Massive open online courses (MOOCs) if true to their name, possess three defining elements. They’re open, meaning that anyone can use them to learn. This also logically implies that they’re free, removing any financial barrier for even the poorest student. Being online means people can access them on the Internet. In providing courses, MOOCs represent a major shift in scale beyond open learning objects (see the sidebar, “Learning Objects and Open Educational Resources”). They operate at the level of a whole course (or subject), meaning that they provide a coherent learning sequence, with integrated learning materials and formative assessment, all created and managed by outstanding teachers from the world’s top institutions. If a course is of high quality, free (open), and readily accessible (online), it follows that massive numbers of students will grab the chance to get a first-rate education for free. This creates scalability challenges. We understand how to engineer websites that gracefully handle huge numbers of users; however, we’re still trying to learn how to handle the scalability issues for the teaching, learning, and assessment models. Researchers acknowledge the importance of social interaction among learners, which is one benefit to MOOCs. A MOOC can call upon its large community of learners to support learning via discussions and to assess work based on peer review.

There is a delightful idealism and altruism in the words of many of those driving the MOOC movement. We all value a quality education, we all acknowledge the huge gap between the educational opportunities of the most privileged and the most disadvantaged learners, and we present MOOCs as a means to help close this gap. We can conjure up images of students from the developing world, the most disadvantaged groups in the first world, and lifelong learners with changing needs, all quenching their thirst for knowledge by learning at the feet of the intellectual giants of the world’s leading research institutions. This is an example of Friedman’s flat world. We can cater to this large, unmet need because of the wide availability of inexpensive networked computers.

Beyond the excitement of the learning opportunities of the actual MOOC courses, a different dimension of promise is in MOOCs as open platforms, built by a new and energetic open source community. Perhaps this will be a revolution in software for authoring and delivering high-quality learning opportunities.

What Is a MOOC?

Despite the name, we really have no clear definition of exactly what is and isn’t a MOOC. Contributing to the confusion around the term, we’ve started defining MOOCs differently. Although in 2012 we saw highly publicized MOOCs, such as Coursera and Udacity, we’ve actually used the term since 2008. In the past, we used it to describe a very different kind of online course run by people like George Siemens. Siemens suggested that there are in fact two entirely separate types of online courses sharing the name “MOOC” and he offered new terms to distinguish them: edX MOOCs (xMOOCs) and connectivist MOOCs (cMOOCs) (www.elearnspace.org/blog/2012/07/25/moocs-are-really-a-platform). The xMOOCs are the new and well-publicized type that moves a traditional university learning paradigm into the online learning space. The cMOOCs are the older type, as developed by Siemens. Administrators base these around learning socially, inspiring creativity, and believing that knowledge exists in the collective minds of the students. Rather than assessable content, teachers provide students with content designed to encourage discussion and debate. Although these terms have gained some traction, the recent media attention has popularized the term MOOC to refer to xMOOCs.
Learning Objects and Open Educational Resources

The IEEE Working Group 12 (WG12) describes learning objects as “any entity, digital or non-digital, which can be used, reused, or referenced during technology-supported learning” (see http://tsc.ieee.org/wg12). The working group aims “to enable learners or instructors to search, evaluate, acquire, and utilize learning objects.” Wayne Hodgins’ championed this work on learning objects when the Web was emerging and growing. He visualized making greater use and reuse of high-quality learning resources by making them open and available to all. For example, WG12 describes one of their goals as “to enable computer agents to automatically and dynamically compose personalized lessons for an individual learner.” By choosing the word object in their description, they reflect the programming notion, with its associated possibilities of reuse. They worked to define standards around learning objects to enable their description and subsequent reuse, and they created many learning object repositories. Critics of the whole notion of learning objects and their reuse highlight the problems of reuse, particularly when a teacher needs to adapt a learning object to fit the context and needs of their students.

Another landmark initiative that aimed to make high-quality learning resources publicly available was Open Educational Resources, or OER. A review of this movement described it aiming to “Sponsor high-quality open content … Remove barriers … Understand and stimulate use.” Its flagship outcome was the MIT OpenCourseWare Project, described as “a very successful, compelling, living existence proof of the power of high-quality open educational resources … a pioneering project that has now become a catalyst for a nascent open courseware movement in service of both teachers and learners.” There is a strong similarity between these sentiments and the current visions presented for massive open online courses (MOOCs).

Exemplar MOOCs

To better understand this new and fast-changing phenomenon, let’s begin with some exemplars. Table 1 explains some key features for artificial intelligence in education (AIED) across a sample of major MOOC platforms, such as Coursera (www.coursera.org), edX (www.edX.org), Course Builder (www.powersearching withgoogle.com), Class2Go (http:// class2go.stanford.edu), udemy (www.udemy.com), and Lernanta (http://p2pu.org/en). We chose these platforms because they represent a diverse set of some of the better-known MOOC platforms.

Both edX and Coursera represent the new, widely publicized MOOCs—funded and provided by large universities. These focus on video lectures, with an important innovation being their use of integrated quizzes. These break up the traditional lecture into much shorter parts, ending each lecture snippet with a self-test short answer question that is automatically graded so there can be immediate feedback to the learner. These do the main content delivery, and the platforms tend to be light on other quizzing capabilities.

Google made their Course Builder open source after the company used it to teach their “Power Searching with Google” course. It requires significant technical work and skill to setup and run a course.

A Stanford team created the Class2Go open source platform. The team’s design is similar to edX and they’re working together on a combined and open platform. Because it promises to be open and high quality, the AIED community finds it particularly interesting.

Compared to the other platforms, udemy stands out because it truly provides a platform for anyone to teach. Notably, it also lets instructors charge students for access to their courses. However, it has no ability to assess or quiz students.

Finally, we included Lernanta as an example of a cMOOC. It powers P2PU, a site for social learning. It has no quiz or video functionality, but it focuses on peer assessment and discussion.

A Diversity of Features and Approaches

Comparing the attributes of each MOOC platform in Table 1, we immediately see how different these MOOC platforms are. Even platforms that support video differ in terms of hosting sites and discussions or quiz integration. Despite their quite minimalistic quiz capabilities, MOOCs already face fracturing in terms of question types supported. In particular, while many offer a short answer-style question, they drastically differ in the ways they mark these answers. This ranges from peer assessment to automated assessment, where MOOCs do this in fairly simple ways, such as matching regular expression or simply comparing student’s input for an exact match against a list of “correct” answers. All of the systems currently have rudimentary facilities to capture learner activity data for analysis. The student can see rather simple information about their marks and progress.

References

teacher facilities are pretty limited, too. Perhaps in the spirit of making use of existing tools, they do not extend beyond exporting comma-separated value (CSV) files of raw data, or using general website analytics, like Google Analytics. Here is a place where there is exciting potential to introduce AIED tools and techniques into MOOCs.

From our small but carefully selected sample of MOOC platforms, we see the diversity in the features for learning and assessment, even at this early stage. This highlights our difficulties in determining what is and isn’t a MOOC platform. We also have difficulty telling the depth of the differences between MOOCs and the widespread Learner Management Systems (LMS; see the sidebar, “Is an LMS Really a MOOC Platform?”). Now let’s consider the more general picture that seems to be emerging. Figure 1 shows a high-level view of the teacher and student views of MOOCs. The teacher needs to design the curriculum, perhaps taking into account formal learning goals for accreditation and certification or broader goals that learners have for lifelong learning on demand, at the times that they recognize the need for new knowledge and competencies. With this foundation, the teacher needs to design and create the learning materials that the students will actually see and interact with. For the current breed of MOOCs, this involves making video snippets, short pieces with the lecturer’s face visible, and other supporting material, such as their annotations of materials. The lecturer needs to create the self-test formative quiz questions as well as the larger assessment tasks. The teacher must also make design decisions for the discussion forums and grades or assessments. For example, the lecturer might create rubrics or questions for use in self- and peer-assessment. The remaining part of the big picture is the lecturer’s use of data about the learning. Some of this is classic management of marks. Another dimension is to reflect on student’s progress and use that to refine the materials and course. AIED has much to offer for all of these stages and elements and we will discuss some examples after we have explored some of the challenges.

<table>
<thead>
<tr>
<th>Features</th>
<th>edX</th>
<th>Coursera</th>
<th>Google Course Builder</th>
<th>Class2Go</th>
<th>udemy or Amazon S3</th>
<th>udemy or YouTube</th>
<th>Lernanta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video lectures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where are they stored?</td>
<td>YouTube</td>
<td>Coursera</td>
<td>YouTube</td>
<td>YouTube and Amazon S3</td>
<td>udemy or YouTube</td>
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<td></td>
</tr>
<tr>
<td>Quizzes integrated with video?</td>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Discussion on video page?</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Additional files and features</td>
<td>Subtitles</td>
<td>Subtitles files</td>
<td>Subtitles files</td>
<td>Subtitles</td>
<td>Subtitles video and slide mashup</td>
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<td>Quizzes</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Are there quizzes outside of videos?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td></td>
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<td>Question types</td>
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<td>✔</td>
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<td>✔</td>
<td>✔</td>
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<td>Short answer</td>
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<td>✔</td>
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<tr>
<td>No. of attempts allowed</td>
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<td>Limited</td>
<td>Unlimited</td>
<td>Limited</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
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<td>Discussion forums</td>
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<td></td>
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<tr>
<td>Can posts be rated?</td>
<td>Positive</td>
<td>Positive/negative</td>
<td>N/A</td>
<td>None</td>
<td>None</td>
<td>None</td>
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<tr>
<td>Grading and analytics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student’s view of progress</td>
<td>Raw marks with graph</td>
<td>Raw marks</td>
<td>None</td>
<td>Raw Marks</td>
<td>Progress percentage</td>
<td>Progress percentage</td>
<td></td>
</tr>
<tr>
<td>Teacher’s view of progress</td>
<td>Unknown</td>
<td>Unknown</td>
<td>CSV* export Google analytics (CSV)</td>
<td>Multiple types of detailed CSV reports</td>
<td>N/A</td>
<td>Can see and edit progress</td>
<td></td>
</tr>
</tbody>
</table>

*CSV = comma-separated value.

So Many Learners
As exciting as MOOCs are, if we want to exploit their potential, there’s
Is an LMS Really a MOOC Platform?

Since Sebastian Thrun’s artificial intelligence course in 2011, there has been a boom in the number of platforms from which a MOOC can be taught. Many of these platforms share common characteristics, including a focus on short video lectures and questions integrated within those videos. We can identify MOOC platforms by these features. However, these new platforms have a lot in common with their conceptual ancestors, Learning Management Systems (LMS). Like MOOCs, developers designed LMSs to move learning online. However, engineers designed LMSs to assist a classroom, whereas they designed a MOOC to replace one. In general, learning institutions have already incorporated LMSs, because they’re older. They’re more advanced, especially when it comes to quiz/assignment design. They have many features that most MOOC platforms lack. Indeed, the only feature MOOC platforms possess that LMSs don’t is the integration of questions within videos, something that LMS platforms could easily add and improve, given their superior assessment capabilities.

The recent emergence of MOOCs is already affecting the LMS space. For example, Blackboard—the creators of Blackboard Learn, a leading LMS—recently launched CourseSites, a hosted version of their popular Blackboard Learn software. Interestingly, despite users describing it as a MOOC platform, CourseSites appears to make no attempt to emulate features of other popular MOOC platforms. For instance, they still have poorly implemented videos. They seem to have confused the purpose of MOOCs. This different, perhaps confused, interpretation results in a product that was not designed to entirely replace face-to-face learning. In attempting to do so, they further blur the line between the LMS and a MOOC.

Similarly, the traditional use of LMS platforms is shaping the implementation of MOOC technologies, with some universities having begun adapting MOOC platforms to run in-house courses as a flipped classroom. In this model, educators deliver content such as lectures outside the classroom, so that more class time may be spent on activities and discussions. For example, in January 2013, the Cultural Complexity and Digital Humanities Department at The University of Western Ontario offered a course that used a modified version of the open source openMOOC platform. The teacher delivered all of the lectures and prescribed readings via the platform, dedicating actual class time to discussions and tutorials.

much to learn from AIED and broader educational research. We do know a good deal about the real challenges of distance learning and what a teacher must do to create effective learning contexts. We now consider these and how AIED work can provide foundations for MOOCs to help more teachers enable more learners to learn more things, more deeply.

The Student

What does it take to be a successful MOOC student? Current evidence suggests that the successful MOOC student isn’t your average student who has decided they need to learn. Indeed, that sort of student might be a rare phenomenon. Although we can’t provide more reliable numbers this early, the current first-generation MOOCs typically have a 5–10 percent pass rate. For instance, in a truly massive course run by MIT, only 7,157 of more than 150,000 students who signed up passed (www.i-programmer.info/news/150-training-a-education/4372-mitx-the-fallout-rate.html). Of course, 7,157 is a very large group of students, but a 95 percent dropout rate is quite high. We clearly can’t treat this fallout rate of 95 percent as directly comparable with fallout rates in university courses or training courses, because even the small amount of available research on student demographics and motivation indicates that a high percentage of those signing-up are just curious (www.insidehighered.com/news/2012/06/m0e5n/eta[1ly3-].demographic-data-hints-what-type-student-takes-mooc). But even students who go beyond the initial “snooping” phase have difficulties finishing the course. Essentially, the MOOC student faces the same challenges as a distance-learning student, such as time management. Researchers have published extensive literature on these challenges and on the kind of support that teaching organizations should provide. These challenges have stayed stubbornly consistent
over time. The new generation’s lifelong access to technology doesn’t address the problem. Researchers have even proven that the widely claimed generation-related increases in technical competence of digital natives are largely a myth.4

How might AIED make important improvements to students’ staying power and success in MOOCs? Students must possess certain competencies, such as self-guided learning and time-management skills. Despite the strict regimen that a typical MOOC imposes on students for handing in assignments, students must self-manage what happens between assignment dates. As we know from psychology, self-regulated learning involves a complex interplay of cognitive, metacognitive, and motivational regulatory components.5

According to recent theoretical approaches, ideal regulatory activities during learning include orientation, in order to get an overview of the task and resources, planning the course of action, evaluating the learning product, and monitoring and controlling all activities. According to research, students who participate in these regulatory activities more successfully learn the content.6 However, only a few students display such learning strategies. Most of us need the educator to prompt or reward us to engage in them.7

Educators might find it hard to change dispositions; however, students can master learning strategies fairly quickly. Keeping a learning journal, if not a more formal learning portfolio, and going beyond the requested assignments by reflecting on one’s learning is another element that could be likely contribute to success in MOOCs.8 In addition, students could organize small learning groups in the context of a MOOC. Engineers built MOOCs on an important theory of mass collaboration, but it’s different from the cognitive and motivational support we get from communicating with a small group of people we trust and whose interests we share.9 In addition to social networking sites, researchers recommend using e-portfolios as a tool for planning and documenting learning, reflecting on learning, and sharing learning and reflections with others.10 Related to this, researchers have revealed competence-oriented open learner models that support self-guided, lifelong learning.11

The Teacher

Researchers built MOOCs on the assumption that there are great teachers out there, and that getting them on video (plus a couple of assignments and quizzes) is largely sufficient for establishing pedagogical quality. No doubt there are great teachers out there, but as MOOCs proliferate (assuming for the sake of argument that they do proliferate), this approach won’t suffice. Not every MOOC lecturer will be rhetorically gifted or trained, and “customers” will become more critical about quality. Great researchers aren’t necessarily also great teachers, and great teachers don’t necessarily produce great online learning experiences. We’ll need to support MOOC lecturers and authors in several of the elements in our table to ensure that they can be effective in instructional design, course development, and student monitoring.

To support technical course development (for example, video capturing and editing, assignment specification), one can build on a good many years of research on, and experience with, developing courseware tools and e-learning software.12 Supporting the instructional design process on the pedagogical-conceptual level is no less challenging, as it has proven difficult to capture the pedagogical rationale and to formalize it in a manner that is conducive to sharing and continuous improvement.13 Researchers have discovered that students build important conceptual foundations by working on learning design patterns.14 On the practical side, engineers have developed numerous tools to support educators in designing for (online) instruction, and they have made some progress in providing shared repositories for learning designs (see www.lamsfoundation.org). In short, the subject specialist creating a MOOC can gain a lot from the body of knowledge on how to create effective online materials and ways to nurture effective learning experiences for students. And, happily, there are already some MOOCs for that!

To monitor the learning activities of potentially thousands of students, e-learning platforms are providing increasingly valuable reporting tools. To some extent, they’re also appearing in MOOC platforms, and we can anticipate refinement and development of these. Engineers are also developing learning analytics for when an educator needs to monitor learning activities across platforms and tools.

Assessment issues are notoriously complex, not only in a technical sense. First-generation MOOCs are fairly simple-minded about assessment, following the United States’ undergraduate model of quizzes and assignments. Although MOOCs can automatically assess quizzes, peer reviews must deal with more comprehensive assignments. However, assessment should be formative, as well. And that goes beyond simple self-test questions at the end of each lecture segment. That is, formative feedback should provide information that can guide learning. In this
respect, neither quizzes nor peer-assessment suffice. Eventually, MOOC course and platform developers must engage with the substantial challenges of online formative and summative assessment.

So Much Potential

MOOCs’ engineers can exploit diverse results and techniques from AIED to improve MOOC platforms and create new opportunities for AIED research. Computer scientists working in fields such as educational data mining and learning analytics find MOOCs particularly interesting. Not only can they create truly “big” learning-related data from MOOC courses (provided that the dropout rate is suitably managed), they can also provide a very heterogeneous student body, because of the open nature of MOOCs. These students can interact in ways that aren’t further structured by established social contracts and roles; therefore, researchers may explore social network analysis methods on MOOCs.

Methods from educational data mining and learning analytics can in general be applied for knowledge creation (learning more about learning and interaction, and relevant technologies). They can also serve applied purposes: supporting students, teachers, educational institutions, and systems. In light of the mentioned attrition rate, computer scientists can use another rather obvious applied challenge—automatically identifying students at risk of failing. They can use similar techniques to “nudge” students who need it, and provide course- or cohort-based monitoring. We can expect the growth of large collections of learning data, similar to the Pittsburgh Science of Learning Center (PSLC) Datashop (https://pslcdatashop.web.cmu.edu). This can provide a new scale in testbeds for EDM researchers. We can then expect to see more innovative uses of learning data to improve teaching, such as an elegant system to generate hints for students, by drawing on historic data from the paths taken by successful and unsuccessful students.

Pedagogic interface agents are one of the current hot topics in AIED. Researchers have proven that these anthropomorphic conversational characters provide real benefits for learning. Although we might expect this effect to be short-lived once the novelty has worn off, recent results indicate that interface agents actually help people stay the course. They seem to promise a valuable role in MOOCs.

In addition to providing general research opportunities on how to support online learning with technical means, MOOCs might also provide a particularly fruitful arena for research on e-portfolio systems, competence management (including assessment), and technical support for lifelong learning (including open learner models).

The quality, timing, and form of feedback is critical to effective learning. MOOCs currently rely heavily on self- and peer-review. Higher education already recognizes the place for such forms. However, they are more effective if students are explicitly taught how to do such self- and peer-assessment, a valuable role for AIED systems.

Another key form of valuable feedback can be provided for learning contexts where high-quality assessment can be automated. This is the case for domains like programming, mathematics, and physics, where there are already many systems that provide high-quality feedback. AIED research has produced many systems that give high-quality feedback in those classes of well-defined learning domains.

These classes of MOOCs can also be part of a hybrid model. For example, many developing countries have a large unmet need for skilled IT professionals, where the learning need involves well-defined technical skills. The most recent MOOCs already offer several attractive options for this situation. Employers can use MOOCs to deliver content and a basic formative assessment to potential employees. The employer can complement this by nurturing learning communities. They can conduct summative assessment that determines employment options, which is a significant motivator for students.

More recently, researchers are moving AIED toward ill-structured domains—most notably, lifelong generic (particularly the meta-cognitive) skills that are a key to success in MOOCs. Educators have successfully taught these skills using AIED.

The rhetoric about MOOCs refers to personalized learning, with reference to Benjamin Bloom’s classic 2-Sigma article about one-to-one tutoring. However, current MOOCs come nowhere near trying to achieve that level of personalization. One key to the success of AIED systems is in the nature of the personalization, which is based on a learner model. Indeed, some have argued that the very core of AIED is the role of the learner model. This core notion of creating an explicit learner model could be readily integrated into MOOCs. Open learner models have been demonstrated to improve learning, and they could be a fundamental means for learners to monitor their progress and plan all aspects of their learning, including setting goals and how to achieve them.

It is hard to conceive of MOOCs as having any lasting impact on (higher) education without concern for how
the single MOOC event (course) gets integrated into individual career planning and personal development, as well as into an comprehensive certification framework.26 Hence, research on how to support the integration of learning events on the individual as well as the societal level will be crucial. The excitement around MOOCs is justified, both in terms of the potential value they offer and the quality of the players who have launched them. What a great opportunity to integrate the lessons, techniques, methods, and tools of AIED!

Acknowledgments

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