (2020)](#) describes South Africa's education system as "perpetuating poverty and inequality" due to its "crumbling infrastructure." There is a lot of work needed to promote fair education outcomes for South African children from different backgrounds, and implementation and standardization of CS would give students the skills needed to enter the global job market. However, despite strides in the progress, the education system is not equipped to provide students with digital CS lessons at the scale needed.

The new proposed curriculum would drastically increase the need for teachers who are qualified to teach CS and computational thinking. Improving teacher preparedness for the subject is therefore the most pressing action that the government and nonprofit partners can take to offer quality CS education to more students.

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