December 5, 2011

Death Knell for the Lecture: Technology as a Passport to Personalized Education

By DAPHNE KOLLER

Our education system is in a state of crisis. Among developed countries, the United States is 55th in quality rankings of elementary math and science education, 20th in high school completion rate and 27th in the fraction of college students receiving undergraduate degrees in science or engineering.

As a society, we can and should invest more money in education. But that is only part of the solution. The high costs of high-quality education put it off limits to large parts of the population, both in the United States and abroad, and threaten the school's place in society as a whole. We need to significantly reduce those costs while at the same time improving quality.

If these goals seem contradictory, let's consider an example from history. In the 19th century, 60 percent of the American work force was in agriculture, and there were frequent food shortages. Today, agriculture accounts for less than 2 percent of the work force, and there are food surpluses.

The key to this transition was the use of technology—from crop rotation strategies to GPS-guided farm machinery — which greatly increased productivity. By contrast, our approach to education has remained largely unchanged since the Renaissance: From middle school through college, most teaching is done by an instructor lecturing to a room full of students, only some of them paying attention.

How can we improve performance in education, while cutting costs at the same time? In 1984, Benjamin Bloom showed that individual tutoring had a huge advantage over standard lecture environments: The average tutored student performed better than 98 percent of the students in the standard class.

Until now, it has been hard to see how to make individualized education affordable. But I argue that technology may provide a path to this goal.

Consider the success of the Khan Academy, which began when Salman Khan tried to teach math remotely to his young cousins. He recorded short videos with explanations and placed them on the Web, augmenting them with automatically graded exercises. This simple approach was so

compelling that by now, more than 700 million videos have been watched by millions of viewers.

At Stanford, we recently placed three computer science courses online, using a similar format. Remarkably, in the first four weeks, 300,000 students registered for these courses, with millions of video views and hundreds of thousands of submitted assignments.

What can we learn from these successes? First, we see that video content is engaging to students — many of whom grew up on YouTube — and easy for instructors to produce.

Second, presenting content in short, bite-size chunks, rather than monolithic hourlong lectures, is better suited to students' attention spans, and provides the flexibility to tailor instruction to individual students. Those with less preparation can dwell longer on background material without feeling uncomfortable about how they might be perceived by classmates or the instructor.

Conversely, students with an aptitude for the topic can move ahead rapidly, avoiding boredom and disengagement. In short, everyone has access to a personalized experience that resembles individual tutoring.

Watching passively is not enough. Engagement through exercises and assessments is a critical component of learning. These exercises are designed not just to evaluate the student's learning, but also, more important, to enhance understanding by prompting recall and placing ideas in context.

Moreover, testing allows students to move ahead when they master a concept, rather than when they have spent a stipulated amount of time staring at the teacher who is explaining it.

For many types of questions, we now have methods to automatically assess students' work, allowing them to practice while receiving instant feedback about their performance. With some effort in technology development, our ability to check answers for many types of questions will get closer and closer to that of human graders.

Of course, these student-computer interactions can leave many gaps. Students need to be able to ask questions and discuss the material. How do we scale the human interaction to tens of thousands of students?

Our Stanford courses provide a forum in which students can vote on questions and answers, allowing the most important questions to be answered quickly — often by another student. In the future, we can adapt Web technology to support even more interactive formats, like real-time group discussions, affordably and at large scale.

More broadly, the online format gives us the ability to identify what works. Until now, many education studies have been based on populations of a few dozen students. Online technology can

capture every click: what students watched more than once, where they paused, what mistakes they made. This mass of data is an invaluable resource for understanding the learning process and figuring out which strategies really serve students best.

Some argue that online education can't teach creative problem-solving and critical-thinking skills. But to practice problem-solving, a student must first master certain concepts. By providing a cost-effective solution for this first step, we can focus precious classroom time on more interactive problem-solving activities that achieve deeper understanding — and foster creativity.

In this format, which we call the flipped classroom, teachers have time to interact with students, motivate them and challenge them. Though attendance in my Stanford class is optional, it is considerably higher than in many standard lecture-based classes. And after the Los Altos school district in Northern California adopted this blended approach, using the Khan Academy, seventh graders in a remedial math class sharply improved their performance, with 41 percent reaching advanced or proficient levels, up from 23 percent.

A 2010 analysis from the Department of Education, based on 45 studies, showed that online learning is as effective as face-to-face learning, and that blended learning is considerably more effective than either.

Online education, then, can serve two goals. For students lucky enough to have access to great teachers, blended learning can mean even better outcomes at the same or lower cost. And for the millions here and abroad who lack access to good, in-person education, online learning can open doors that would otherwise remain closed.

Nelson Mandela said, "Education is the most powerful weapon which you can use to change the world."

By using technology in the service of education, we can change the world in our lifetime.

Daphne Koller is a professor in the Stanford Artificial Intelligence Laboratory.

OPEN

MORE IN SCIENCE (1 OF 35 ARTICLES)

Note to Christo: Don't Start Hanging the Fabric Yet

Read More »