CRACKING THE CODE

SIX KEYS TO BETTER CODING INSTRUCTION IN K-12 EDUCATION

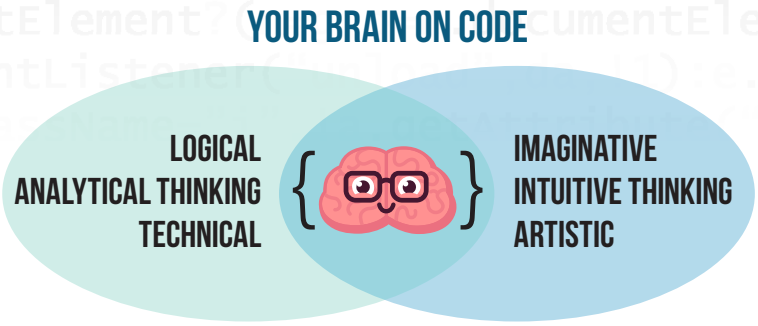
As society increasingly depends on technology and the call for 21st-century skills intensifies, STEM and STEAM continue to be a critical component of K-12 education.

These acronyms — which stand for Science, Technology, Engineering and Mathematics, and Science, Technology, Engineering, the Arts and Mathematics, respectively — are some of the biggest buzzwords in education today. Their rise to prominence is understandable, given the demands of the workforce. The U.S. Bureau of Labor Statistics predicts there will be more than nine million STEM jobs by 2022.[1] Additionally, more than one-third of the skills considered important today will have changed by 2020, and coding and computer science will become more important.[2]

Cultivating creativity will be critical in the coming years as well. A recent survey from IBM showed many CEOs feel creativity is critical for success. The good news: Creativity can be developed and learned if school districts focus on cognitive skills and enable kids to explore and discover for themselves.

The best way to equip students with these skills is to teach them in school, at an early age. One way to do this: More code. By learning to code, kids use their analytical left-brain skills in combination with their imaginative right-brain skills. Collaborative, hands-on and project-based learning with the right kind of coding instruction emphasizes whole-brain thinking, enhancing students' creativity and interpersonal skills. It also can be a heck of a lot of fun.

Building coding instruction into STEM and STEAM curriculum positively impacts education across multiple subject areas. However, schools can more effectively engage students by incorporating exercises and tools that are designed to inspire curiosity, creativity and invention through connected play, like Sphero Education's SPRK+ robots, coding canvas and STEAM activities, to name a few.



STATE OF THE UNION

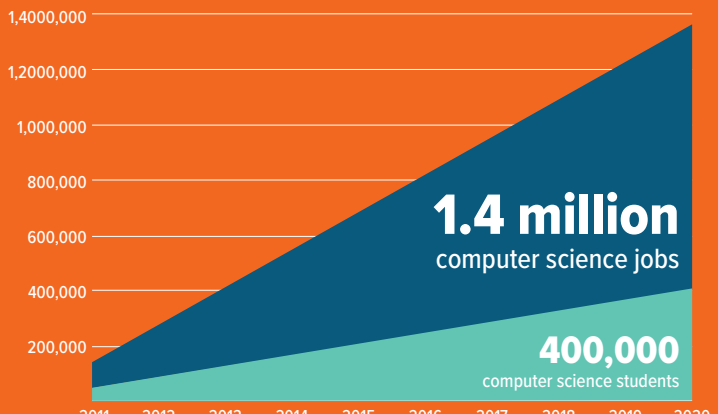
Before sharing best practices in coding instruction, it's important to look at the K-12 education landscape, and how most schools and school districts currently incorporate coding into their curriculum. Overall, there is a lack of focus on high-quality coding instruction, for various reasons.

Many schools and school districts participate in the nationwide "Hour of Code" initiative. But that's one hour, during one week, once a year. Many districts don't teach coding at all, and thousands of others don't teach it adequately. What's more, according to a recent opinion piece from *Education Week*,[4] "the drag-and-drop coding apps and tutorials that many K-12 schools use to teach students the beginnings of code may be entertaining, but they don't mimic the work that real computer scientists do."

The results from an October 2017 Center for Digital Education (CDE) survey support these claims. The survey, "Coding and Robotics Education in K-12," culled responses from 127 respondents representing a cross-section of K-12 education, including teachers and administrators.

THE JOBS OF THE FUTURE

Experts predict **1.4 million computer science jobs** will be available by 2020, but only 400,000 computer science graduates are expected to fill them.[3]



By one popular estimate, children entering primary school today ultimately will end up working in **completely new job types that don't exist yet.**

Perhaps the most notable takeaway of the survey is that respondents do not believe coding instruction currently is meeting students' needs for STEM and STEAM skills — only one-quarter of respondents think students' needs are being met or that they are being adequately prepared for higher education or the workforce.

Other key findings:

- While district support for technology overall is meeting individual school needs, support for robotics and coding is not as robust.
- Few respondents believe they have high levels of support for coding instruction from their respective states.

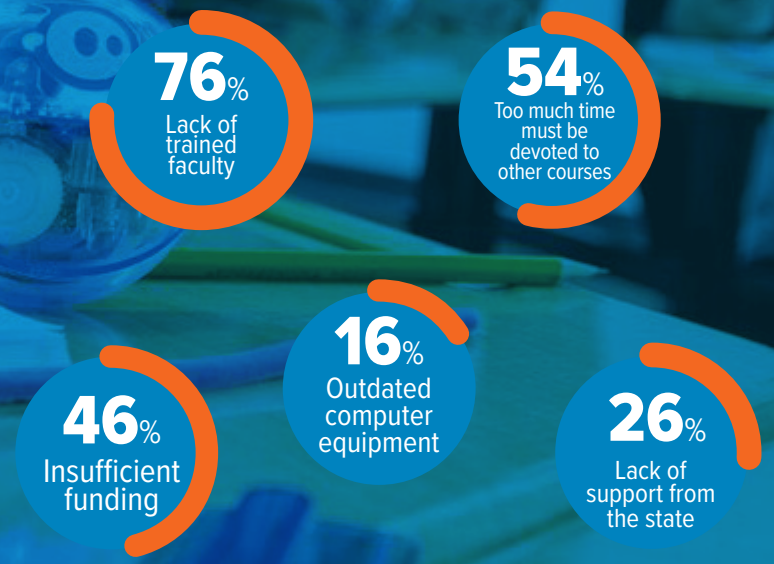
The survey also investigated the challenges schools face in implementing coding, technology and robotics, and the findings are equally alarming. For instance: 99 percent of respondents find it difficult to implement coding instruction in the classroom. Key barriers include a lack of trained faculty and time, and respondents noted that coding equipment is often too expensive. Furthermore, survey data indicates that teachers receive some professional development for technology, but it appears to be insufficient to meet student needs. By extension, this data indicates a need for simple, intuitive tools that are cost-effective and support learning outcomes.

Although a majority of respondents had negative things to say about the current state of coding instruction, many also said they consider technology, robotics, coding and STEAM to be highly or moderately important, and 92 percent of respondents said they consider robotics to be a valuable part of STEAM.

Finally, the survey found that many districts teach coding as part of computer technology education (CTE), mostly after school. Many districts also enlist non-computer science teachers to teach it.

Do you think the coding instruction at your school or district meets students' needs?

What challenges does your school or district face in providing proper coding instruction to students?



Source: October 2017 CDE Survey, "Coding and Robotics Education in K-12"

A BETTER WAY

There is a better way to coding instruction — a strategy that makes learning about coding fun. In totality, this approach incorporates robotics and technology with collaborative STEAM activities, and nurtures students' imaginations. This better path comprises six specific components.

Educate constituents on the importance of coding.

Why are STEM and STEAM important? Perhaps Bill Gates said it best: "Basic knowledge of the sciences, math skills, economics — a lot of careers in the future will be very demanding on those things, and you need to understand what can engineers do and what can they not do."[5]

Demand will also be high for skills in these disciplines. According to a recent WIRED article, the IT field is set to expand by 12 percent between 2014 and 2024, and the national average salary for IT jobs is about $81,000 — more than double the national average for all jobs.[6]

However, while finding quotes and statistics to demonstrate the importance of STEM and STEAM is easy, educating constituents on the these disciplines can be more difficult. For this, it's always good to share industry-accepted reasons to teach coding. An infographic titled "10 Reasons to Teach Coding" outlines these well.[7] Among the highlights:

- Coding allows students to create content and not just consume it.
- Coding is a place for students to take risks and fail safely.
- Coding is inclusive and builds self-confidence.

Allow teachers to be learners who explore coding.

The CDE survey indicated that a lack of trained faculty is the biggest obstacle to better coding instruction. One way to combat this problem is to teach teachers as if they were the students first. Engineering this discovery doesn't require radical changes to the pedagogy; it just means districts must build in time for teachers to be learners who explore coding as well.

For those schools and districts that have had success with the Sphero SPRK+ and Sphero Mini, one- or two-day professional development sessions that provide educators time to explore the robots and understand their capabilities have proven to be invaluable. Armed with this knowledge, educators who spend time familiarizing themselves with the technology feel much more confident utilizing the tools to teach coding to their classes in the future.

Start small.

New curricula have the best chance of survival when they start modestly, and a new spin on coding instruction is no exception. As such, the very best strategy for schools or districts is to first incorporate the new tools into one or two classes. This incremental thinking works for two reasons: 1) It shuts down those individuals who might argue over the balance between coding and computer science theory;[8] and 2) It provides an opportunity to establish teacher advocates/ coding champions who can shepherd the program as it evolves.

These advocates are key players in actualizing better coding instruction. With their help, rave reviews of a new approach spread by word-of-mouth, generating return on investment with every new teacher who wants to know more. Without them, there's virtually no way for educators across a school or a district to find out how their colleagues are embracing coding.

Roll out gradually.

With teacher advocates singing praises of the new curriculum, a school or school district can capitalize on rising interest and grow the new coding program organically. The first expansion might be from one or two classes to three or four; from there, officials can determine whether to roll out the new approach to an entire grade level, or entire cohorts (depending on the school model). Here, it's critical to let positive experiences drive interest — the more people in the district who are talking about the new approach, the better.

It's also important to make sure that as coding instruction grows, it is taught on its own, not just as part of the "Hour of Code" or the pre-existing computer technology education curriculum. There are dozens of apps through which educators can extend and amplify coding instruction, such as Code.org, Codesters, Code Academy and more. However, it's important to note that these coding platforms only teach block-based coding. With Sphero, the robot connection helps students make sense of the abstract nature of the code and increases their understanding.

Give students time to explore.

Just as educators need time to get comfortable with a new approach to coding, so too do students. This might mean allowing students to take programming apps or robots for proverbial test drives — giving them a week or two at the beginning of the unit to just play around and get a feel for what they can do. Educators say this is important because it enables students to establish some confidence with the new curriculum. Out of that confidence comes curiosity and the willingness to try and try again.

Not every student will be excited about coding. Most students will embrace it as something new and fun, but others will reject it as boring, too conceptual and too new. Giving students time to get comfortable with this aspect of STEM and STEAM education also provides them with the opportunity to accept this as something they'll have to learn.

Align with standards.

All new curricula must satisfy state standards, and in states that require coding, it's important for schools and school districts to make sure any changes to their new instruction fulfill these criteria. Experts say the safest approach is to put the new plan in writing, and as part of that document enumerate how the amplified coding instruction meets regulatory objectives. Consider this an exercise in codifying coding instruction; the clearer this master document is, the less likely a school district will receive pushback from state authorities about complying with the standards at hand.

If a school district operates in a state that does not require coding instruction (there are only a few of them left), it could pay to chronicle peripheral benefits of a new instruction plan anyway — to answer questions and concerns from parents, school board members or local journalists.

CONCLUSION

STEM and STEAM curriculum are a critical part of K-12 education, and superlative approaches to sharpening 21st-century skills will hinge on better coding instruction. The best solutions include coding that is interactive and fun, but also strategies that go beyond code by incorporating robotics and technology with collaborative STEAM activities, nurturing students' imaginations in new and exciting ways. These types of solutions appear to be moving the needle for school districts looking to improve coding instruction. According to the CDE survey, respondents who use Sphero solutions were more likely to say that coding instruction was meeting students' needs.

Instead of looking at coding as a requirement to fulfill, K-12 schools and school districts should consider it an open-ended form of art. Offering coding instruction and infusing technology at various points throughout the school day will make the coding seem less like an "extra subject" or another language, and more a relevant and integral part of regular instruction. Better coding instruction sparks divergent thinking and creativity; these concepts, coupled with the real-world benefits of learning how to program, will change the playing field for every student in America over the next five years and beyond.

PROFILES IN CODING EXCELLENCE

Currently, a handful of schools and school districts across the country have embraced a deeper and more comprehensive take on coding instruction. Two public districts in particular — Federal Way Public Schools (FWPS) in Washington state and Cobb County Schools in Georgia — exemplify the very best of this approach.

Federal Way Public Schools

Federal Way Public Schools' strategic plan, developed by more than 3,000 stakeholders (district staff, families, scholars and community members), includes STEM and STEAM experiences for all scholars. Scholars experience culturally responsive, standards-aligned, project-based learning opportunities preparing them for future STEM careers.

Over the last few years, the district and school staff worked in partnership to develop STEM and STEAM programs and experiences that bring scholars face to face with a variety of technologies throughout their elementary and secondary school careers. One of those technologies: Robots, including Sphero SPRK+.

Going beyond Hour of Code, the use of Sphero allows for sustained learning throughout the year that is showcased at the district's annual STEM Exploration Night. At this year's STEM night, scholars in elementary and middle Sphero clubs will demonstrate their learning of Sphero with a miniature golf showcase and a live competition with a Sphero maze challenge.

FWPS Superintendent Dr. Tammy Campbell shared the importance of STEM enrichment experiences: "Research tells us students make decisions about their futures as early as elementary school. If we are to have more student-scholars successfully enter STEM career fields, we must increase their exposure to these types of opportunities early."

Megan Walker, a secondary science facilitator, says the Sphero tools are currently used in 12 of 38 schools in the district, and notes they

form the centerpiece of two academic programs so far. The first of these programs is student-facing; fourth- and eighth-grade teachers build Sphero challenges into the curriculum, targeting math and science lessons around the technology and ways students can control it. In eighth grade, the challenge treats the Sphero as if it were the Mars Rover, and students must use the tool to "explore" a virtual planet they create.

The district has also embraced Sphero robots through professional development. At two-day sessions every summer, Federal Way teachers engage in a robot jousting competition to get a sense of how the robots work and move, and use the tools for other collaborative activities such as tractor pulls and mazes.

"When teachers first walk into the room, there always are some people who are intimidated," Walker says. "Halfway through [the lessons], everyone is engaged; it's remarkable to watch."

Looking forward, FWPS plans to expand coding instruction and eventually purchase Sphero robots to use in every school across the district. Chief Academic Officer James Crawford says the technology "hits all the components" of what STEM should deliver: creativity, collaboration, critical thinking and the opportunity to make math and science fun.

Crawford notes: "The way we see it, this is the future."

Cobb County Schools

STEM is a relatively new concept for Cobb County Schools. The district has offered advanced computer science, math and science classes for years, but these subjects always have been taught separately — until recently.

The push to bring disciplines together emerged in the early part of this decade. Officials took a closer look at the demographics of students who had signed up for computer science and saw they all fit the same mold: mostly boys, few girls, few students of color. These officials knew they had to make a change but wanted to build the new program around a curriculum that would appeal to everyone. That's when they discovered robots from Sphero.

Dr. Sally Creel learned about the robots at a science conference when she attended a session on coding. She didn't know much about it and didn't know what to expect. When the session leader whipped out the tiny ball-like robots she and other educators could control with codes, she was hooked.

"The experience gave me a moment of clarity that was a point of action," says Creel, who now serves as supervisor for STEM and Innovation for the district. "I knew in that moment I could put this in someone's hands and give them a tool they could use to truly understand what coding was all about."

Once Creel had this epiphany about the new approach to teaching coding, she decided she needed to do whatever she could to get them into teachers' hands. That opportunity came in the form of professional development courses. Creel built entire training sessions around the robots, allowing teachers to play with the tools to get them to think about ways in which coding can be fun. The district even launched an annual "STEMapalooza" professional development conference during which Creel gives away Sphero robots as door prizes.

Today, though the opt-in program is still relatively small, it's growing steadily. Many of the teachers who have received Spheros use them, and Creel estimates that at least one educator in each of the district's 115 schools has worked the devices into his or her curriculum. Active users regularly share lesson plans with colleagues who are interested in broadening their horizons and incorporating coding instruction into their classrooms. Students are responding positively to the new approach, as well; Creel says attendance is improved on the days when students know their teachers are going to do a coding lesson with the Sphero.

"It's like the excitement about this new approach has trickled down from teachers to their students," Creel says. "To have [students] think and think differently about coding, that's our goal."

> "I knew I could put [the Sphero robot] in someone's hands and give them a tool they could use to truly understand what coding was all about."
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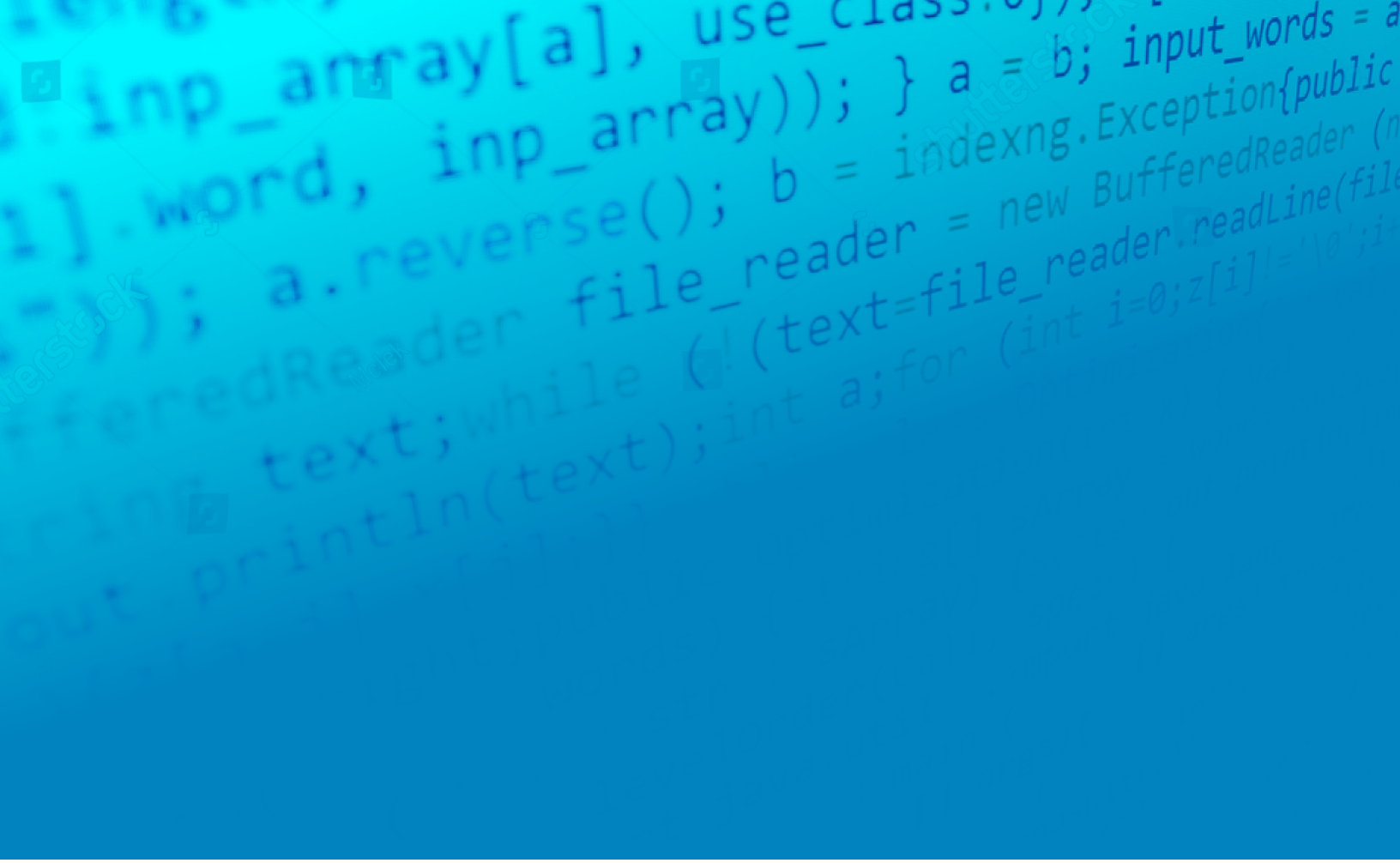
> DR. SALLY CREEL, SUPERVISOR FOR STEM AND INNOVATION, COBB COUNTY SCHOOL DISTRICT



ENDNOTES

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sphero edu

Creativity. It's at the very core of education and is widely seen as critical for success. Luckily, it is also something that can be developed through the cultivation of cognitive skills and independent exploration. Sphero Edu uses app-enabled robots to foster creativity through discovery and play, all while laying the foundation for computer science.Sphero Edu provides a toolset that is unbounded in its potential. It's not our role to limit young minds and place them on an established path, but to knock down the barriers and let them forge their own. We believe that sometimes the best lessons are the ones we teach ourselves. While coding and 21st century skills are necessary, our program also goes beyond code by incorporating robotics and technology with collaborative STEAM activities, nurturing students' imaginations in ways no other education program can. Our cross-platform apps are approachable for all skill levels and allow users to progress with ease, enabling us to reach as many minds as possible and provide ongoing challenges. Think outside the bot and inspire your future. This is Sphero Edu.