MOOCs Make Their Move

Tens of thousands of students are signing up for free massive open online courses (MOOCs). Is this the future of education?

by Alan S. Brown

This fall, Allison Okamura, an associate professor of mechanical engineering at Stanford University, will begin teaching an unusual class on haptics. Ordinarily, she brings a handful of students to her well-equipped lab to build electromechanical systems that provide tactile feedback for digital games, simulations, and robots.

This fall, however, they will work with a $50 kit of haptics parts. Considering Stanford’s $160,000 price tag for a four-year engineering degree, $50 is not much to spend on supplies. But Okamura is looking beyond her Stanford classroom. Instead, she plans to make her haptics class freely available to thousands of students around the world. Then anyone who can afford $50 worth of supplies could take her course over the Internet, build haptic devices, and receive a grade on their work.

“At first, I wasn’t interested in online courses,” Okamura explained. “As a teacher, I like interacting one-on-one with my students. But I’m also a real believer in this technology.”

Yet she was keenly aware of how inexpensive robotics kits inspired thousands of people and led to innovative designs and applications. She believes that her online course and cheap supplies could produce a similar explosion in creativity in haptics.

“My idea is to distribute inexpensive kits to the maker community and people in other fields who are not trained like my graduate students and see how they use them. This might open new ways to build and use haptic devices,” Okamura said.

Okamura’s is one of several projects Stanford is funding to put some of its best courses online for free. It is part of a sudden explosion in massive open online courses, or MOOCs.

MOOC Explosion

In some ways, MOOCs resemble online education, an increasingly common element of academic life. According to Babson College’s 2012 Survey of Online Learning, one-third of all higher education students have taken at least one course online. Many graduate and night students work during the day and squeeze online lessons into lunch breaks and evenings.

Yet MOOCs differ from conventional online learning in three critical ways. First, they are free and have no prerequisites. Anyone, any-
Second, they attract an extraordinarily diverse audience. Students range from bartenders in San Francisco and bankers in Bombay to high school prodigies in Prague and retirees in Boca Raton. They often have very different perspectives and questions from students who usually attend class.

Third, they are indeed massive. In March 2012, 155,000 people registered for MIT's introductory circuit design MOOC. This is more students than MIT has graduated since it opened in 1864. So not only are they diverse, but they have the critical mass needed to generate self-sustaining and often very interesting online discussions.

The ease of taking a MOOC may contribute to their high dropout rates. Students may lack the necessary background, find the work too hard or too time-consuming, or simply lose interest.

Only a small fraction of the students who signed up for MIT's circuits course completed it. According to Anant Agarwal, an electrical engineer who heads edX, the $60 million joint MIT-Harvard MOOC initiative, 23,000 students completed the first problem set; 9,000 passed the midterm; and nearly 7,200 passed the course.

That is two orders of magnitude less than the course's initial enrollment. Yet it is still 60% greater than MIT's total undergraduate population.

While classes with 100,000 or more students are not the rule, they are not rare either. Most classes attract tens of thousands of students. Those numbers are simply too big—and exciting—to ignore.

It is why the Gates Foundation is spending $3 million to study them, and why venture capitalists have pumped millions into MOOCs offering free courses.

Debate Rages

Meanwhile, debate rages. Advocates believe MOOCs—or some form of online learning—will revolutionize education, improve course quality, and reduce costs.

Skeptics, meanwhile, argue that MOOC-driven cost cutting will result in students with standardized points of view and limit that type of teacher-student interactions that nurture critical thinking.

The arguments can get heated. Last summer, when University of Virginia's trustees fired their president, they said one of the reasons was because she was slow moving the university online. (They rescinded their decision after heated protests.)

The debate raises fundamental questions about the role of higher education. Why are colleges doing this? Can online learning replace classrooms? What do high MOOC dropout rates really mean? Should colleges give credits for MOOCs? How will universities stay in business if they give their best courses away for free?

Why?
The answers are far from straightforward, and they have important implications for engineering. So far, math, science, and technology courses are among the most popular MOOCs. Fewer engineering courses have gone online, in part because they are so hands-on. Yet, as Okamura's haptics class shows, this may be coming too.

Schools have many reasons for jumping into MOOCs. MIT's Agarwal, for example, wants to mine the “big data” that hundreds of thousands of students generate to understand how people learn best.

Joseph Burns, a physicist and Cornell University's dean of faculty, who is considering MOOCs, finds this argument compelling. MOOCs, he says, are the first courses large enough to run statistically valid tests.

“If we have 10,000 people doing this course and if a lot of them are asking questions about homework problem 12, we know we need to clarify something in how we teach that area,” he said.

An example is an analysis of an introductory MOOC programming class by Coursera, one of several MOOC startups. It found that students' approach to solving their first assignments predicted course success better than their right or wrong answers.

Teaching Competence
Peter Macedo, director of distance learning at Virginia Tech, sees MOOCs as a recruitment tool. They can demonstrate his school's quality and distance teaching competence.

“Many people would like to try a lecture or two and get
a feel for the instruction. It’s a very valid approach. Lots of people who pursue their master’s degrees are paying out of pocket and take some courses online, and they need to make an informed decision where they want to spend their money,” Macedo said.

Both Agarwal and Burns also mention their schools’ sense of mission. Cornell, Burns explained, is a land grant institution established to further practical knowledge as well as teach students.

“We could bring agricultural knowledge to Africa and Southeast Asia. What an incredible opportunity that is,” he said.

“There is something really appealing about MOOCs,” he added. “I feel that I’m blessed here at a place like Cornell, where I’m surrounded by bright people who are really excited by what they do. Now imagine somebody 40 or 50, trapped in a job that he or she no longer likes, or a high school student surrounded by people not as bright or curious. Now, suddenly, they have the world’s smartest people to interact with. We want to bring this out to the world.”

Then there is cost. Student loans have edged above $1 trillion, and educators are looking for ways to deliver classes for less money. MOOCs and other forms of online learning might help by educating thousands instead of dozens or handfuls of students at a time. Colleges could cut costs by eliminating classrooms, automating grading, and reducing (or perhaps, redeploying) faculty.

But first, educators have to determine whether students really learn from MOOCs and other online courses, and how they can grade the results.

Gamification
It is far too early to evaluate MOOCs, but online learning has been around for nearly two decades. Many studies have attempted to assess it. While the results are mixed, most educators believe online courses get results.

Of the academic leaders surveyed in Babson College’s 2012 Survey of Online Learning, 77 percent believe online courses achieve the same learning outcomes as face-to-face classes. Seven out of 10 say online learning is a critical part of their long-term strategy.

Yet those same leaders identify high online dropout rates as a problem and note that only three out of 10 faculty members accept the value and legitimacy of online education.

Some faculty are clearly suspicious about pitting dry scholarship against the showmanship of some of the most effective MOOC teachers.

Others are suspicious. Online education has developed a set of best practices that include robust presentations with illustrations, photos, videos, and animations. They break lectures down into 10-15 minute segments, often with a quiz at the end. Not every teacher likes the format, since it does not support the back-and-forth of traditional classes.

Most Extreme
At its most extreme, this type of immersive experience, with ongoing rewards (like quiz points and grades) to capture student attention, is called gamification. By making classes more like video games, educators hope to motivate students who may not have the discipline to complete an online course.

Sebastian Thrun likes this approach. Thrun, a computer scientist, led the development of the self-driving Google Car. He then taught a breakthrough MOOC on artificial intelligence that drew 165,000 people in 2011. He later co-founded Udacity to develop MOOCs.

“It’s not my lecturing that changes the student, but it’s the student exercise,” he explained in an online interview. “So our courses feel very much like video games, where you’re being bombarded with exercise after exercise after exercise. That’s very different from the way I teach at Stanford, where I’m much more in a lecturing mode.”

Macedo argues that gamified MOOCs are not that different from a textbook. “A textbook is prepared by an authority in the field, it has examples and problems you can solve within the book itself, and it is a self-paced exercise.”

Online learning, with its videos and animations, is more immersive than a textbook. Instead of discussing the lesson in class, students can share the experience in online discussion groups, Macedo said.

Discourse
Yet the quality of online discussions varies wildly. This is due to course structure, says George Siemens, who taught the first-ever MOOC in 2008. He is a strategist at the Technology Enhanced Knowledge Research Institute at Athabasca University, which offers a robust range of online courses from Alberta, Canada.
There are really two types of MOOCs, Siemens explains. The first are top-down MOOCs based on conventional online education. They have solid course designs, use existing online learning technology, and put the faculty member at the center of the experience. They are more about knowledge duplication than knowledge creation,” Siemens explained.

Most experienced MOOC teachers find ways to encourage richer interactions. Tucker Balch of Lucena Research recently taught a course on computational investing to 53,000 students through Georgia Tech. At first, he logged onto class forums to answer questions and keep enthusiasm high. When his workload increased, he tried a well-honed technique: He asked students to post questions and “vote up” the ones they most wanted answered. He then made a video where he answered the most popular questions.

“These were my most popular videos,” he explained.

Then there are the discussions generated by the type of MOOCs Siemens teaches. His MOOCs rely on size to create self-sustaining networks where participants create and learn on their own.

“The faculty member is important, but still just one node within a larger network. In some areas, he or she is dominant. But other people know different things and they contribute in different ways,” he said.

Siemens calls this approach connectivism. He saw it in the first MOOC, which included 25 students in class and 2,300 students online. The vast number of students enabled the class to create new types of connections.

“There was more global participation. We had people from Africa, China, India, and Latin America. In addition to learning course content, students also learned about other cultures and their educational technologies,” Siemens said.

New Dynamics

It also created new dynamics. Students broke into online subgroups that met regularly to discuss topics that caught their interest. Some met face-to-face in coffee shops, others on Facebook or other online environments. Students translated the curriculum into five different languages, so they could share it with educators in their own country. Each group developed its own style of interaction, raised its own questions, and proposed its own solutions.

“They not only read what I posted, but generated their own materials as well. There was a lot of creativity. When you teach in an open format and don’t put too many claims on the intellectual property, people will write themselves into the course. It becomes a platform for others to build on,” Siemens said.

Siemens believes this type of back and forth creates the highest form of critical thinking, since students share, challenge, and synthesize new ideas. It is also the most difficult form of MOOC to grade.

Before MOOCs truly enter the mainstream, educators must wrestle with several issues. Schools cannot keep giving their best classes away for free. To be self-sustaining, MOOCs must somehow earn a profit. Schools must also come to grips with how students earn credits and credentials from free online classes.

It is relatively easy to grade introductory MOOC courses that teach new skills by using video game-like quizzes, though preventing cheating is more difficult.

Advanced courses, however, demand more
In addition, the best MOOCs might become the equivalent of today’s textbooks: Resources that could be sold to schools around the world. After all, what community college student studying electrical engineering would not want to take an introductory circuits class from a top professor at MIT?

And that is the time bomb, or at least one of them. Schools that rely on MOOCs and other online education might need fewer professors to teach courses.

Engineering the Future
That might satisfy some educators, especially in financially strapped state schools. Others argue that MOOCs will never replace the give and take of a classroom full of students debating the best approach to a problem.

Besides, many courses do more than teach new methodologies. Engineering projects, for example, do more than teach students to apply concepts and use laboratory equipment. They also help students learn how to work together on complex undertakings.

“I don’t think you can replace the lab,” Burns said, “Maybe I’m old. I don’t know how things are going to change. But the most important part of those projects is learning to work with people, to interact, to lead, and to benefit from the expertise of others.”

Instead of replacing classrooms, MOOCs and online learning are more likely to complement them.

“If we step back and look, the real thing we got out of our college education came from interacting with smart, engaged people and creating a social network driven by our peers. Maybe we can do that same thing without as much faculty time spent standing in front of a classroom lecturing.” Burns said.

He gives a sophomore dynamics class as an example. Some students who took the class at Cornell got a lower grade on the final than if they had picked multiple choice answers at random.

Hardcore Materials
“Can we do better? Maybe the way we do better is to take the lectures online, then come into the classroom having already done the rote work and work with your professor to make use of those principles. We get great lecturers from the university and others to provide the hardcore materials, and people with other types of skills to provide the interaction,” Burns explained.

Combining online with classroom education is called a “flipped classroom.” Rebecca Griffiths, a program director at Ithaka, a firm that researches digital education, has spent two years studying how 600 students at six institutions learned statistics in conventional and flipped classrooms.

“Basically, there was no difference between students who went to class and those who spent two-thirds of their time with an online learning platform. That result held true across all different student demographics and backgrounds,” she said.

Griffiths was not surprised. In fact, some of her colleagues believed the flipped students would have outperformed classroom students if their professors had previous experience teaching flipped classes.

In fact, Okamura plans to use a flipped model for next fall’s haptics class. She plans to limit it to 100 Stanford students. They will watch lectures on their computers, then come to the lab to work with her as they program their devices. She may record her lab sessions, so online students can see how she and her students solve common programming and mechanical problems.

If the online material appears to work, Okamura could launch her MOOC within two weeks after her class starts. She has even figured out a way to grade student projects remotely.

Backup Plan
“Students will have to write a program to create virtual walls, dampers, and springs. If they just submitted their code, we could test it but we wouldn’t know what they were feeling.

“So we want to attach low-cost force sensors to their devices. Then we could acquire data through the haptic device itself. That way, we would get some sense of what they are feeling, and judge whether they had done the assignment correctly,” Okamura said.

That’s the plan. She also has a backup plan. If her online lesson need more work, she may put off her MOOC until the second semester.

Okamura’s class, like MOOCs themselves, is a work in progress. Yet her vision—flipped classroom, devices that automate grading—suggests that MOOCs could find a role in tomorrow’s universities.

After all, MOOCs are not likely to replace classrooms or instructors or staying up late with your team to complete a project in the lab.

Instead, they are a delivery system, like mechanical models, slide projectors, and computers. They are certainly a powerful way of transmitting information, but they are not an end unto themselves. They are just another way for students to learn, one more part of the toolkit.

Alan S. Brown has been an editor and freelance writer for more than 30 years and lives in Dayton, NJ (insight01@verizon.net). A member of the National Association of Science Writers and former co-chair of the Science Writers in New York, he graduated magna cum laude from New College at Hofstra University in 1974. He is an associate editor of Mechanical Engineering and contributes to a wide range of engineering and scientific publications.