Jere Confrey’s business card sports a job title only a geek could love: chief mathematics officer. While somewhat more appealing than vice president of long division, it’s probably not an occupation most kids would place at the top of their list of potential career options. In fact, when people ask what she does for a living, Confrey knows it won’t be a long conversation.

“Once I tell people what I do, they tell me how much they hate math and how bad they are at it,” she says. “Then they slink away.”

If Confrey has her way, math could soon be as popular as recess.

Confrey is on a leave of absence from her position as the Joseph D. Moore Distinguished Professor of Mathematics Education at NC State to work with Amplify Education Inc., an independent subsidiary of News Corporation that is pioneering new digital tools for teaching math, science and language arts.

There, she heads up math education efforts at Amplify Learning, the division responsible for designing digital curricula and teaching tools to help schools implement the new Common Core State Standards.

If you haven’t heard of Common Core, you soon will. Schools across the country — including elementary and secondary schools in North Carolina — are in the process of re-engineering the educational experience to better prepare students for success in college and their careers in a global economy. The state-level effort, launched in 2009 by the National Governors Association Center for Best Practices and the Council of Chief State School Officers, is backed by 45 states, the District of Columbia, Puerto Rico and the Virgin Islands.
The standards are demanding, calling for more intense instruction that requires students to use more complex reasoning. In math, the standards focus on helping students make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, be precise, look for and make use of structure, and achieve consistency in reasoning.

Schools are tasked with imparting these skills while continuing to teach students the math concepts we all know and love, such as counting, operations and algebraic thinking, base 10, fractions, measurements and geometry.

AROUND THE LEARNING CURVE

Confrey is more than a little familiar with Common Core. She served on the initiative’s national validation committee, a group of 25 education experts charged with verifying that the proposed standards in math and language arts were clear, specific and grounded in research.

Among the data the committee reviewed were international assessments of students’ math skills in elementary and middle-school grades. U.S. students’ math performance lags behind that of students in many Asian and European countries. Committee members weren’t happy to make that discovery, but it was useful information.

“We looked at the countries that succeed in math education,” Confrey explains. “We looked at what they taught at particular grade levels, and then we looked at the research on how kids learn, and we tried to put those together.”

That same philosophy drives her work at Amplify, where efforts to improve teaching and learning draw heavily on research and evidence-based models. In fact, Amplify worked with NC State to license an innovative framework developed by Confrey for understanding and assessing student learning, called learning trajectories, as the foundation for its Common Core teaching products and tools.

It’s a good fit. Learning trajectories are woven into the Common Core standards and are championed by Confrey and other researchers around the country.

Learning trajectories are essentially descriptions of the paths students take as they move from informal ideas toward increasingly complex concepts over time. They help teachers understand students’ conceptual development and identify clusters of related concepts for each grade level.

The underlying message is simple: the more you understand about your students’ learning of concepts and skills, the more readily you can identify tasks and teaching methods that support student success and efficiently target weaknesses. One technique that leverages learning trajectories is the practice of giving students a hands-on challenge to see how they approach it.

“You might show them a wind-up toy moving a certain distance in a certain number of steps when fully wound. Then you wind it up, place it and ask them to predict if it will fall off the end of the table,” Confrey explains. “They know there’s a solution to the problem, and they want to be the one to solve it and get it right.”

This intuitive approach leverages kids’ innate curiosity and reasoning ability. It’s not too different from the can-do attitude that sparked Confrey’s own love for math when she was in high school.

“It’s not just students who are adapting to new classroom dynamics. Many teachers are facing challenges as they begin teaching to the new standards, she says.

“The Common Core standards for the middle grades are ambitious compared to the previous standards,” Confrey says. “There’s now a much stronger introduction to statistics, for example. It may be hard for our middle-grade teachers because they’ve only taught rudimentary statistics in the past. So that’s a big shift.”

INTO THE DIGITAL DOMAIN

One solution is to bring teachers into the 21st century by giving them digital tools designed to help them manage the classroom and tailor instruction to individuals and small groups of students. Amplify is in the forefront of developing tablet-based applications to do just that.

The platform includes real-time assessment tools so teachers can quickly gauge student performance and comprehension, as well as classroom management tools and a playlist-like feature that allows them to push out assignments and lessons.

“We are on the edge of inventing this new way of doing things,” Confrey says. “A lot of the work that we’re doing now is to define what that should look like. It needs to have the right combination of elements that motivate kids and further the goals of education.”

Although interactive digital tools may be new to the classroom, they’re hardly new to the students. **continued**
“Students today are highly immersed in interactive environments,” Confrey says. “Using these new media tools will allow us to move seamlessly among curricula and to support students working in groups and sharing online in real time. The future of digital learning is interactivity.”

Computers and tablets can also make learning fun. Education experts now talk about the need to “gamify” instructional programs to make them as challenging, competitive and richly entertaining as video games.

OPENING DOORS

At the Friday Institute for Educational Innovation on NC State’s Centennial Campus, Confrey’s husband and colleague, Alan Maloney, is immersed in his own digital learning environment. He is spearheading an effort to educate teachers about mathematics learning trajectories through a massive open online course.

MOOCs, as they’re known, have been enthusiastically hyped in recent years in the mainstream media. *Time* magazine praised them for bringing “the Ivy League to the masses.” But large online courses have gained detractors as well, with some educators wondering whether they’re more of a passing fad than a viable education tool.

Maloney says the course he helped develop at the Friday Institute meets a critical need for teachers and other education leaders who are struggling to adapt to Common Core’s new paradigm.

“How do teachers make sense out of Common Core standards in a way that allows them to support student learning?” he asks. “The fact is there’s no coordinated professional development system in this country; there’s nothing systematic that identifies teachers’ needs. Implementation of the Common Core has been ad hoc by schools, districts and states — somewhat chaotic when looked at nationally.”

The MOOC — called a MOOC-Ed to indicate its status as a course for educators — focuses on learning trajectories for math teachers, providing a detailed framework for planning and implementing Common Core standards in the classroom. The course drew nearly 800 participants last summer.

Another MOOC-Ed developed at the Friday Institute last year examines ways to use digital learning to meet the challenges of the new standards and prepare students for college, careers and citizenship in the global, digital world in which they live. That course attracted more than 2,600 participants from 60 countries.

Glenn Kleiman, professor of education and executive director of the Friday Institute, developed the digital learning MOOC-Ed in collaboration with Mary Ann Wolf, former head of the State EdTech Directors Association. He says educators have been eager to tap into the wealth of knowledge offered through the courses. Kleiman encourages educators to work in local teams so they can work through all the materials and apply what they learn to their local plans more efficiently.

“Education professionals know how to learn, are motivated to learn about new standards and new technologies, and know how to be self-directed,” he says. “And they prefer to learn from colleagues. So the idea that this would be socially connected learning was a good fit.”

More MOOC-Ed courses are on the way, he adds. The institute recently received a $600,000 grant from the William and Flora Hewlett Foundation to develop new courses and conduct research into their effectiveness. Smaller gifts were received from Google and Lenovo, and a grad student nabbed a Gates Foundation research grant.
“We’re one of the few universities that has the expertise to really make these MOOC-Eds work,” Kleiman says.

ENGAGING MINDS

The payoff from all these challenges and changes will be worth it, he adds.

“We used to talk about the three R’s: reading, writing and arithmetic,” he says. “Now we talk about the three R’s and the four C’s: communication, critical problem-solving, collaboration and creativity. If you talk to business and industry, those are the four critical things that they’re looking for in the workforce, and our schools don’t do a great job with those.”

Emphasizing learning trajectories and employing interactive tools to engage young minds could help. Kleiman and Maloney say it’s not uncommon for students to struggle with them in the elementary grades.

“When you’re using a fraction as a number, that’s a very different way of thinking about a fraction than if you’re using it as a factor or a ratio in a multiplication problem or in an equation or as a slope,” Maloney says. “We represent them all the same way, but for students, understanding how you’re supposed to reason about that representation is a huge challenge, and it represents a lot of cognitive organization and reorganization over multiple years of schooling.”

In some cases, students muddle through their homework and exams. But if their understanding is incomplete or flawed, they’re headed for trouble.

“These issues are sleepers in a sense,” he says. “If students have been taught mostly procedures, and they master procedures but don’t understand the underlying concepts, they might get everything right in the fourth grade, fifth grade and sixth grade. But in the seventh grade, all of a sudden they’re doing things that require them to put a lot of things together, to really understand, for example, how to move between defining a slope as a ratio and using that slope as a fractional operator in an equation. Then it blows up and they have no idea how to make sense of it.”

Worse, the teacher may have no idea what went wrong.

“When those same seventh-grade students perform poorly on end-of-year tests, their teacher looks bad,” Maloney says. “But we know that robust conceptual understanding in mathematics develops over years, so poor student performance in complex middle- and high-school math topics is not necessarily the sole responsibility of this year’s teacher. If the current teacher did know how to identify gaps and flaws in students’ conceptual understanding, then he or she would be better able to adapt the instructional plan to strengthen the child’s specific mathematical competencies going forward.”

Learning trajectories enable teachers to understand how their students are seeing — or not seeing — math principles and to understand the math better themselves in the bargain.

“One thing teachers have to do is take on the assumption that kids are doing things that are reasonable to them. You may not know what it is, but you’d better find out so you can understand what is reasonable, promote that, and guide them into the concepts and conventions of mathematical expression.”

STUDENT-CENTERED

Back at Amplify’s Durham office at the American Tobacco Campus, Confrey works with a group of sixth-grade students who are trying out some of the company’s tablet-based math programs. She takes notes as the students eagerly try their hand at constructing a rectangle twice as wide as it is tall.

Afterward, she muses about a concept called “productive struggle” that encourages students to think about ways to approach a problem before they begin working on it.

“There is a fairly limited number of predictable things kids do,” she says. “Of course, kids are fantastic and always seem to find new ways. But if you can understand their typical approaches, you can build on their thinking.”

The key to successfully implementing the state’s new Common Core standards, Confrey believes, is to keep the focus on the students. “As a society we’re not giving them our best,” she says. “We could really be inspiring students to pursue math and science.”

“One thing teachers have to do is take on the assumption that kids are doing things that are reasonable to them. You may not know what it is, but you’d better find out so you can understand what is reasonable, promote that, and guide them into the concepts and conventions of mathematical expression.”

— ALAN MALONEY

Below: Alan Maloney, left and Glenn Kleiman of the Friday Institute are leaders in developing massive open online courses in education.