

## **The Developing World of MOOCs**

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OK, good morning. It's actually really fun to listen to two of the presentations before. And as an academic, it's a real challenge not to start the discussion right now.

We all are really big fans of the open education resource movement pioneered by OpenCourseWare. And I was actually at the UNESCO meeting along with Steve Carson from OCW. This was on June 22 of last year in UNESCO.

And it's amazing, the number of countries and world leaders that are involved in something that started out pretty small but really became a worldwide movement. Let me echo John's comment that it is actually tragic that MOOCs are supposed to be open, and it's about open access. They have not moved to open content, and I for one, really exhort all our universities to move to open content.

I do want to give a big pat on the back to Delft University. EdX has 27 international partners having courses on edX, and Delft is the one partner that has come on board onto the platform, putting all its courseware as a MOOC under a Creative Commons license. So they're the first ones to do that, and I'm hoping that others will follow, including some of the leaders of the OER movement.

So today, let me talk about MOOCs and where things are going and so on, and I'll start with the developing world. So this is a classroom, believe it or not, in India. So this is under a bypass highway. It's interesting to see that there are multiple classes going on. And this is a classroom at this little institution, a private institution in the northeast of the US with three letters in its name. The first one begins with an M.

And you look at what's different from the previous classroom and this one. I think this has sliding blackboards, which is pretty nice. The other classroom did not have sliding blackboards. But I think this points to a fundamental issue in our education systems – that really not much has changed in hundreds of years. John showed a set of pictures from tablets and so on with a sage at the stage lecturing and learners learning. Now there have been many ideas that have popped up, various forms of the flipped classroom model that's happened. But if you look at the predominant majority of what's going on, not a whole lot has changed.

We also have a real issue with access to education. So believe it or not, this is not a rock concert, and that's not Madonna. This is a classroom at the Obafemi Awolowo University

in Nigeria. And we've all heard of distance education, but those students sitting in the back 200 feet away from the professor, that is long-distance education.

So there is a real challenge with access to education as well. So edX was formed as a nonprofit venture founded by Harvard and MIT with several goals in mind. One goal was to increase access to education. The missions of our universities are to increase access and make education and knowledge available to everybody, so access is a big part of what we do. An equally important part is to improve education period – improve on-campus education, improve online education, simply improve education. That was a really important part of our mission as well.

A third big part was open source platform. Why is open source platform important? As both our previous speakers pointed out, even with MOOCs, a precious few universities have gotten into it, have had the opportunity of jumping into it. EdX has 27 international partners. If you look at Udacity, they have a few. Coursera has 80 or 90 or thereabouts. So not a whole lot of people have had access to this kind of new technology that's coming out.

So what edX did was, we felt that there was really no way, given the closeness with which we wanted to work with our partners, no way that we could create a peer community that was really large. So we said, by open sourcing our platform, we add a second O in the picture. Open access. We're looking to get open content over time, and Delft has started that movement. We're also looking to get an open source platform on edX.

So two weeks ago, edX, true to its word, made its platform available as open source to the world. This means that the software that we are developing is free. Anybody can pick it up and do what they want with it. Our hope is that they will all add to the platform and contribute to it, and it's been really heartening to see.

For example, Stanford came on board the open source platform effort as a collaborator. And in a matter of six weeks, they were able to take edX as open source software. If you go to [class.stanford.edu](http://class.stanford.edu), they launched their MOOC courses on June 11, a week ago, and you will see several courses on there. And they were able to do this and launch their courses, put the content, use the edX authoring platforms in the space of six weeks. And again, Stanford is not any university anywhere in the world, although some on the East Coast may think so. But our hope is that a number of universities can pick up – a lot of universities are picking up the platform and doing it.

There's also a lot of pressure on edX to take one additional step. Folks are saying, hey, edX, why don't you also provide a hosting service? It's this camel-in-the-tent story where the camel keeps coming into the tent more and more. And so it's one of those things where people are looking for a little more from edX, where they're saying, why don't you create a hosted site as well, where it becomes really easy for any university to put up

courses? And that is something that we're actively thinking about, so openness is a big deal for us.

Research and learning is another really important part. We view the edX platform as – I like to call it – the particle accelerator for learning. We're gathering a huge amount of data, and we're open about it. We look at mouse clicks. We look at what answers students are giving. And a lot of researchers are analyzing it, and I'll show you some early results from folks such as Lori.

Lori Breslow at MIT, Dave Pritchard at MIT, and Andrew Ho from Harvard are researchers that are using the data and doing research into how students learn, so I'll show you some of the early results that are coming out.

So edX is a nonprofit venture, and our view is that – I think Sanjay put it really well – it's stakeholders versus shareholders. I have my own little play on words there. It's about principle, not profit.

So as we created edX and began this technology, there's been a lot of hype. So my hope here is to go to the next step and see what's happening next. So I think a lot of hype has been caused by two things. One is the caliber of institutions that have put up courses, and second is the numbers. The numbers have been absolutely staggering and befuddling, to say the least.

When edX put its first course online, it was an MITx course on circuits and electronics, a hard course with differential equations as a prerequisite. And we were not shy about advertising hard prerequisites. We were not looking for big numbers. Heck, we were looking for about 2,000 was our sweet spot.

And 155,000 students from 162 countries enrolled in the course. And that caused a lot of anxious moments within edX, because the platform had not been tested beyond on about 20 or 30 people hammering away on it. So of those 155,000 students, 26,000 tried the first problem set “Active Learners.” So there's a lot of discussion about attrition in MOOCs and are people all able to complete and so on. And I'd like to pick up on a discussion that John, our previous speaker, began, and I even have a term for it.

If you look at traditional universities, if you look at MIT – I've been part of the admissions process at MIT for many years, at undergraduate and graduate levels. At the undergraduate level, last year we had about 18,000-19,000 students apply. And the number of students that came to campus, we admitted about less than 10%. So about 1,500 came to campus. So less than 10% we admitted.

So we have this funnel. The funnel goes like this: we had a lot of applicants, and then we let people into MIT or into any university through an admissions process and we let this smaller number through the bottom end of the funnel. But the people that could even start

are a small number, and so we lose a lot of people in the admissions process. I like to think of MOOCs as flipping the funnel.

What does flipping the funnel mean? It means that anybody can come in, OK? Geography doesn't matter. Your income level doesn't matter. Who your parents were doesn't matter. Whether you were an alumni or not doesn't matter. It doesn't matter how much you've contributed to big new buildings and new campuses or something. Just nothing matters, OK?

All you have to have is the will to learn and an internet connection. Now it's a small matter of a little device. So anybody can come in and take these courses, and the beauty of this is that this completely democratizes education. It becomes a complete meritocracy. Everybody has an equal chance. And if you can cut it, if you can pass the muster, you will get a certificate at the end. If you can work hard and if you can do it, you will pass. It doesn't matter what your parents were. It doesn't matter how much money you have.

It doesn't even matter if you don't have the background, because you can go and get the information. We put links to OpenCourseWare, to Khan Academy, so people can go and get the resources as they need, as they're learning. And so this really democratizes education, and people can come in and learn.

We had 155,000 students start the course and 26,000 students tried the first problem set. Many students were just what I call the online equivalent of rubberneckerers, online rubberneckerers – just were curious. And so 26,000 students were serious. Of those, 7,200 students passed a really hard course and got a certificate.

Now 7,200 is a big number. First of all, it's about 5% of 155,000. That's not very different from the admissions rate of many of the top universities. In fact, it's a much higher admissions rate than the IITs. The admissions rate at the IITs in India is 1%. 1 in 100 students get in.

So 5% of the students did a really hard course, and they got a certificate. I would have to teach at MIT for 40 years twice a year, two semesters, to teach this many students. So don't let the attrition rate of MOOCs fool you.

Just remember the buzzword. I mean, buzzwords are nice. They help you remember things. Think of MOOCs as flipping the funnel. So instead of the funnel being this way, we flip it. Anybody can come in.

Next, let me talk about how MOOCs are impacting campus education. And so here in this country far, far away, two high school teachers. This is in the Sant High School. They blended the classroom. They used the edX course material, and they had students do videos in their own rooms and homes and came to class, and they had to solve problems together, discussions and a lab.

And so this was in a high school, and this was in Mongolia, completely unbeknownst to us at edX. We found a blog, and that's how we discovered them. In fact, this very class in Mongolia produced a prodigy, Battushig. So Battushig was a 15-year-old. This character – and I took this as a personal affront – in the edX circuits course from MITx, this 15-year-old kid scores 100 in the whole course.

Now that was a personal affront to me and Jerry Sussman and my colleagues who put the courses together. Heck, I would not get 100 if I took the exam myself. So this 15-year-old, he's a prodigy. And guess what? He's been admitted to MIT. He's going to MIT this fall.

And then he used the material he developed from this course, and he built a little invention. So he put a little device in the garage of his building where he could provide an early warning system for pedestrians who were leaving the building going up and warn them of cars going across. So this guy was really amazing.

EdX is also doing blended learning pilots in a number of places. Here's an example of an experimental pilot that we did along with San Jose State University. And the early results are very promising, and I'll talk about why we think quality will improve as well. There, semester upon semester in the same circuits course, they had a 40% retake grade. With the blended class, it fell to 9%.

So in future semesters, we're trying to understand what where the sources of the improvement in the outcomes. We have a number of blended pilots happening throughout the world, from Tsinghua in China to Mongolia to Turkey, all the way to the East Coast, Berkeley, and even at the Hawaii Pacific University. The Berkeley course has been used in a dozen places, so a number of these blended pilots are happening in a number of places around the world.

Next let me talk a little bit about why is it that online learning can improve education, whether it's on campus or education anywhere else. What are some of the key aspects, and what is some of the research behind it?

The first idea is called active learning. With active learning, the basic idea is to engage the student while you teach. So what we do at edX is that we have innovated in the UI – User Interface – as well to promote this kind of pedagogy. We show learners 5, 10 brief videos with exercises interweaved.

Now again, this is not a new idea. Eric Grimson and Tomas Lozano-Perez did that here at MIT in an early programming language course in the late '90s. So what edX has done is picked up that idea, innovated a little bit in user interfaces and so on, and made it available on a large scale. And so this interactive form of learning has been known to improve outcomes. This is a landmark paper – if you haven't read it, I strongly urge you

to read it – by Craik and Lockhart in '72 that said learning and retention is related to how deeply learners process information as they go along.

A second key idea is self-paced learning. Now in normal lectures, you go to a class and there's a professor who – to use Sanjay's terminology – the professor raves or rants or whatever, and students are listening. If it was me, and the students around me were much brighter in my IIT class and they would be following, I would stop following the lecture around the fifth-minute mark and then scramble to take notes.

Now with online learning, I can watch these videos online. I can pause the videos. I can rewind the videos. And guess what? I can even mute the professor. In fact, in a blended class we taught at MIT, a majority of the students watched exactly like that. They were actually fast forwarding at 1.5x speed and reading the transcript and muting the professor. So this gives you self-paced learning.

There again, there's not a whole lot that's new in MOOCs, folks. Really, there's just really not a whole lot that's new. A paper by Mayer in 2003 showed that students who were able to simply hit the pause button did better than those who were not able to do so. Self-paced learning.

A third idea is instant feedback. So we have a number of technologies – at edX and other MOOCs and in a lot of the tutorials being developed online in a number of places – where we can provide instant feedback to students by using computation to grade the exercises. So here's an example of a learner working with chemical equations. Now we can do a number of these things, and thanks in part to people like Ike Chuang, who single-handedly must have contributed more to the grading technologies at edX than anybody I know.

Can you believe we can now do matrix equations in edX? To my knowledge, no other MOOC can, to my knowledge. I think I complained to Ike, “Ah, we don't have matrices,” and the next morning he comes and tells me, “Hey, Anant, go check it out.” So it's pretty amazing with the contributions we've been getting from everybody.

So here's a quick little demo of students doing chemical equations. And you can enter – you get it wrong, hey, you can learn as you go along. My colleague here, Ed Bertschinger in physics, he made this comment about instant feedback the other day. He was doing the physics course by Walter Lewin on edX, and he had this epiphany, and he sent out this email. In that email, he made this statement, and I think this statement will appear 10 or 20 years from now. It'll really be memorialized. It's just incredible. The statement goes like this. He said, "Instant feedback turns teaching moments into learning outcomes." Just remember that. That is huge.

And this is not going unnoticed by our students. Students are telling us that they go to bed at night dreaming of the green check mark. This has become somewhat of a cult symbol

at edX. In fact, there was a student who took the circuits course that my colleagues and I taught the beginning of last year, and then he took a Berkeley software course in the fall. This is what he had to say on the discussion forum when he just joined the course of the green check mark. "Oh god, have I missed you." OK? I mean, can you believe students dreaming of homework? I mean, this has not happened before.

And there again, there's nothing new here, folks. Chen, Whittinghill, and Kadlowec demonstrated that rapid feedback has a significant and positive effect on student performance. There's been research. So there are papers showing all of the stuff we're doing.

Another thing we do is we use simulation technology and virtual gamification technology to create online labs and really engage the students. So here's a circuits laboratory. The challenge with MOOCs is, how do you teach design? OK, we all know analysis. We give you a problem, you go solve it. The real challenge is, how do you teach design? How do you teach creativity? And creativity and design is about building something when nothing existed. Give someone a blank sheet of paper, and how do you build from it? So we do this.

So we have an online lab for the circuits part built by Chris Terman and Jacob White where we use online simulation technology to give students a lab-like experience. So learners can build circuits much like you build an online LEGO system, and they can analyze it, and it can also be graded. So this kind of engagement is also very helpful.

I'm actually not sure who said this but, generally, if you're not sure who said something, it is safe to attribute it to Ben Franklin. So he said, "Tell me and I forget. Teach me and I remember. But engage me and I learn." It's been attributed to many people.

Another key aspect is peer learning, where students are learning from each other. So let me tell you a story here. When we did the first course on edX over a year ago, and we had a lot of students on the platform, I didn't sleep for three nights. We said on the discussion forum, how do we answer questions from this many students? So we had about as many instructors and TAs as we have in a 100-person class on campus. So I said, folks, 7 by 24. We're going to be up all day, all night, answering questions.

So promptly at 2:00 AM at night, I was sitting there, and a question pops in from a learner, I think from Pakistan. And I'm trying to type the answer. I'm not a great typist and as I type, before I can finish, in pops an answer from, I think, someone from Egypt. Ah, not quite the right answer, so I've got to correct the answer.

Before I know it, another answer is put in by someone from the US. I sit back fascinated, and boom, boom, boom, boom. By 4:00 AM in the morning, they've been discussing it, and they get the right answer at the end. And all I had to do was go in and say, good answer. That was an epiphany for me.

Now when I mention this anecdote to my learning colleagues who've been doing research in learning for decades before I got into education, they said, "Oh, yeah. I've known this all along." So people have known this apparently, but it was an epiphany for me that students are teaching each other. By using technology, we're able to now scale to large numbers where they answer each other's questions. So in a blended class on campus, we also got the feedback from our learners that the ability to pace themselves, the immediate feedback, and the quick responses from the discussion forum were things that they liked a lot.

Finally, in the last couple of minutes I want to talk about the research that we're doing at edX and MIT and Harvard and a number of other universities. So here's some interesting data. Now we all wondered, if students were given the chance, would they watch a video first, or would they do homework? OK, the campus equivalent would be, would they go to lecture first, or would they start a homework first?

So we've got a bunch of data, and what is interesting here is you see the result. So this is for the circuits course. You notice that in the first week, 70% of the learners start by watching the video first, but about 25% start by doing the homework. But as the course wears on, by the time the course is done, it completely flips and 60% of students start with homework, and then they go and get the resources that they need to solve the homework. So this really questions some of the biases we've had all along in terms of what may be the right way to teach.

Another example is from research that Lori Breslow and her team here at MIT and Harvard have done. A simple example. Students say, well, what's the point of homework? Well, here's some data that shows a very strong correlation in your performance in the course in terms of overall grade in the course to the amount of time you spent on the homework. There's a straight correlation between the amount of time you spent on homework to your overall grade in the course.

So we have a lot of data of the sort. Here's some data from Dave Pritchard's research. He looked at what kind of resources the students are looking at. The area of a circle is the amount of time spent on it. So when students are doing homework, you notice that they access lecture videos a lot. But when they begin doing an exam or a midterm exam or a final exam, that flips around, and they begin to access the textbook a lot.

Now my next question to Dave was, "OK, why is that?" "Well," he said, "that's future work." So I think we're getting a lot of data in terms of how students are learning, and I think we're now beginning to question, and in turn understand why, this is so. Can we use that knowledge to improve education on our campuses? So with that, let me stop and take some questions. Thank you.