

ROBOTS REVOLUTIONIZE STEM

Schools use range of
devices for real-life
demonstrations of math
and science concepts

By Matt Zalaznick

The new breed of robots rolling, dancing and flying into classrooms is giving educators at all grade levels an engaging new tool to fire students' enthusiasm for math, computer programming and other STEM-related subjects.

The most well-known, widespread use may be the competitions in which students use kits to build robots that can be programmed to negotiate obstacle courses or even to play games. But industrial-sized robots also are being integrated into high school voc-tech courses while simpler models are introducing elementary school students to the basics of design and computer programming code.

"We can really get a robust robotics program going that starts with our young chil-

dren in elementary and takes them right up through high school, and that opens doors for them with college options," says Kathleen Schofield, the curriculum coordinator for the 35,000-student School District of Clay County in northern Florida.

With funding from a series of U.S. Department of Defense Education Activity grants several years ago, the Clay County district's leaders began developing an extensive robotics program that now runs from fourth grade up through high school. And though many of the districts' programs across the nation aren't quite as extensive as is Clay County's, educators are finding that robots may be unrivalled in their capacity to bring complex STEM concepts to life due to the sheer nature of their high-tech, but human, element.

Math comes alive

Educators are using robots to give live demonstrations of math concepts. Onslow County Schools on the North Carolina coast uses kits by RobotsLab in a variety of STEM classes at three of its seven high schools, says John Shannon, the director of career and technical education.

The RobotsLab kit comes with curriculum activities, a tablet computer, a quadcopter and three smaller devices: a robotic arm, a "sphero" programmable ball and a rolling tube with a mustache called the "mobot."

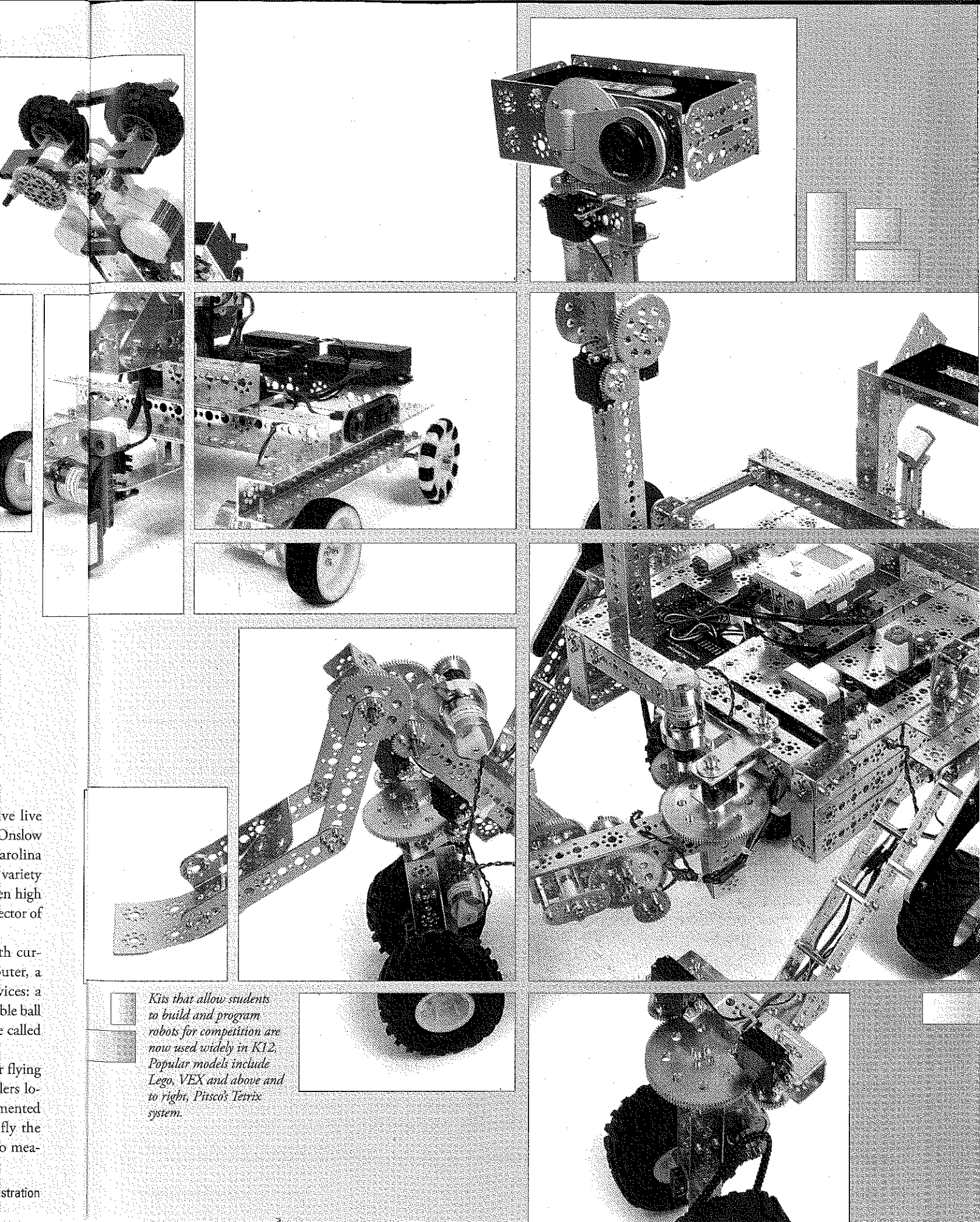
The quadcopter consists of four flying disc-sized rings with small propellers located inside. Students use the augmented reality function of the tablets to fly the quadcopter and to track its path to mea-

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Kits that allow students to build and program robots for competition are now used widely in K12. Popular models include Lego, VEX and above and to right, Pitsco's Tetrix system.

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sure curves and solve quadratic equations. With the sphero ball, students can write linear equations to make it roll across the classroom floor.

"You can do the math in a book, you can graph it on a calculator, but when you've got this quadcopter—and kids are using that with augmented reality—they're really seeing what the math is," Shannon says. "That, to me, is the power of using these robots—they get to see it in real time."

The robots also are putting the district's 3D printers to use. The "mobot," which rolls to help students understand radius and distance, is built completely with a 3D printer. If a part breaks, students can put the mobile file in the 3D printer and make a replacement, Shannon says.

Robots, from LEGO and Pitsco, also are playing a project-based learning role at Okaloosa STEM Academy, a two-year-old middle school in the Okaloosa County School District in the Florida Panhandle. Seventh graders this year built an iPad-controlled, Mars rover-like robot they used to explore a board covered with

blue and red balls. Using the robot's camera sensor, they collected only the blue balls with the rover. Then, using a "data logging" program, they programmed the rover to find and collect the blue balls on its own, says Robert Jernigan, who teaches robotics and algebra.

This is the same type of programming used to control unmanned aircraft such as drones, he says. "The robots have increased the passion the students have for math and science because of the flexibility of what the robots can do," Jernigan says. "We're not having students hit the wall with algebra and say, 'this is too hard.' We're having people jump over that wall."

Programming and presenting

But it's not just STEM skills that are getting a boost from robotics instruction. The projects which Clay County students are working on also incorporate a range of Common Core skills, says Schofield, the curriculum coordinator.

One of this year's middle school robotics projects was called "Nature's Fury," in which students had to research natural di-

sasters and then program the robots to, if it was a real scenario, assist in emergency response by clearing storm debris and fallen trees on roads so rescue or supply trucks could reach victims.

"In terms of Common Core, they're doing all of the research, they're writing, they're speaking and listening because they're communicating with folks who are in the business sector or other organizations involved in the topic they are studying," she says.

In seeking the grants, Schofield says her goal was to get elementary school students hooked on computer programming so they would continue to develop their skills through high school and beyond. The first Department of Defense grant that Clay County received was for \$2 million and it supported creating robotics programs in 11 of the district's 26 elementary schools in the 2011-12 school year. Those 11 schools were eligible for the defense funding because more than 15 percent of the students had families with military connections.

In the first year, the district bought

Robots connect with students on autism spectrum

Robots are opening new channels of communication for students on the autism spectrum or those with other disabilities. Educators at New York City's special education District 75 say the NAO robot—a bright-eyed, two-foot-tall humanoid developed by Aldebaran Robotics—is now considered a virtual classmate by some students.

Students can talk and read to the friendly and mobile robots, which can respond verbally and with head nods and hand gestures. The students also can sing songs with the robots and work on color- and word-matching exercises, among other activities. The district also has trained its teachers to program the robot to perform new functions, such as reading stories back to students, District 75 STEM Director Leslie Schecht says.

"We have seen, in a couple of instances, where students who were completely non-verbal are verbal, and students who would not touch are actually hugging the robot," Schecht says. "Is this a silver bullet? No, but do we see actual changes in several students? Absolutely."

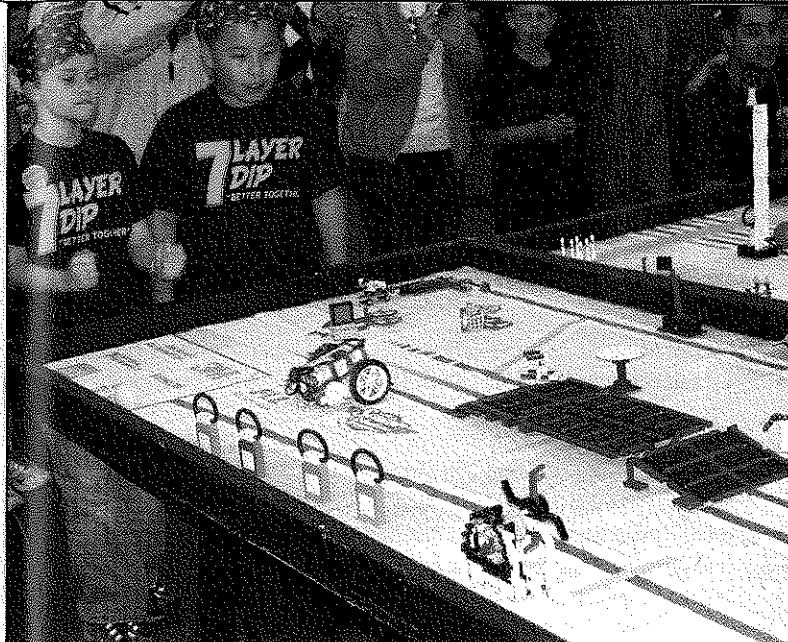
District 75 operates special education programs for about 23,000 students in New York City schools. It has two robots each in two schools—P.S. 9932, a K12 school in Queens, and 10X, a K8 school in the Bronx.

Since the robots were introduced, there has been a drop in inappropriate behavior, such as temper tantrums, when transitioning between class activities, District 75 Superintendent Gary Hecht says. The ultimate goal is for the students to transfer the social skills they're learning to the rest of their school day and their lives beyond.

"We're seeing a pattern now that hopefully will translate into those academic performance activities where students will be able to focus and to attain greater opportunities through this experience with the robot," Hecht says.

Four NAO robots are being used in Edison Public Schools in New Jersey to build relationships between high school students in advanced engineering classes and elementary school students with autism, says Christopher Conklin, the district's assistant superintendent for pupil special services.

The engineering students this spring will learn to use and to program the robots to follow directions and use language, among other activities. They will then bring the robots to classrooms for students with autism. "The engineering students will get to see a side of life they're not used to seeing," Conklin says. "It's about connecting two groups of kids who would otherwise never connect."



Clay County schools students participate in a Lego robotics competition. A series of U.S. Department of Defense grants allowed the northern Florida district to establish an extensive robotics program that runs from elementary through high school.

LEGO robotics kits, with which students can build and program a range of humanoid and other types of robots. The district also trained one faculty member at each school to coach a small robotics club of about a dozen students.

Last school year, the Clay County system received its second grant, for \$765,000, to expand the robotics clubs to two of the junior high schools that are fed by the 11 elementary schools. The district also began hosting statewide robotics tournaments in partnership with the computer science department at nearby St. John's River State College, which Schofield says was interested in improving the computer programming skills of students who graduated from the district.

The district's third grant, also for \$2 million, funded expanding robotics programs to another two junior high schools and five of its seven high schools. Schofield says she's planning to add a program—perhaps by the 2015-16 school year—in which high school students can work toward industry certifications in robotics and engineering.

Catching Toyota's eye

Thanks to the industrial robots at the Southern Indiana Career & Technical Center in Evansville, high school students are getting a jumpstart on their careers. Students start with simpler programs, such as making a robotic arm write their names

and trace lines. Among the more advanced skills students are learning is how to program robots to work on conveyor belts and assembly lines, says Trevor Weaver, an electrical/robotics instructor.

"To have a robot stop a part in an exact spot on a conveyor belt, then set it down

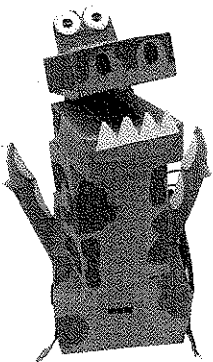
on another conveyor belt, and have another robot pick it up — that's an intricate program," Weaver says. "When they got that assignment completed, they were really proud."

The school, which is part of the Evansville Vanderburgh School Corporation,

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bought eight robotic arms from Yaskawa Motoman in 2011. They are similar to the robots used by major manufacturers.

Two of Weaver's seniors have been accepted into Toyota's Advanced Manufacturing Technician program at nearby Vincennes University. The students will start off earning \$17 an hour working at least two days a week at a Toyota factory, Weaver says. "Toyota likes the fact that the kids have already had the opportunity to use robots that are similar to what they use," Weaver says.

Two of Weaver's students are programming a robotic arm to play a piano. "There is a lot of problem-based learning with the robots," Weaver says. "When the students start to put a project together, everything doesn't just fall into place. The students always encounter problems—just like in the real world. They're getting a lot of practical experience."

In a separate workforce prep initiative being developed in northern Louisiana, four robotics kits will be shared by physical science and geometry students among more than a dozen high schools in four school districts.

A \$64,000 Chase Foundation grant will be used to buy the VEX Robotics kits, which students can use to build and program small humanoid, vehicle- and machine-like robots. The grant also will fund a curriculum that is being developed with help from a company called Red Stick Robotics, says Lynn V. Clark, a leader of the program and an assistant professor of curriculum, instruction and leadership at the University of Louisiana at Monroe.

Students will build a 18-inch tall robot, known as the Claw Bot, which has a claw and sensors, to study Newton's laws of physics. The students will program the robots to collide with moving and stationary objects, and then test different materials that could be used to build a shield to protect the robots from damage.

The hands-on nature of robots makes STEM subjects less intimidating for many students, Clark says. "It is the ideal integrated STEM approach," she says. "Students will be getting the math and they will be getting the science—they'll be get-

III students become 'rockstars' with robot

Tutors and class work sent home can help students keep up academically when they miss extended amounts of school due to illness or injury. What's harder to make up is the lost social interaction with friends.

A startup, VGo, has created a robot—which looks like a much sleeker version of a Segue scooter—that lets these students attend school without having to leave a bedroom, hospital or other medical facility. Students use a computer or tablet to connect to the VGo and their faces are displayed on its screen. Students can see the classroom through VGo's cameras, transmit their voices and drive the robot from class to class.

Mike Flanagan, assistant superintendent of Tyngsborough Public Schools in Massachusetts, says his son, Connor, used a VGo after his double-lung transplant in October. The VGo not only helped Connor, then in middle school, keep up with his class work but kept him in closer contact with his friends than social media could, Flanagan said.

"Within the first week of using VGo, by being able to interact and see that the other kids still treated him like Connor—that emotional connection that VGo allowed Connor to make with his friends helped integrate him back into the school," says Flanagan.

Connor returned to school in March.

The VGo—which uses Wi-Fi—doesn't have arms, but its lights flash when the students want to raise their hands to ask a question. A popular feature is the camera that students can use to take pictures of whiteboards and other educational materials.

"The kid on the robot is treated like a rockstar," says Ned Semonite, VGo's vice president of product management and marketing. "The robot takes on the same characteristics as the student. People end up treating it as a person—not a robot. They don't call it the VGo, they call it by name of the student."

There are about 100 of these robots in use. They cost \$6,000 apiece and there is a \$1,200 yearly maintenance fee. In some cases, school districts have bought the units for students, but mainly they have been purchased by parents and charitable organizations.

ting it together. And then they'll get this other layer of very basic concepts of computer programming."

Dancing and wrestling

This past December, middle school students became the robotics instructors during national Computer Science Education Week at Montclair Public Schools in New Jersey. A company called Birdbrain Technologies loaned Mt. Hebron Middle School 50 of its Finch robots, which look like an oversized computer mouse with wheels, eyes and a nose that students can personalize by making it glow in different colors of their liking.

About 40 interested students spent two months of after-school sessions learning the technology and developing programs to make the robots dance, draw pictures, wrestle with each other, or play tag and

Resources

BirdBrain Technologies,
www.birdbraintechnologies.com

First Lego League,
www.firstlegoleague.org

LEGO robotics,
www.lego.com/en-us/mindstorms

NAO, Aldebaran Robotics,
www.aldebaran.com/en

Pitsco,
www.pitsco.com

Red Stick Robotics,
www.redstickrobotics.org

RobotsLab, www.robotslab.com

VEX Robotics, www.vexrobotics.com

VGo, www.vgocom.com

Yaskawa Motoman, www.motoman.com

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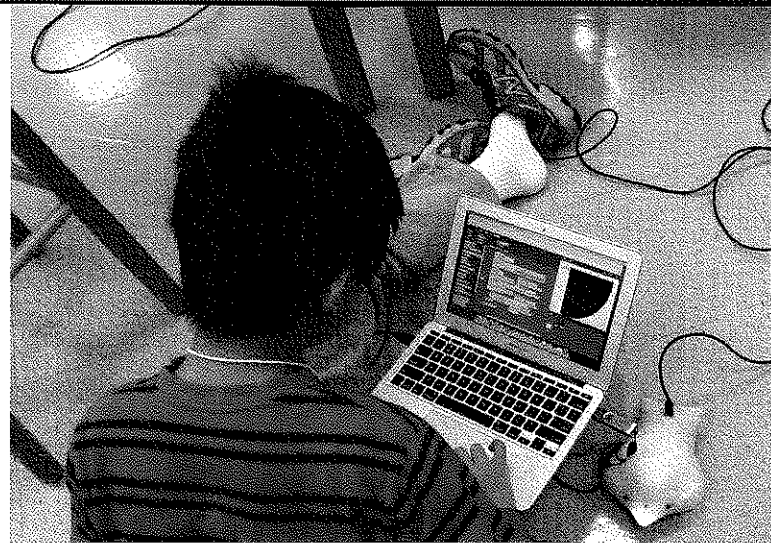
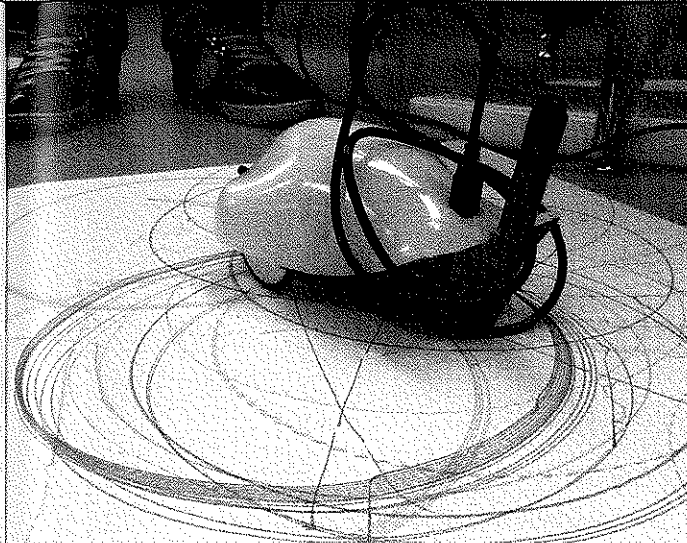
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Students at Mount Hebron Middle School in Montclair, N.J., learned basic programming to make their Finch robots dance, draw, wrestle, race and play soccer. The Finch is the white device with the glowing nose.

soccer. Those students then brought the Finches and the activities to the rest of their classmates, who experimented with the robots during flex periods two to three times a week.

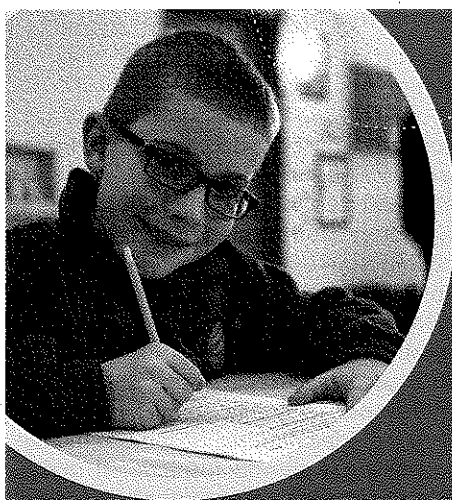
"Some of the students came up with their own programs, like racing down the hallway or pushing an object around the classroom," says Mt. Hebron STEM coor-

dinator Daniel Taylor.

Students became so engaged because they could make robots perform these tasks after just a little bit of instruction in programming, says Ursula Wolz, a visiting computer science professor at nearby William Paterson University who helped develop the Mt. Hebron robotics program. "The Finches have enough sophistication

that you can do some amazing things—they're also compact enough and uncomplicated enough that you can do powerful things really quickly," says Wolz, who also has a daughter at Mt. Hebron. "Every kid in the school had to do some programming, and they made it their own." **DA**

Matt Zalaznick is senior associate editor.



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