Association for Computing Machinery
Advancing Computing as a Science & Profession

Ubiquity, an ACM publication
June 2014

Ubiquity Symposium

MOOCs and Technology to Advance Learning and Learning Research

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Editor's Introduction

Whether MOOCs can provide a good education and broaden educational opportunities at lower cost is an ongoing discussion. In this article Stanford professor, John C. Mitchell, reflects on Stanford University's pioneering role in the MOOC movement, explains how to harness the power of digital technology, and offers predictions for the academic landscape.

[1] The Stanford University Campus is sometimes colloquially referred to as "The Farm."

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Somehow, MOOCs have taken the world by storm. Why? Apparently, professors and decision-makers at prestigious universities are excited about putting something that looks superficially like a college course online for free. Amazingly, millions of people around the globe have time and energy to participate in these "courses," in some cases devoting hundreds of hours to an experience that may have many personal rewards but does not presently produce college credit. Who would have thought?

This personal reflection on the last two years of MOOC activity is based on initial data from various sources, published opinions, analysis and predictions (e.g., [1]), and conversations with many faculty and university administrators about their activities, goals, and fears. Initial research [2] suggests for every 100,000 people actively engaging with a MOOC, approximately 50,000 are going to explore a relatively small section of the material, perhaps learn whether the topic is something they are interested in, and then withdraw to other pressing activities in their lives. Approximately 25,000 are similar to auditors in traditional college classes—they sit in the back of the room, watch casually, but don't try to do all of the assignments, quizzes, or projects. That leaves around 25,000 participants who seem to behave like students enrolled in a college or night-school class: They start out watching and reading the material presented, answer questions they are asked, do assignments, and so on. Roughly speaking, about one-third of these typically finish, while two-thirds do not. This is sometimes viewed negatively as a low "completion rate" in the range of 5-9 percent, or positively as the surprising fact that millions of people (over a large number of recent MOOCs) would spend so much time on challenging

college-level topics. This massive online interest in academic subjects is itself a revelation, if not a revolution.

In the recent wave of MOOC activity that started with three Stanford courses in the summer of 2011, many faculty have enthusiastically produced MOOCs, often devoting hundreds of hours each to the process. Anecdotally, most MOOC-active faculty I have talked with at Stanford and elsewhere were exhilarated, engrossed, and sleep-deprived by the process of reaching tens of thousands of people with their demanding academic material. As academics, we all try to communicate insights in our chosen field through publication, conference talks, visits to other institutions, and the like. Reaching a wider audience is highly rewarding and part of our larger goal of communicating our findings broadly. On top of that, faculty interest, enthusiasm, and scattered healthy skepticism have led to more energetic discussion about teaching on campus than any other time in my 25-year academic memory. This, at least, has to be a good thing.
Institutional support for MOOC production varies widely. Some institutions have privately shared approximate figures. Some public universities have allocated $5,000 per course to pay for student editing of faculty-produced home video, while one or two private institutions with deeper pockets have spent as much as $150,000 for each of a few selected flagship courses. These rough figures count only additional staff effort and production costs. Faculty time is significant, but the faculty time involved in course production also contributes to regular teaching if the course material is also used in on-campus courses.

Why are universities supporting free “courses” that give their most marketable products away? It seems that a few universities see MOOCs as a potential business opportunity, hoping for direct revenue or indirect financial benefit by increasing enrollment in other revenue-generating programs. However, so far, many universities simply recognize the opportunity for publicity, the potential for disruption (e.g., [3]), and do not want to watch from the sidelines. I have not talked to many professors who think they are going to make a lot of money from MOOCs, although book authors can profit from increased sales. On the other hand, four Stanford faculty have run off to start three technology-based companies (Udacity, Coursera, and NovoEd) that aim to turn a profit.

Two as-yet unanswered questions are: (i) Can MOOCs or online offerings that evolve from them provide a good education, and if so, (ii) will they lead to broader educational opportunities at lower cost? Most discussion of cost and disruption are presently speculative, but we are beginning to have data on how students engage in MOOCs, how they are learning, and what we might do to improve the educational experience. Further, there is a body of prior educational research that can usefully inform the development of future online courses at any scale, if the

MOOC enthusiasts and educational researchers can find the time to learn from each other. As quality improves and becomes better understood, there will be many opportunities for a wide range of colleges and universities.

Educators' Goals

There are many potential ways to harness the power of digital technology and the new teaching and learning models it supports.

Improve education. We can use technology on campus to support richer learning experiences and more valuable in-person interaction. The "flipped classroom," in which students watch lecture via online video and use class time for in-person interactive activities, has received widespread interest. This is one compelling idea, but moving lectures to video is not the only way to use technology. For example, experimental environments can be constructed through online digital simulation, allowing students to learn by virtual doing. Another promising direction involves online collaboration tools, mirroring those used in work environments to support problem-solving teams. The flipped classroom and other new models raise more questions than they currently help answer. Does a good classroom lecture make good video? What sort of interactive activities are most effective for learning? And looking longer term at teaching new topics on video, do we need to give lectures to focus groups before recording them? Or will online analytics give teachers better suggestions on how to improve their classes than puzzled looks across an auditorium?

Extend an institution's reach. If classes are built around online activities, students may enroll from a distance. With more students using fewer classroom resources, an institution could expand its student body without increasing its physical investment. This is not a new concept. Many public and private institutions have existing online university extension programs, continuing education programs, and/or professional education programs. The new twist is the way these might be expanded using MOOC technology. However, if existing universities are going to shift some of their core degree programs online, we want to know whether we are increasing educational quality, to what degree, in what ways, and what essential benefits of time-honored traditions might go down with the bathwater.

Provide new teaching resources to others. A professor at one university can use the online components of a MOOC produced elsewhere in their class. Students register for a class at their school, perhaps do additional homework or exams not provided by the MOOC, and receive regular university credit. A few publicized experiments, such as those at San Jose State using an electronics course from MIT [4], suggest the promise of this practice. In a sense, this is a logical

extension and evolution of current practice with textbooks. If a professor writes a successful textbook, professors at other universities teach courses from the book. Increasingly, textbook authors tend to provide additional teaching material on their own web sites, or those of their book publishers, to aid adopting faculty and increase book sales. Publishers of academic textbooks recognize new opportunity too, developing "textbooks" with richer media, perhaps in a way that will intersect or collide with MOOC portals.

Public recognition and public good. Popular free or close-to-free learning experiences bring recognition to faculty and their institutions. Sharing knowledge is part of a university's mission and as educators we can all feel good about teaching what we know to anyone who will listen. If we are teaching about better health, ways to save energy, professional productivity, or fostering reflection on the vast incomprehensibility of human existence, we can achieve recognition in our academic communities and enrich the lives of others around the world. Everyone should feel good about this.

Data science. The quality and quantity of data generated by online learning will revolutionize educational research. We can study how students learn best by instrumenting learning activities and introducing variations to measure certain variables. Not only will this lead to fundamental insight, but we can use our findings from this year's course to improve next year's. The confluence of social science and quantitative data science will be intellectually stimulating, productive, and practically effective.

Two challenges facing educational data science today are data sharing and student/user privacy. Current university-generated MOOCs are hosted through a variety of platforms, including some developed and operated by independent organizations with different interests and incentives. The platform organizations collect varying kinds of data, all useful for studying educational effectiveness. However, universities must be sure the platforms they use, through whatever hosting agreements they might make, give them the data ownership that serves their current and future students best. Further, we need public data formats and ways to share data across institutions so that educational research can be advanced and reviewed according to accepted academic standards.

Privacy presents a second challenge. MOOCs yield clickstream data, free-form text discussion, and who knows what else. Sites may ask for demographic information, career goals, learning abilities, and so on, all of which may be important for studying whether certain learning models are more effective for certain demographics. However, text data, profile data, and potentially other forms of data may support re-identification and inference of sensitive information. (See,

e.g., [5, 6]) Given the complex privacy issues, a panel of respected experts should work together to establish best practices.

Activities at Stanford

After the initial wave of public MOOCs and the 2011 spin-off of Udacity and Coursera, from January 2012 to August 2013 Stanford built faculty experience with online teaching and learning, created an organization supporting online course design and production and delivery, developed a catalog of online material, and formed a fledgling data-oriented educational research effort. Stanford also developed a free public open-source delivery platform Class2Go, partnered to release open-source OpenEdX, and saw a third 2013 spin-off, NovoEd, producing yet another external platform partner.

Seed grants. The Stanford faculty seed grant program provides up to $25,000 in direct funding to help a teacher develop online material for an on-campus course or MOOC. These grants do not pay faculty salary, but can provide teaching assistants, freelance editing, or specialized equipment; faculty receive other course development and production assistance without charge. In keeping with university priorities, development must benefit Stanford students and contribute to educational research.

Support teams. A small but effective pedagogy team provides instructional design support; a similar production team manages recording facilities, editing, and additional production assistance as needed. For Environmental Physiology—which investigates the impact of extreme conditions on the human body—members of the team suffered altitude sickness filming from the summit of Pikes Peak, enjoyed the inside of an altitude chamber, and captured footage of the instructors in fighter planes at high acceleration.

Online catalog. In calendar 2012, 60 faculty developed 25 on-campus courses around new online material and over 25 distinct MOOCs, some of which were offered more than once. The Vice Provost for Online Learning (VPOL) office currently supports and/or tracks approximately 100 projects (in summer 2013) across all seven schools of the university, with major activity in the schools of Engineering, Humanities and Sciences, and Medicine; moderate activity in the Graduate Schools of Business and Education; and emerging activity in Earth Sciences and Law.

Platform. In addition to delivering Stanford online courses through Coursera and NovoEd, Stanford developed and released the first free open-source platform for MOOCs and flipped courses, Class2Go. Later, the team shifted to a collaborative agreement with EdX to release the free open-source OpenEdX platform for everyone. Subsequently, Google has joined forces,

promising to speed software evolution and support content hosting. These efforts helped produce meaningful competition among hosting providers. Further, a free public open source platform allows academics and universities to research new approaches and package programs for any size audience in any way they choose.

Educational research. The Lytics Lab represents an initial organizational effort to conduct data-centered research on online learning. Currently, the lab includes graduate students and postdoctoral scholars from at least the Graduate School of Education, Computer Science, Statistics, Physics, and Communication. Publications and ongoing efforts are reflected on the current site. As additional faculty with broader interests are become interested in the topic, it is likely that there will be further efforts to combine educational research, data analysis, and online course development.

Market Evolution, Disruption and the Academic Ecosystem

We have seen an explosion in free online courses at scale. Over time, all of us will develop a better understanding of how to provide meaningful educational experiences at much lower marginal cost, using automated assessment, peer interaction, and new ideas. Given the dramatic cost issues facing higher education and the high demand for learning, we will definitely see changes in the academic and educational landscape. As of summer 2013, no one really knows exactly what will happen. Here are some highly speculative personal predictions and a few questions, offered as food for thought.

Prediction 1. New technology, such as interactive video with automated responses to student input and online group interaction will become commonplace in college and at least some K-12 courses. Just as PowerPoint has replaced chalk, teachers will master and use technology commonly used for demonstration, communication, and interaction in other walks of life.

Prediction 2. Free MOOCs will serve the massive audience for educationally meaningful unaccredited experiences, rivaling or eclipsing educational television. Funding in some form will follow.

Prediction 3. Weak forms of accreditation or employer recognition will allow high-volume low-cost online opportunities to become an established educational mainstay. Hundreds of thousands of students, or more, could be productively served at low cost each year. Even if some MOOCs are not a good way to learn a whole new skill, they could provide meaningful certification or employer screening.

Prediction 4. A set of advanced high school and basic college courses will be commoditized online. A relatively small number of courses account for a significant percentage of college units in the U.S. These are basic college and community college classes such as writing, mathematics at the pre-calculus or calculus level, introductory economics; courses that could also be offered to advanced high school students or used for advanced placement. Students taking these courses could enter conventional colleges and universities with one or two years of transfer credits. The potential impact on current institutions is complex.

Prediction 5. Inexpensive online degree programs will appear and some will succeed. Georgia Tech's announced $7,000 online master's degree in computer science is an aggressive experiment. Even if this program attracts the thousands of students annually that apparently are needed to balance the books, it will be impossible for several such programs to compete successfully without raising prices, lowering quality, or finding new ways to achieve comparable educational outcomes more efficiently.

Prediction 6. Online options for education throughout the life course will improve and increase. Commodity courses at the advanced high school or beginning college level will thrive because of the immense market, providing content that also will be repackaged for older learners. Colleges will similarly repackage portions of their on-campus and distance learning content for alumni. However, the glut of such offerings will make this seem commonplace. Rather than distinguishing their institutions in the minds of their alumni, colleges will simply have to do this to remain competitive with their peers.

Questions about the future. Academic institutions and the educational ecosystem they depend on are exceeding complex. Research institutions, for example, combine classroom teaching with peer-reviewed academic research. Research projects provide advanced training for students, while at the same time advancing knowledge that feeds into future classes. If teaching is somehow separated from research, will this slow worldwide innovation? Could leading research universities operate successfully while producing only one-tenth as many classes, each taught to ten times as many students? How would research be funded if it were not also part of educating students, who currently work hard for low cost in order to advance their knowledge and their careers?

Hopes for the Future

Just as news, music, video, shopping, personal and business communication, and social interaction have moved online, many aspects of a newly varied educational ecosystem are destined to flourish online. The coming transformation, which may be incremental, jarring, or

episodic, opens new options for academic institutions, with many challenges and much uncertainty. Universities can stand by idly or they can plunge in with trepidation or enthusiasm.

As entrepreneurs explore new business models and develop new products for new and old markets, universities and their faculty have important roles. While no single institution can effectively tilt the glacial demand for educational opportunities, we as academics can do our best to bring insight and understanding into the public vision. Experienced educators can develop successful teaching and learning models, publicize their accomplishments, and publish evaluative studies meeting high academic standards. This may help distinguish the educational value of free public courses from the benefits of enrollment in structured degree programs. We can hope that the widespread interest in teaching that has developed as a result of the MOOC explosion will continue, and public visibility of college courses will lead to stronger appreciation of faculty teaching and greater rewards for those who inspire students effectively.

Education will change radically over the next 5-10 years. Hang on for the ride!

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About the Author

In 2009, with six summer undergraduate interns, a Ph.D. student, and an enthusiastic postdoc, John C. Mitchell started developing a web platform to support better social networking in classes on campus. From 2009-2011, the Stanford CourseWare project developed web technology to support teaching innovation, in response to interest from individual faculty. This led to interactive video, automated quizzes, instructor analytics, and integration with an innovative video framework (ClassX) that allowed easier capture of classroom lectures. In 2012, Mitchell chaired a faculty committee on online education appointed by Stanford president John Hennessy; he was also appointed Vice Provost for Online Learning. Mitchell has taught programming languages to thousands of students over the last 20 years and, with Dan Boneh.

DOI: 10.1145/2591679