EAB

# Implementing K-8 Computer Science Programs

May 2024
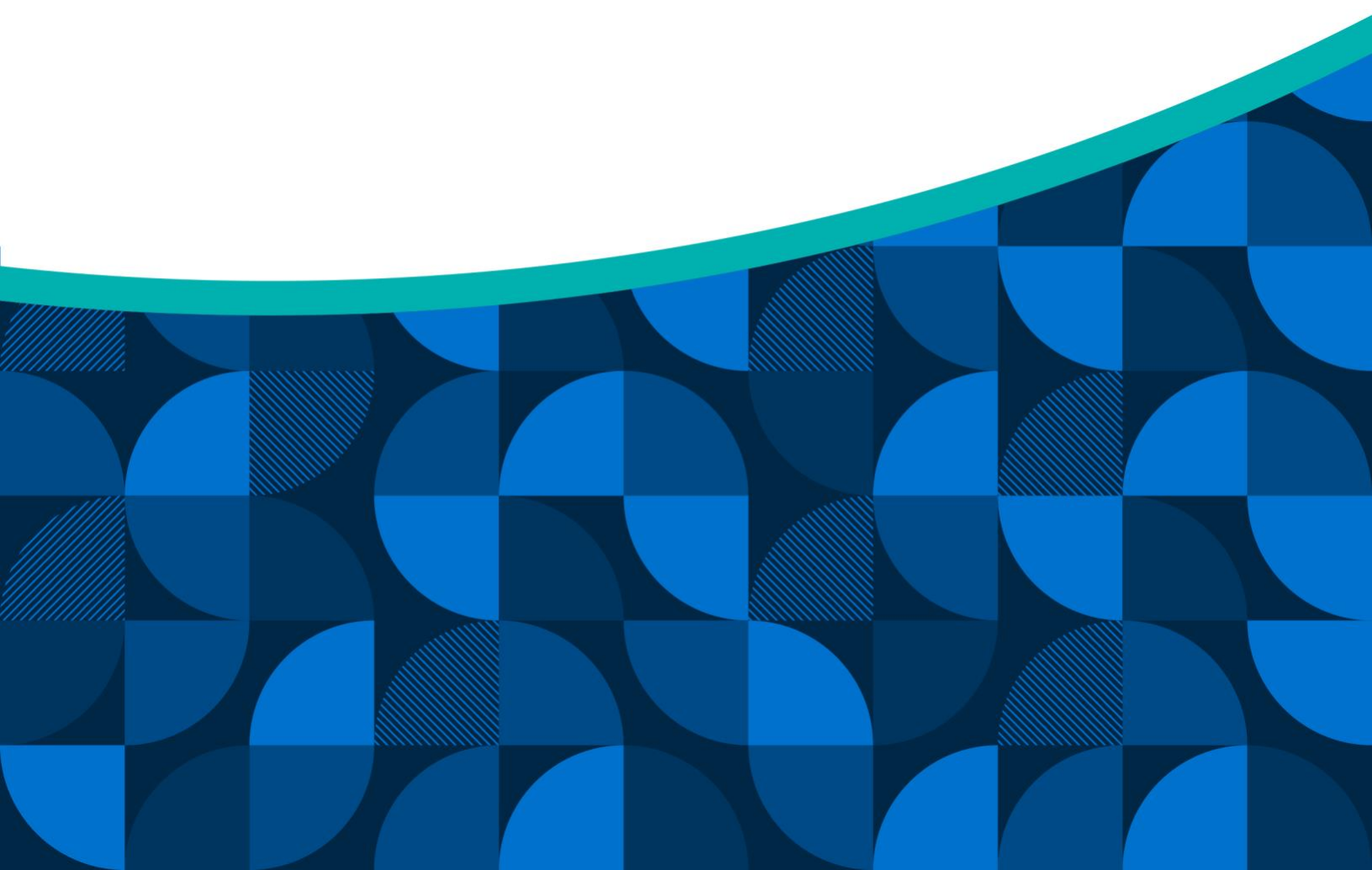
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# 1) Research Methodology

Our research team spent eight weeks researching school districts' computer science programs for K-8 students. The goal of this research was to explore district practices regarding the implementation of computer science programs for younger students, including potential implementation challenges.

If you have any questions about the research itself or our methodology, please reach out to your dedicated advisor.

**Profiled School Districts**

| District | Region | Approximate Enrollment |
|----------|--------|------------------------|
| District A | Pacific West | 15,000-20,000 |
| District B | South | 200,000-250,000 |
| District C | Mountain West | 50,000-75,000 |
| District D | Northeast | 2,500-5,000 |

# 3) Executive Overview

## Key Observations

**All profiled districts noted the difficulty of staffing for computer science at the K-8 level.** As school districts across the country navigate the overall teacher shortage, contacts mentioned the additional difficulty in finding teachers who are prepared to teach computer science. Despite computer science's growing popularity for elementary and middle school students, the number of pre-service teachers with computer science certifications has not grown at the same rate. This has required school districts to use a combination of in-house professional development, outsourced training and staffing, and program adjustments to offer computer science classes with reduced staff.

**School districts benefit from both superintendent buy-in and grassroots momentum when developing their computer science programs**. Superintendents at two profiled districts played key roles in creating their districts' computer science programs, taking initiative and pushing for courses to be brought into schools throughout the district. Contacts at a third profiled district said that once the program had been introduced, using teachers who were strong supporters of the program to spread knowledge and encourage other teachers to bring computer science into their classrooms helped maintain the program's momentum.

**School districts use a mix of integrated classes and specials to find time for computer science and engineering in the curriculum**. For many districts, one of the biggest hurdles they faced when establishing their computer science programs was time limitations. To find time for courses, two profiled districts adapted previously existing blocks in schedules to include computer science content. Two districts offered computer science as a special separate from other courses, while the third and fourth districts used a combination of integrated computer science classes and specials with different formats at different schools within the district. Districts who integrated computer science curricula did so with the goal of introducing computer science principles into as many subjects as possible, ranging from English Language Arts to physical education.

**Profiled districts took advantage of grant funding opportunities to get programs off the ground**. As school districts and state legislatures continue to recognize the growing importance of teaching computer science, grant funding opportunities for computer science programs grow as well. Contacts at three profiled districts cited grant funding as an important tool of support when launching their programs and used funding from government grants and other organizations. A fourth profiled district, which has more autonomy from the state over its budget, designated money from the district's budget for its computer science program.

**Districts should prioritize increasing accessibility and equity in their computer science programs.** Creating accessible and mandatory computer science programs helps ensure that all students have access to the foundational STEM skills that are necessary to advance into higher-level STEM classes. Districts can also take additional steps to ensure that computer science programs are reaching all students. One profiled district prioritizing placement of specialists in schools with students who might otherwise not have access to computer science, and another profiled district working with outside organizations to make tools accessible to English language learners and students with disabilities.

# 4) The Push for Computer Science in K-8 Classrooms

## Why Districts Are Prioritizing Computer Science

### All States are Mandating Some Degree of Computer Science Education

States across the U.S. are increasingly highlighting the importance of teaching computer science, recognizing that the skills taught in computer science are necessary for students to compete on the ever increasingly technology-driven global stage.[1] This has led to an increase in the number of states that require computer science in schools. As of 2022, all 50 states in the nation have at least one law or policy intended to promote K-12 computer science education,[2] and the federal government has also released several policy initiatives that promote computer science.[3]

However, while computer science is becoming more popular and accessible overall, progress still lags at the elementary and middle school levels. According to the most recent data, while 51 percent of U.S high schools across 19 states offered foundational computer science, only around 30 percent of K–8 schools offered foundational computer science.[4]

### Parents Value Computer Science, but their Children Do Not See the Same Importance

Parents also value teaching their children computer science, with a Gallup survey finding that almost 70 percent of parents say that it is important or very important for their child to learn computer science.[5]

However, the same survey found that less than half of students think that learning computer science is important. Girls are also less likely than boys to find value in computer science, with only 31 percent of girls considering computer science important to learn in comparison to 49 percent of the boys surveyed.[6] This tasks schools with the challenge of engaging all students in computer science, especially those who question its value.

### Offer Computer Science from an Early Age to Increase Accessibility and Interest

Students need early exposure to STEM to become interested in science. Exposure to STEM at a young age increases children's (especially girls') participation and success in STEM fields in college. A child's interest in STEM is largely determined by upper elementary and middle school.[7]

Early exposure is also key to leveling the playing field for minority students. Minority students overall are less likely to be exposed to computer science than their white peers.[8] Hispanic, Latino, English language learners (ELLs), students with disabilities, and economically disadvantaged high school students in particular are underrepresented in computer science, and are less likely than their white and Asian

1) MS Computer Science and Cyber Education Equality Act. (n.d.). *Mississippi Department of Education.*
2) Sparks, S. D. (2023, October 5). States are calling for more computer science classes. Now they need the teachers. *Education Week.*
3) 2021 State of Computer Science Education. (2021). *Code.Org, CSTA, & ECEP Alliance.*
4) Ibid.
5) Calderon, V. J., & Marken, S. (2020, September 29). *Parents think computer science education is important*. Gallup.
6) Ibid.
7) K-5 STEM. (n.d.). Nevada Governor's Office of Science, Innovation & Technology.
8) *U. S. Minority students less exposed to computer science*. (2016, October 18). Gallup.

peers to take foundational computer science courses.[9] Early exposure gives young students a chance to learn about the full range of opportunities that come with participation in STEM, and helps minority students enter the field at the same level as their white peers.

**The Risks of Not Offering STEM to Young Students[10, 11]**

## 33%
Percent of boys and girls lose interest in science by the fourth grade.

## 24%
Percent of teachers report that inequitable access to early computer science deters students historically excluded from pursuing the computing field.
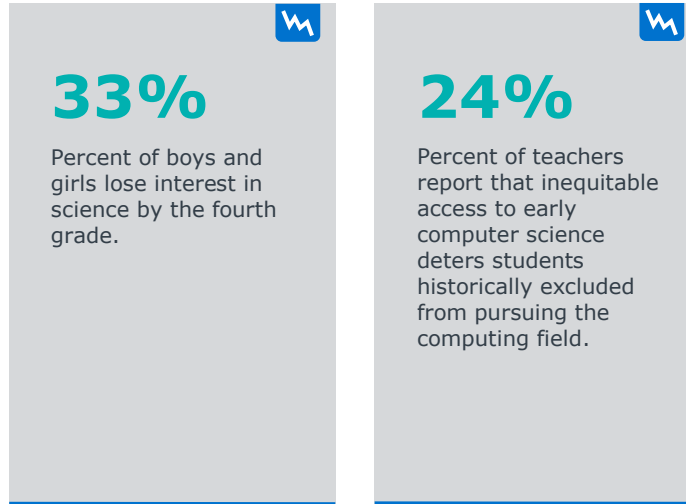
Participation in STEM has benefits outside of STEM fields as well: when children are allowed to explore questions that matter to them, they exhibit increased motivation.[12] Contacts at **District C** highlight how participation in STEM fosters critical thinking and reasoning skills, collaborative learning and communication skills, and responsibility and autonomy.

9) Code.org. (2022, September 21). *New report shows disparities in access to computer science education persist, except in states where coursework is required for graduation*. PR Newswire.
10) *K-5 STEM*. (n.d.). Nevada Governor's Office of Science, Innovation & Technology.
11) Koshy, Ph.D., S., Martin, Ph.D., A., Hinton, L., Scott, Ph.D., A., Twarek, M.A., B., & Davis, M.P.A., K. (2021). The Computer Science *Teacher Landscape: Results of a Nationwide Teacher Survey*. *Computer Science Teachers Association*.
12) National Academies of Sciences, Engineering, and Medicine, Division of Behavioral and Social Sciences and Education, & Board on Science Education; Committee on Enhancing Science and Engineering in Prekindergarten Through Fifth Grades. (2022). *Science and engineering in preschool through elementary grades: The brilliance of children and the strengths of educators science and engineering in preschool through elementary grades* (E. A. Davis & A. Stephens, Eds.).

# 5) Integrating Courses into the Schedule

Finding Time for Computer Science

## Already Packed Schedules Limit Opportunities for New Courses

For many school districts, the greatest challenge to including computer science content is a simple lack of time. Our profiled districts noted how difficult it is to add more content to the schedule, particularly at the elementary school level where the curriculum is already largely determined by required core classes. However, while time is limited, educators value computer science, with the majority of public school teachers, principals, and superintendents considering computer science to be just as important as other required courses.[13]

**School Teachers and Administrators Value Computer Science Education[14]**



Percentage of respondents that think computer science as important as other subjects.

■ Teachers   ■ Principals   ■ Superintendents
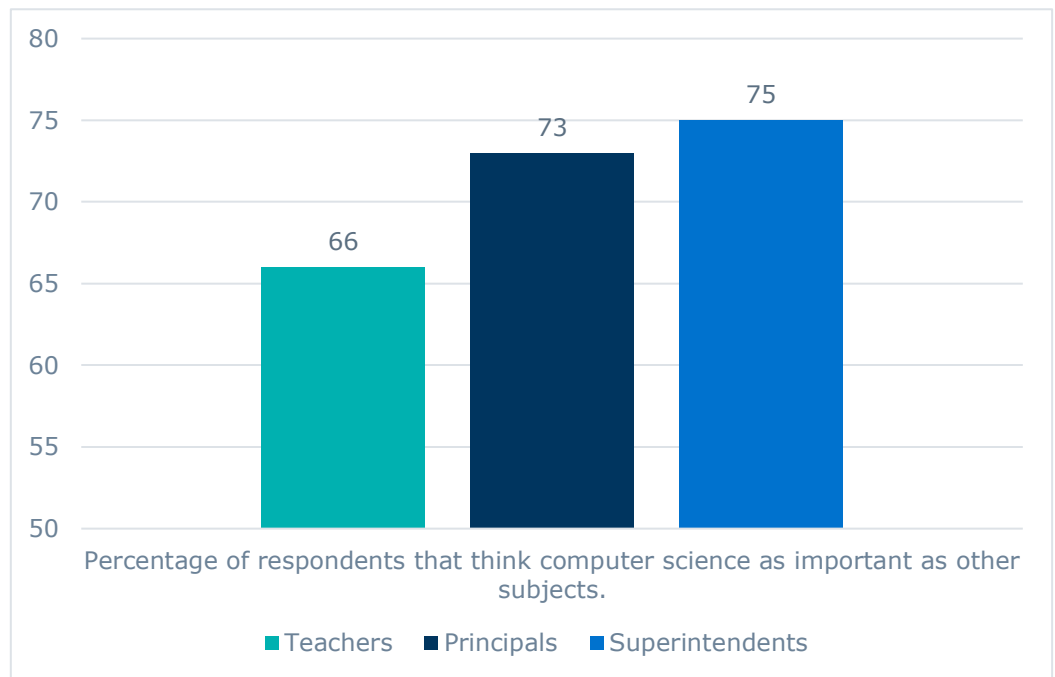
Given the importance of computer science, all our profiled districts used a wide variety of solutions to build in time for this critical content despite time limitations. Profiled districts used a range of dedicated specials, rotating specials, integrated classes, and electives to find time in students' busy school days for computer science.

13) Calderon, V. J., & Marken, S. (2020, September 29). *Parents think computer science education is important*. Gallup.
14) Ibid.

**Fitting Computer Science into Busy Schedules**
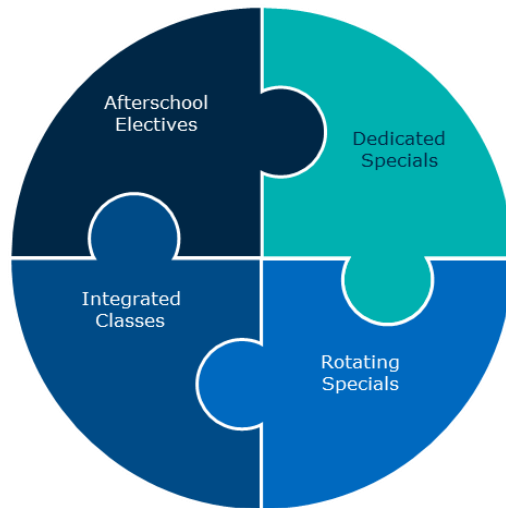


**Dedicated Specials**
Create dedicated time for computer science learning through specials.

**Rotating Specials**
Find time for learning opportunities for computer science, even when time is limited.

**Integrated Classes**
Incorporate computer science into the curriculum of other classes to expand learning opportunities.

**Afterschool Electives**
Offer additional opportunities after the regular school day to explore computer science.

## Create Dedicated Learning Time with Specials

Contacts at all four districts have incorporated computer science into the curriculum through special elective classes in dedicated class blocks.

To create time within the districts' busy schedules, contacts at two school districts shared that they have adapted previously existing class blocks into computer science classes. **District D** converted library time to include computer science content. Similarly, **District B** converted the literacy block in schedules for computer science time. Computer science is built into the cycle with teacher prep time at **District C**. While teachers are working on prep, their students are cycled into class with computer science specialists, similar to rotations for specials like art and health. **District A** is currently piloting a range of models, including one 40-minute class a week taught by a specialist in some of its elementary schools.

At **District C** and **District A**, which both have programs that deliver content through specialists, elementary students all have at least one computer science class each week. In 2023, Over 40,000 elementary school students at **District C** receive at least 30 minutes of computer science education taught by one of the district's 72 dedicated computer science specialists each week. Students at **District A** have one 40-minute class a week taught by a specialist in some of its elementary schools.

**Computer Science Specials Minutes Per Week**

| District A | District C |
|---|---|
| In one pilot model at District A, students receive one 40-minute computer science class per week. | Elementary school students at District C receive a minimum of 30 minutes of computer science instruction per week. |

## Integrate Computer Science into Existing Courses to Maximize Time and Expand Reach

Two school districts have also been able to further integrate computer science into the curriculum at some of their schools. Two elementary schools in **District A** have computer science integrated into all classes, with at least one hour a week of related learning. Teachers receive help from a Computer Science Facilitator, who helps with coteaching, coaching, and developing the class curriculum. There are also additional dedicated computer science classes.

### Computational Thinking Goes Beyond STEM

**District A** integrates computer science content into other subjects to connect it to other areas of knowledge to help students see the full range and potential of computer science, bringing it beyond just science/tech activities.

Similarly, **District B** has integrated computer science content into other subject areas at some of their schools, in subjects ranging from English Language Arts (ELA) to Physical Education (PE). Contacts noted that it was easier to integrate computer science into subjects with longer blocks of time. **District B** has a project in collaboration with the state's flagship university and a large private university called "Time for CS," which powers interdisciplinary learning by providing elementary school teachers with curriculum tools and instructional resources to help make integrated computer science accessible and relevant for all students.[15]

### Incorporating Computer Science into Every Subject

Schools in **District B** have brought computer science into as many electives as possible, including physical education (PE). Students use micro:bits and make timers or step counters to collect data.

## Supplement Limited Class Time with Electives

To help supplement limited learning time for computer science, contacts at three school districts mentioned electives and afterschool activities as one possible solution. **District D** considers extracurricular activities as one of the key components of the school district's computer science curriculum. The school district offers a robotics club, a LEGO League, and a junior LEGO League, as well as additional in-house opportunities.

Likewise, **District C** offers electives and afterschool offerings. As the district's computer science programs have grown and developed within the curriculum, so have its supplemental offerings, with the district now offering robotics teams in approximately 75 percent of their schools. Their robotics teams are highly competitive, and teams from the district have competed at the regional and state levels.

15) *About*. Time for CS.

**District B** also offers robotics competitions for students from elementary school through high school. Many of the schools in the district also offer robotics and [Girls Who Code](#) clubs during after school hours.

**Computer Science After School Activities**

**Robotics**

Teams of students work collaboratively to design and build robots.

**LEGO League**

Elementary and middle school students compete in regional, national, and international tournaments.

**Girls Who Code**

Young girls, who are generally underrepresented in computer science, participate in beginner to advanced computer science programs.
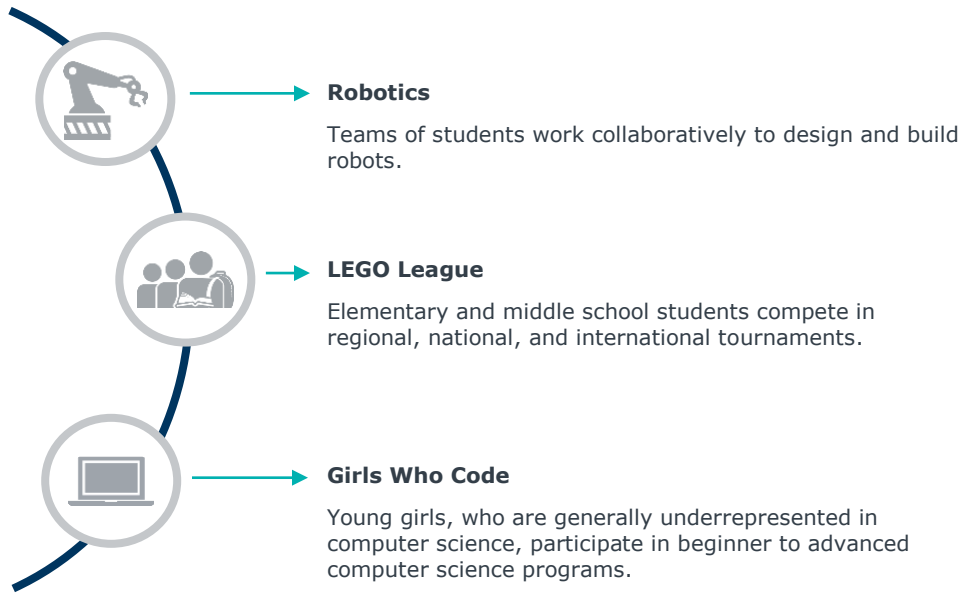
# Expanding Reach: No One-Size-Fits-All Approach

## Allow for Flexibility and Adaptability in Rollout as Computer Science Programs Develop

Contacts at two profiled districts noted that computer science programs needed adaptability during the rollout and in implementation across the district.

Our contacts at **District D** shared that flexibility is necessary when implementing computer science programs. Instead of trying to implement computer science with a one-size-fits-all approach, districts need to offer their schools flexibility and a degree of autonomy in implementing programs.

During the rollout of its computer science program, **District A** has been piloting both specialist and integrated programs in different schools. This has allowed **District A** to identify the strengths and weaknesses of each model. Although the district found high-quality teaching within their schools with specialist teachers, our contacts were most impressed with the integrated model used in some of their schools.

## Superintendent-Led Initiatives Strengthen Program Standing within the School District

Superintendents at two districts played key roles in advancing computer science offerings in their respective districts. Contacts at **District C** noted that having support from the superintendent and a push from above to implement computer science within the district helped navigate major hurdles in the rollout process. For example, the superintendent's initiative allowed the district to take the step to negotiate with its teachers' union to mandate a minimum number of minutes that would be dedicated to computer science education in schools. Similarly, the superintendent at **District D** began a push to bring computer science to the district after finding

*kidOYO*, a self-led "computational literacy" platform.[16] This superintendent-driven interest in computer science has enabled **District D** to give all students the opportunity to take computer science classes.

## Energize Grassroots Efforts to Help Get Initiatives Off the Ground and Build Momentum

**District B** encourages its enthusiastic computer science teachers to talk with their peers, which promotes the class to teachers and gets it into more buildings. This word-of-mouth approach was instrumental in getting its computer science program off the ground and integrated into schools across the district.

Our contacts at **District B** noted that expert teachers' grassroot efforts were also instrumental in helping the computer science program maintain momentum. As teachers have come and gone from the district and district leaders have had to navigate disruptions to the program, such as the COVID-19 pandemic, program administrators have had to refresh and reenergize interest in computer science. As a large district, **District B** has used its current computer science teachers to encourage other teachers and schools to expand their computer science course offerings. They also share course events and accomplishments on social media and in local news sources, showing the quality of the course offerings. Program administrators also promote computer science within school buildings to teachers and principals to grow interest.

**District C** hosts STEM community engagement nights at approximately 25 percent of their elementary schools to help reach members of the community. These events give schools a chance to showcase classes to parents and other members of the community who may not be aware of the extent of the district's offerings.

## Increase Computer Science Accessibility by Targeting Overlooked Groups

Due to limited resources for computer science, school districts must figure out how to maximize program value and reach. Even within the same district, students from one school to another will have differing levels of access to computer science content, both within the school and outside in their personal time. **District A**, which cannot afford to have a specialist in all schools, has focused its rollout on students who are least likely to have access to computer science to help the district with its push toward equality.

**District B** expanded its computer science course accessibility through grant funding from CS for All. The district has worked with robotics manufacturers to get modified equipment that is more usable by students with disabilities, with features such as adapted buttons or braille on the programming cards. **District B** has also received funding from the University of Floria for a project that gives access for exceptional student education (ESE)-eligible students. In addition to using grants to increase opportunities for students, computer science leaders in the district present at principals' meetings to review who is getting placed in computer science classes to ensure that counselors are not only placing students identified as "gifted" in programs.

16) *About kidOYO*. (n.d.). kidOYO.

Finding Educators to Fill Roles Proves Difficult

## Profiled Districts Faced Challenges with Finding and Hiring Qualified Staff

Although computer science is becoming increasingly popular as a subject at the K-8 level, the number of available certified computer science teachers has not kept pace with demand. Despite having the funding necessary to create new programs, many districts cannot find the educators they need to teach in those programs.

> In North Carolina, for example, only **one percent** of computer science teachers have been specifically certified in computer science, making it difficult for school districts across the state to find the specialized educators they need to fill their open computer science teacher positions.

Contacts at **District B** specifically cited computer science knowledge limitations with pre-service teachers, with new teachers entering the workforce without the computer science knowledge and training necessary to teach courses. The contacts noted that this trend had persisted over the past ten years, despite the growing understanding of the importance of computer science as a skill. **District C** also noted difficulties with a high turnover rate amongst its computer science teachers. Within the time it took the district to train new computer science teachers, most of the teachers had already cycled out.

## Districts Use a Variety of Tactics to Find Qualified Teachers

**District D** has partnered with outside provider *kidOYO* for teaching and evaluating course content. *kidOYO* provides training and certification to college students with computer science knowledge, who then evaluate student work. As a result, the school districts' teachers do not have to be responsible for knowing content, leaving them only responsible for overseeing students' learning. This helps the district avoid overloading teachers. **District D** also worked with *kidOYO* to train the school district's librarians, who took on key roles in teaching computer science.

Using a different approach, **District C** focuses its computer science teacher recruitment on members of the local community such as parents or recent retirees. Our contacts at the district cited a high teacher turnover rate as one of the main difficulties that its program computer science program has faced. To fight the impact of turnover, **District C** has kept teacher training in-house and created its own tight, lockstep curriculum to keep courses on track despite high turnover. This lockstep curriculum allows for teachers to filter in and out of the position with minimal disruption and reduces the impact of teacher departures on student outcomes.

**District B** uses a grassroots approach to develop teachers already within the district into computer science teachers, reaching out to teachers in related roles with more relevant backgrounds and offering support to encourage these teachers to get the training they need to become certified teachers. The school district also offers teachers a bonus for getting certified to incentivize teachers to make the switch.

# Prepare Educators to Teach Computer Science through Regular Professional Development

Contacts at three profiled districts offer both initial training and ongoing professional development for their computer science teachers.

**District A** offers an in-house 10-hour course to train its teachers, as well as professional development for computer science at all-person professional development opportunities. Trained computer science teachers are already experienced general education teachers with classroom experience prior to training. **District A** also uses its professional development training to inform teachers of the value of computer science.

While **District D** has also offered training for staff in after-school and in-school sessions, much of their subject-specific training comes through their partnership with *kidOYO*. While the district has also internally trained its librarians to help teach computer science to their students, *kidOYO* has provided training for the staff that evaluates and grades student work.

## Teachers as Peer Mentors

When a teacher with computer science experience was about to retire, **District D** turned them into a specialist and then had them train other teachers before they left. Facing a shortage of trained computer science teachers, Mineola leveraged one of their own teachers as a resource to help train others.

In addition to training for dedicated teachers, **District B** has also trained other specialist teachers – such as art, music, and physical education – in computer science so that those teachers can introduce computer science when within the context of their electives.

## Computer Science Educator Titles

**Computer Science Specialist**

**District A** and **District C** use "Computer Science Specialist" to refer to their educators.

**Teacher, Computer Science**

**District B** titles computer science educators in the same format as its other teachers.

## Offer Challenging Coursework to Motivate Students and Keep Them Interested in Computer Science

Two profiled districts mentioned the challenge of offering students content that was adequately challenging, especially for students who have different abilities. As school districts are already working with minimal scheduling opportunities for computer science, schools need to maximize the available time they have to teach computer science in the most engaging way possible.

**District D** offers students an "explore-on-your-own" model that allows students to choose between coding languages and tasks to provide themselves with a challenge that is appropriate for their personal skill level and relevant to their interests. The district also emphasizes the importance of gamification and age-appropriate loops at the elementary level, with students choosing which language they wish to learn and completing modules to earn badges at their own pace. For example, a student can choose to learn Scratch or Python, depending on their own level.

**District C** noticed that students were often becoming disengaged around fourth or fifth grade, as students begin to become bored with block coding. To present students with a challenge that would reengage them, **District C** accelerated its program to advance students out of block coding and into coding language and syntax at an earlier age than other schools in the state.

## Use Outside Organizations to Increase Options for Exploration

With its "explore-on-your-own" model and partnership with *kidOYO*, **District D** offers its students a wider range of activities and coding languages. With the platform, students can complete a range of activities and learn a variety of languages at an age-appropriate level, expanding the curriculum options.

While their curricula is not as connected to single outside partner, **District B** and **District C** also offer or have offered content from organizations such as Code.org and Girls Who Code, which provide additional opportunities for students to explore computer science.

# 7) Adding Computer Science to the Budget

## The State of Computer Science Funding

### More States are Offering Funding for Computer Science

As more states encourage or mandate computer science within their school districts, increasing numbers of states also offer funding for programs. As of 2023, 25 states have passed over $120 million in funding for computer science education.[17] A large amount of funding is dedicated to computer science for younger students, with 40 percent of all CSforAll grants from the National Science Foundation awarded in 2020–21 focusing on preK–8 computer science programs.[18] An increasing number of states are also offering funding for computer science professional development opportunities for teachers, aiming to help close the gap between open computer science teaching positions and certified teachers.[19]

**States Offering Funding for Computer Science Professional Development in 2023[20]**

*Dark Blue = Yes. Grey = No. Black = Other.*
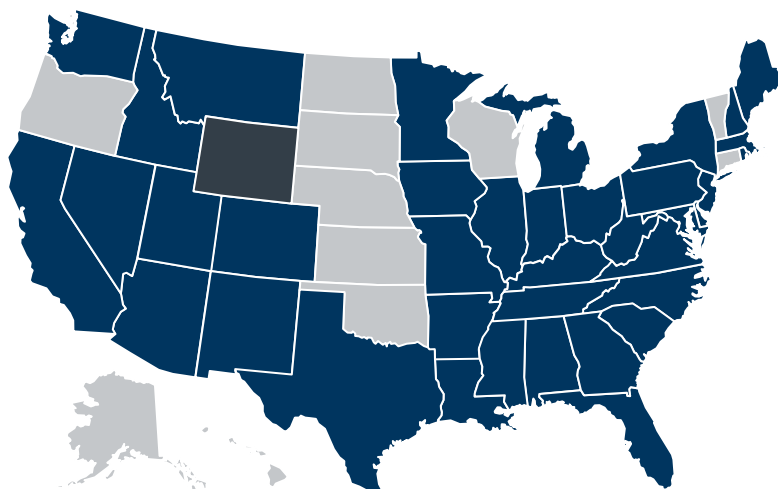


## Expanding Funding with Grant Opportunities

### Use Grant Funding to Get Programs Off the Ground

Contacts at three profiled districts cited grants as a key element when getting computer science programs off the ground. **District C**'s initial kickoff, which included training, was funded through a STEM action center grant, which has funds earmarked for STEM professional learning. Most of **District A**'s funding comes from grants. The district has an ongoing grant with the district's major fundraising organization.

**District B** has received funding from the state of Florida, which is based on the number of students in the district. During the first years of developing their program, some of the other large districts in the state were not using the available funding, leaving more available for their program. **District B** also receives funding for projects from the National Science Foundation and Google.

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17) 2021 State of Computer Science Education. (2021). *Code.Org, CSTA, & ECEP Alliance.*
18) Ibid.
19) 2023 State of CS Report. (n.d.). Code.org.
20) Ibid.

### Continue to Access Grants for Ongoing Funding

In addition to using funds to help establish computer science programs, school districts can access ongoing funding to maintain programs. As computer science continues to be a priority for state legislatures and other organizations, contacts at school districts shared that there were a number of funding opportunities they could take advantage of. **District C** continues to apply for grant funds every year, and has received millions of dollars over the last decade. **District B** continues to receive funding from the state of Florida, which is based on the number of students in the district. This additional grant funding has allowed profiled school districts to continue to further develop their programs and offerings.

## Integrating Computer Science Programs into the District Budget

### Incorporate Computer Science Funding in the Budget to Solidify Program Status

Contacts at **District C** and **District A** shared that funding for teacher salaries primarily came from the school budget. **District D**, which has more autonomy from the state over its budget, designated money from the district's budget for its computer science program. Teacher salaries are included in school costs, and as much of the district's program is covered by their partnership with *kidOYO*, most of the costs associated with the program, including training, are as well. The district also does not need to make additional expenditures on items such as textbooks.

# 8) Project Sources

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