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A 'new approach' to teaching computer science: Get rid of the computer

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HOLYOKE — This fall, a dozen area high schools will take a new approach to computer classes — sometimes by ditching the computer.

While much of the Exploring Computer Science program does in fact feature computer work, the yearlong curriculum encourages hands-on learning and problem solving through journal writing, group brainstorming and the use of toys to illustrate concepts.

During a weeklong workshop earlier this month at the Massachusetts Green High Performance Computing Center in Holyoke, 15 teachers took their first steps in spreading a new wave of computer science education to local students. The workshop is a national initiative that takes a three-pronged approach to teaching: equity, inquiry and computer science concepts.

The Holyoke workshop was part of a statewide program organized by the University of Massachusetts Amherst and the Massachusetts Exploring Computer Science Partnership. It was funded by a \$40,000 National Science Foundation grant.

The dozen western Massachusetts and Worcester County schools that will offer the curriculum this fall join a handful of schools around the state that began offering it two years ago. The high schools that will begin offering the program are Easthampton, Gateway Regional, Granby, Ware, Greenfield, Holyoke, Putnam

Vocational Technical Academy, Wilbraham and Monson Academy, Lenox, Chicopee Comprehensive and Murdock in Winchendon.

It might seem radical that some of the lessons put aside high-tech devices in favor of toothpicks and marshmallows — but teachers say the concepts taught during the workshop lay an important foundation for critical thinking skills that can be applied to advanced computing and other disciplines.

Experiential learning

You won't find any lectures in the Exploring Computer Science curriculum. Nor will you see the instructor delivering speeches from a dais during the teacher training workshop.

Sitting around a table after the workshop had ended for the day, about a dozen teachers sang the praises of the program. Some planned to use what they learned to revamp their computer science departments, while all of them agreed that Exploring Computer Science provides a path to the future for today's students.

"It's the very antithesis of teaching to a standardized exam," said Brian Tolan, a chemistry and computer science teacher at Lenox Memorial Middle and High School.

The course consists of six units: human computer interaction, problem solving, Web design, programming, computing and data analysis and robotics. Each of the lessons includes opportunities to consider ethical and social issues.

During the Holyoke workshop, the teachers were introduced to the Exploring Computer Science lessons and teaching methods. A large amount of their time was spent working through the actual lessons, as their students will be doing come fall.

For example, one lesson asks students to use Lego bricks to compute the construction time for a theoretical tower, built according to specific guidelines. To solve the problem, the students need to use the toys to create an algorithm.

"What would you do if I told you to come up with a mathematical equation in 45 minutes?" Kathleen Gorski, science department chairwoman at Wilbraham and Monson Academy, asked rhetorically.

She said the hands-on activity does the same thing that a computer-generated equation would do while "demystifying" the rule-based language required to do it on a computer.

"They're discovering their own algorithms," said Maia Valcarce, a math teacher at Greenfield High School.

Experiential learning is a cornerstone of the Exploring Computer Science curriculum. Rather than teaching how to use Microsoft Word or a set of HTML codes, Exploring Computer Science focuses on teaching concepts that open the door for the critical thinking students need to learn advanced computing.

“They’ll be learning the concepts behind what makes a computer do what it can do,” said Renee Fall, regional director of the Massachusetts Exploring Computer Science Partnership and a project manager at the College of Information and Computer Sciences at the University of Massachusetts Amherst.

Valcarce noted that many people confuse computer skills with computer science. “The kids know how to use technology, but they don’t know how it works,” she said, adding that Exploring Computer Science aims to teach the workings of computers. “No matter what problem you’re faced with, you’ll have the solutions to solve it.”

Another example of the critical thinking and programming skills taught through the curriculum comes from a peanut butter and jelly sandwich.

The question seems simple: How exactly do you instruct someone to make the sandwich?

Steps include picking up the jar of peanut butter, unscrewing the lid, inserting the knife, scooping out the peanut butter and spreading it on the bread. And that doesn’t even include getting the materials out of the cupboard.

The example is designed to show the level of detail needed to program a computer to perform a task.

“You don’t realize how many steps it takes to make a peanut butter and jelly with no presumptions whatsoever,” said Linda Courtney, a business and technology teacher at Ludlow High School. With no intuition, computers — unlike people — only know what you tell them.

“We’re not telling students that they need a highly structured, rule-based language to program computers or robots,” Tolan said. “They discover that organically.”

“It sets them up so they can understand it, because if you understand it you’re not afraid of it anymore,” Courtney said of the approach.

The teachers say that the skills fostered by the curriculum will help students keep pace with technological advances that are developing faster by the year.

“The principles that we’re teaching here can be applied to the future,” Gorski said.

“To solve tomorrow’s problems,” Valcarce added.

“What makes teaching so hard is that we’re not teaching for today’s jobs — we’re teaching for tomorrow’s job,” Tolan said.

Research foundation

The Exploring Computer Science curriculum was created in response to research outlined in the book “Stuck in the Shallow End” by Jane Margolis. Margolis exposed what she determined were structural inequalities present in computer science education in the Los Angeles school system, finding that black, Latino, and female students did not receive the encouragement and support needed to build the foundation for pursuing advanced studies in computer science.

“Both students and teachers had a lot of stereotypes of who did and didn’t belong in computer science,” said Gail Chapman of the University of California at Los Angeles, who led the Holyoke workshop and was one of the writers of the Exploring Computer Science curriculum.

On top of that, Margolis found that course material was often based on teaching typing skills, or applications such as Microsoft Word. That makes for a big gap in a generation that is supposed to be much more tech-savvy than their parents.

“The only way to address the problem was to create a whole new course,” Chapman said.

When the Exploring Computer Science team began working on the 300-page textbook and curriculum guide and accompanying professional development workshop for teachers, they aimed to close that achievement gap just in the Los Angeles schools. During the summer of 2008, Chapman led a development session with six teachers in the city.

Eight years later, through partnerships with the National Science Foundation and local universities, Exploring Computer Science is offering 36 sessions in 26 different regions of the United States this summer. Chapman herself taught 11 of those sessions, including the one in Holyoke.

The group of 15 teachers who participated in the August workshop will come together four more times throughout the year to go in-depth in specific topics.

And as they learn together, they’ll learn how to teach together.

“We’ve now built a community of learners, and we can now support each of us,” Gorski said.

And that’s just what Chapman intended.

The teachers who learn the Exploring Computer Science curriculum can go on to become facilitators like Chapman. However, she urges that administrators need to understand that change is slow, and that they can’t rush this computer science renaissance. Teachers need to have the support of their administrators, and administrators need to know that it will take teachers a few years to become comfortable with these new teaching methods and for enrollment to grow, Chapman said.

“Here in western Massachusetts, they’re doing it right,” Chapman said, adding, “I like to work myself out of a job.”

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