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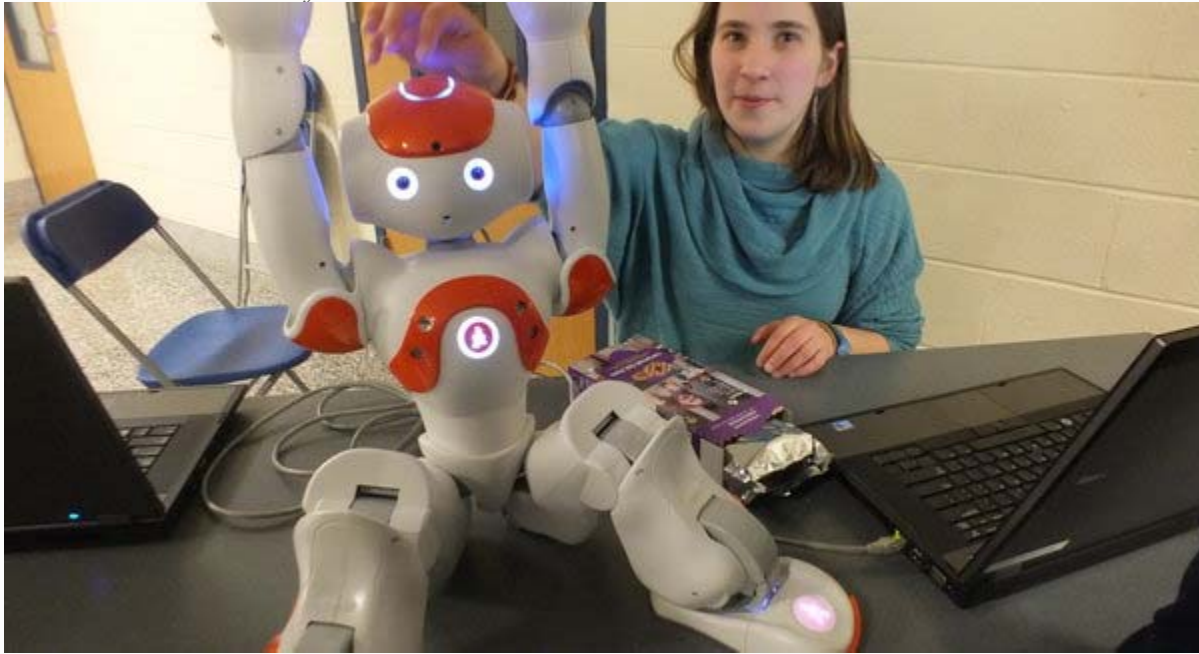
Coding from kindergarten to graduation

Districts expand computer science instruction to give students critical job skills

By:

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[A middle school student from Springfield Township district takes a STEM and a tech course to learn about robotics, programming and animation.](#)



We interact with computing devices every day—so should we have a better understanding of the science behind them?

An increasing number of districts are saying yes.

This year, 25 states require [computer science](#) courses for high school graduation, compared to only 11 states in 2013, according to the Computer Science Teachers Association (CSTA).

Districts are teaching basic coding to students as early as kindergarten, embedding computer science principles into core curriculum, and mandating computer science courses for graduation. The lessons teach students logical reasoning, algorithmic thinking and structured problem-solving—concepts and skills that are valuable in any discipline, proponents say.

Computer and mathematical occupations are projected to add 778,300 new jobs between 2010 and 2020, after having added 229,600 new jobs from 2006 to 2010. This represents 22 percent growth from 2010 to 2020, making the computer and mathematical occupational group the sixth-fastest-growing major occupational group, according to the federal Bureau of Labor Statistics.

“It’s a new path in the curriculum and it presents a whole lot of opportunities for kids,” says Eric Schneider, assistant superintendent for instruction at Minnetonka Public Schools in Minnesota.

“Computer programming is the tool that will be used in the future to connect creativity with problem-solving. It’s a school’s obligation to raise students’ awareness about it, and give them a basic level of competency and understanding of the science behind it.”

An example of its growth could be found in the news. Edmentum announced in March a new elementary school program on coding. It will teach students how to stay safe online, introduces programming and features the Code Crunch programming tool, and considers the use of technology to create solutions and complete tasks such as internet searching and identifying reliable websites.

Uniformity, integration

CSTA is advocating for uniform and required course offerings, along with consistent teacher certification. The association created a curriculum that calls for teaching fundamental concepts to students within the context of other academic subjects beginning in elementary school. Concepts include internet safety, hardware and software basics, and the problem-solving formulas known as algorithms.

Start a computer coding program

Other than professional development and teacher support, it’s not that hard to start offering coding and computer science lessons, district leaders say.

1. Play with free tools. “My advice to administrators is to just try some coding activities and give teachers professional development time to play with some of the free tools available,” says Axel Reitzig, robotics and computer science coordinator at the Innovation Center at St. Vrain Valley School District in Colorado.

2. Ensure lessons are focused. Minnetonka Public Schools in Minnesota made sure its lessons were focused and well-constructed before they were rolled out to teachers. For example, the instructional team structured content to teach important concepts in the fewest lessons possible. “Delivering very strong initial lessons is really important,” says Eric Schneider, assistant superintendent for instruction at Minnetonka. “They have to work well when teachers take their first shot in the classroom. If teachers can take that first step and the kids get excited, then it will snowball.”
3. Use standards. The ISTE and CSTA standards can be used as benchmarks to start developing a program, according to Tammy Pirmann, K12 coordinator of computer science and business at The School District of Springfield Township in Pennsylvania.

In grades 6 through 9, the students take computer science courses or receive the instruction as components of other classes. For grades 10 through 12, schools are encouraged to offer secondary-level courses to prepare students for the workforce or college. CSTA mapped the intersection of its proposed instructional standards to those of the Common Core.

It starts with a code

The approaches to computer science curriculum vary considerably among districts. However, coding—the creation of instructions in language that a computer understands—is a good place to start. “A key idea in coding is the concept of sequencing—putting instructions in step-by-step order to achieve a desired result,” says Karen Brennan, assistant professor of education at Harvard Graduate School of Education.

Brennan and her team run ScratchEd, an online community for educators who teach Scratch, a programming language that makes it easy to create interactive art, stories, simulations and games. Members of the community have access to coding projects they can do in the classroom, and workshops and resources to learn more about teaching coding.

Just this school year, Minnetonka launched computer programming for students in kindergarten through fifth grade. Kindergartners through second-graders are required to receive at least four lessons a year in coding; however, many teachers have doubled that number. Students in grades 3 through 5 receive eight lessons each year.

Using interactive programs like Bee Bot, young students apply basic coding skills to make an onscreen character move, for example. With more advanced skills, students can make animated birthday cards and create interactive comics.

Adding the additional lessons is a “tight fit” in the school day, says Schneider. Teachers are shortening other lesson periods or reducing review time on other subjects to accommodate the new lessons. “When

teachers see how effortless it is (to teach coding), and the way kids are drawn to it, they are eager to make room and adopt it,” says Schneider.

Creating a curriculum

The School District of Springfield Township in Pennsylvania provides a full K12 curriculum built upon the CSTA curriculum. Kindergartners and first graders receive computing instruction 30 times a year for 45 minutes. They learn vocabulary and a basic understanding of computer devices.

In grades 2 through 5, teachers incorporate the CSTA standards into other courses. For example, the standard of “gather and manipulate data using digital tools” is incorporated into lessons on weather. Students collect data, such as temperature and wind speed, from a school weather sensor, and they graph the information to help calculate the day’s average temperature.

Coding and computer science resources

- [Bee Bots](#)
- [Code.org](#)
- [Code in the Schools](#)
- [Codeacademy](#)
- [Code-to-Learn Foundation](#)
- [CoderDojo](#)
- [Computer Science Teachers Association](#)
- [Girls Who Code](#)
- [Harvard Graduate School of Education ScratchEd](#)
- [Hour of Code](#)
- [The International Society for Technology in Education](#)
- [Kodable](#)
- [Lightbot](#)
- [National Science Foundation](#)
- [Sphero](#)
- [Tynker](#)

“We are meeting Common Core and computer science standards at the same time,” without loading too much on teachers, says Tammy Pirmann, K12 coordinator of computer science and business.

Middle school students must take one STEM and one tech course where they learn robotics, programming and animation. High school students must take Introduction to Computer Science as a half credit to graduate. Students learn the parts of a computer and their functions, networking basics, computational thinking, and more. They can also choose from electives in robotics and websites. Coding is taught in all the courses.

And not all instruction time is spent interacting with a screen. “There’s a lot you can learn without a computer,” says Pirmann. “Students need to first think about what they are trying to do and plan it out. They have to reason, communicate, plan and develop a hypotheses. And when they test it on the computer and it works, they get really excited.”

And computer science classes help students in their other courses, Pirmann says. The number of students who scored “below basic” proficiency in Algebra 2 dropped from 25 percent to 10 percent during the five-year period when the district was adding more computer science courses.

St. Vrain Valley School District in Colorado is creating a computer science framework built on the standards from CSTA and ISTE. ISTE standards focus on general digital-age skills that students need. Some of CSTA’s standards overlap with ISTE’s; however, CSTA’s have a clearer focus on computer science skills.

“Our guiding philosophy is that students need a basic level of literacy and skills in computer science,” says Axel Reitzig, robotics and computer science coordinator at the district’s Innovation Center.

How computer science is taught, if at all, varies greatly across the district that serves 33,000 students. The goal is to create recommendations based on learning objectives for each level. For example, what are the learning objectives for computer science for middle school, and what tools are best suited for reaching them?

Teachers and administrators will give feedback over the next few months. And this summer, the district plans to have teams of teachers begin redesigning or designing units and lessons around the learning objectives.

Ideally, the units and lessons will be integrated into existing lessons and work toward other content standards. And leaders hope to begin developing computer science-specific lessons. “As we begin

developing these curricular goals, we will start to define and provide professional development,” Reitzig says.

Minnetonka’s plan

In the 2015-16 year, Minnetonka plans to roll out a program for grades 6 through 12. Instruction in middle school will take place in three ways:

1. Computer science concepts will be integrated into existing sixth-grade tech education and seventh-grade STEM required courses.
2. Students can participate in extra-curricular robotics and tech teams and a CoderDojo programming club.
3. Programming applications will be integrated into other classes, like English and science. Students are encouraged to apply coding to create interactive presentations rather than simply using PowerPoint. For instance, a student could create an interactive game to illustrate a book report.

Minnetonka high school students will have the option of taking AP and IB courses, and possibly even online, for elective graduation credit.

Support teachers

The need for PD is evident as more interested teachers make use of free instruction. CSTA’s bimonthly computer science Google chats for teachers are popular, more than 15,500 teachers belong to the ScratchEd online community, and many educators access the site’s resources.

Minnetonka Public Schools started training its 300 teachers in workshops last August and regularly uses staff development time for additional instruction. Also, the district created an online introductory computer programming course in response to teachers’ request for more training. Teachers receive a small stipend for completing the course. CSTA is pushing for teachers to be certified in computer science just like their colleagues in science, English, history, math and the arts.

Teachers who are uncomfortable with teaching coding and other technology need support in the classroom, says Schneider. During the school day, instructional team members can help or a teacher can ask another teacher to help deliver a lesson until he or she is comfortable with the technology. Teachers also have the option of bringing in classes of older students to help teach computer skills to younger learners.

Elementary teachers at Springfield Township can ask for support from tech coaches in each of the schools. The coach can walk around to ensure students are in the right place and that computers are

working appropriately during lessons. Or the coach might teach the computing concept while the teacher addresses overall project goals.

Middle school teachers have integrated the computer science principles into their STEM and technology courses. One standard is “use the basic steps in algorithmic problem-solving to design solutions.” This could be met in the Tech Ed course via an engineering problem to build a bridge with given materials that can hold a large load.

A village

It appears likely more schools will deliver some form of computer science instruction, given the workforce demand, the push by different associations like CSTA and CodetoLearn, and the backing of industry giants like Microsoft, Google and Oracle. “A lot of people are working to get this to happen,” says Deborah W. Seehorn, chair of the board of directors at CSTA.

“But it takes a village. It takes the support of administration, the superintendent, the school boards, and the teachers saying, ‘I want to do this.’”

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