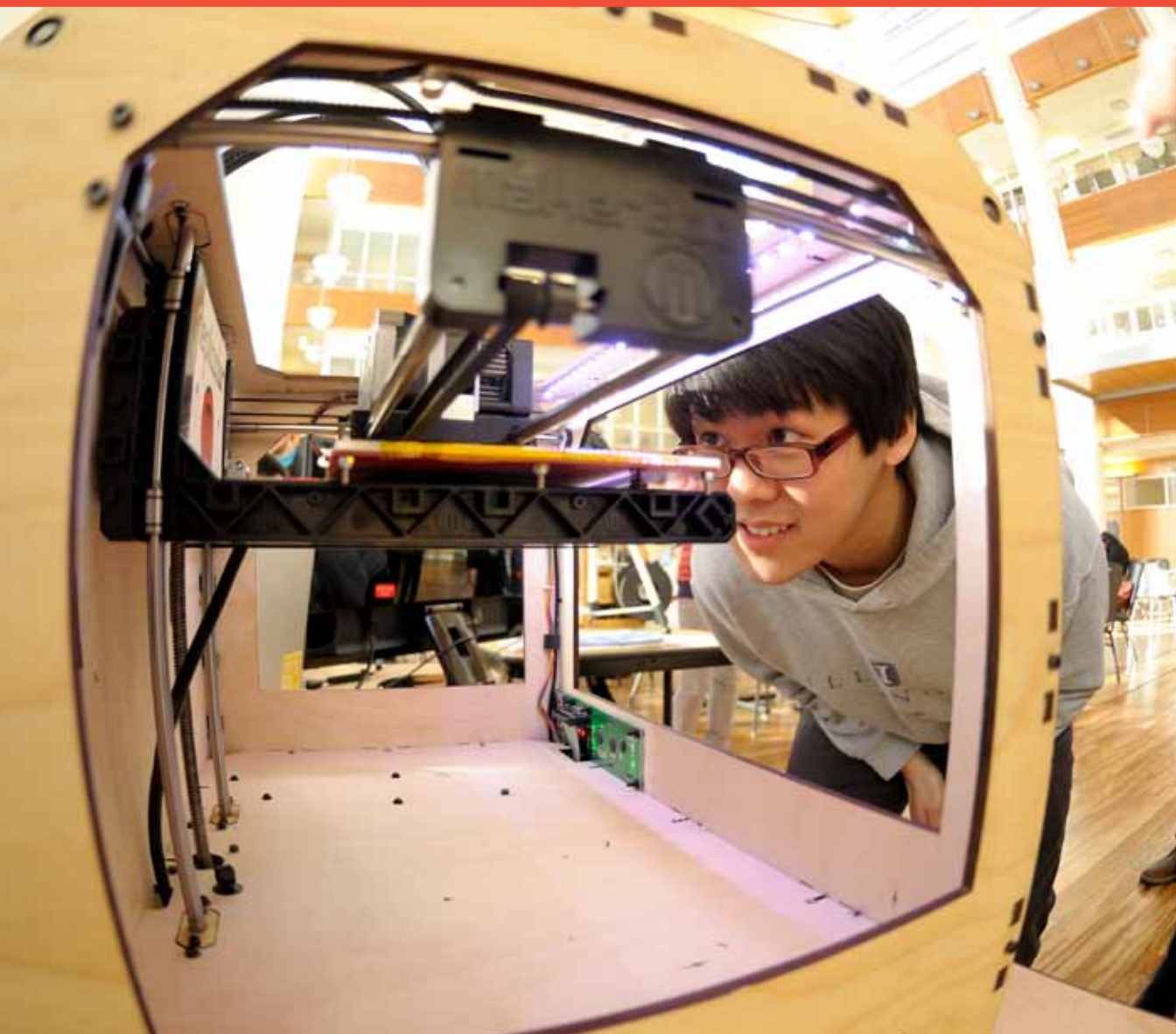
NMC

Horizon Report > 2013 Higher Education Edition



The *NMC Horizon Report* is an unbiased source of information that helps education leaders, trustees, policy makers, and others easily understand the impact of key emerging technologies on education, and when they are likely to enter mainstream use.

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The *NMC Horizon Report: 2013 Higher Education Edition* is a collaboration between the New Media Consortium and the EDUCAUSE Learning Initiative, an EDUCAUSE Program.

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Executive Summary

Welcome to the *NMC Horizon Report*, a series of publications designed to help education leaders, policy makers, and faculty understand new and emerging technologies, and their potential impact on teaching, learning, and research. This specific volume, the *NMC Horizon Report: 2013 Higher Education Edition,* is framed specifically around the unique needs and circumstances of higher education institutions, and looks at that landscape with a global lens over the next five years.

The internationally recognized *NMC Horizon Report* series and regional *NMC Technology Outlooks* are part of the NMC Horizon Project, a comprehensive research venture established in 2002 that identifies and describes emerging technologies likely to have a large impact over the coming five years in education around the globe. Since 2005, this particular edition has been produced via a collaborative effort with the EDUCAUSE Learning Initiative, and examines emerging technologies for their potential impact on teaching, learning, and creative inquiry within the higher education environment.

To create the report, an international body of experts in education, technology, and other fields was convened as an advisory board. The group engaged in discussions around a set of research questions intended to surface significant trends and challenges and to identify a wide array of potential technologies for the report. This dialog was enriched by an extensive range of resources, current research, and practice that drew on the expertise of both the NMC community and the communities of the members of the advisory board. These interactions among the advisory board are the focus of the *NMC Horizon Report* research, and this report details the areas in which these experts were in strong agreement.

The report opens with a discussion of the trends and challenges identified by the advisory board as most important for the next five years. The main section highlights six promising technological areas and their practical, real-world applications in higher education settings. Each section is introduced with an overview

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that defines the topic, followed by a discussion of the particular relevance of the topic to teaching, learning, and creative inquiry in higher education. Next, several concrete examples are provided that demonstrate how the technology is being used. Finally, each section closes with an annotated list of suggested readings that expand on the discussion in the report.

These resources, along with countless other helpful projects and readings, can all be found in the project's open content database — the NMC Horizon Project Navigator (navigator.nmc.org). All the ephemera of the *NMC Horizon Report: 2013 Higher Education Edition*, including the research data, the interim results, the topic preview, and this publication, can be downloaded for free on the NMC website (nmc.org), as well as iTunes U (go.nmc.org/itunes-u).

Each of the three global editions of the *NMC Horizon Report* — higher education, K-12 education, and museum

education — highlights six emerging technologies or practices that are likely to enter mainstream use in their focus sectors within three adoption horizons over the next five years. Key trends and significant challenges that will affect current practice over the same period frame these discussions. Over the course of just a few weeks in the early winter of 2012, the advisory board came to a consensus about the six topics that appear here in the *NMC Horizon Report: 2013 Higher Education Edition*. The examples and readings under each topic are meant to provide practical models as well as access to more detailed information. The precise research methodology employed is detailed in the closing section of this report.

Tablets are proving to be powerful tools for learning inside and outside of the classroom.

Technologies to Watch

The six technologies featured in the *NMC Horizon Report: 2013 Higher Education Edition* are placed along three adoption horizons that indicate likely timeframes for their entrance into mainstream use for teaching, learning, and creative inquiry. The near-term horizon assumes the likelihood of entry into the mainstream for higher education institutions within the next 12 months; the mid-term horizon, within two to three years; and the far-term, within four to five years. It should be noted at the outset that the *NMC Horizon Report* is not a predictive tool. It is meant, rather, to highlight emerging technologies with considerable potential for our focus areas of education and interpretation. Each of the six is already the target of work at a number of innovative organizations around the world, and the projects we showcase here reveal the promise of a wider impact.

Near-term horizon

On the near-term horizon — that is, within the next 12 months — *massively open online courses* (MOOCs) and *tablet computing* will see widespread adoption in higher education. MOOCs have become an increasingly popular option for online learning that often promise free, high quality education, though media attention surrounding this category has prompted critics to examine the most prominent models very closely. Tablets have proven to be a solid fit with today's always-connected university students, and the recent expansion of the tablet market is presenting them with a wide array of affordable options.

> **Massively open online courses** have received their fair share of hype in 2012, and are expected to grow in number and influence within the next year. Big name providers including Coursera, edX, and Udacity count hundreds of thousands of enrolled students, totals that when added together illustrate their popularity. One of the most appealing promises of MOOCs is that they offer the possibility for continued, advanced learning at zero cost, allowing students, life-long learners, and professionals to acquire new skills and improve their knowledge and employability. MOOCs have enjoyed one of the fastest uptakes ever seen in higher education, with literally hundreds of new entrants in the last year; critics loudly warn that there is a need to examine these new approaches through a critical lens to ensure they are effective and evolve past the traditional lecture-style pedagogies.

> **Tablet computing** has carved its own niche in education as a portable and always-connected family of devices that can be used in almost any setting. Equipped with WiFi and cellular network connectivity, high-resolution screens, and with a wealth of mobile apps available, tablets are proving to be powerful tools for learning inside and outside of the classroom. Many universities have already designed software for tablets along with best practice guidelines for educators and students. With more major manufacturers producing tablets all the time, the competition in the tablet computing market is a significant driver of innovation. As the market matures, students and institutions can expect a rich and growing array of features from these small devices.

Mid-term horizon

The second adoption horizon, two to three years out, is where we expect to see widespread adoptions of two

technologies that are experiencing growing interest within higher education: *games and gamification,* and the further refinement of *learning analytics*. Games in higher education aim to engage students, providing them with digitally enhanced scenarios that challenge their understanding of new concepts in their field. The topic has been expanded this year to include gamification and how elements of game design are informing curricula. Learning analytics is a burgeoning body of work rooted in the study of big data, which aims to use analytic techniques common in businesses to gain insights about student behavior and learning. Information derived from learning analytics can inform instructional practice in real time, as well as aid in the design of course management systems that personalize education.

> **Games and gamification** are two sides of the same approach. Educational games immerse the student in the game, where content and curricula are delivered or juxtaposed. Gamification aims to incorporate elements of games, such as levels and badges (but also via quests and other strategies) into non-game activities. In gamified curricula, students can accumulate points or other rewards by accepting different challenges, and often have more freedom in choosing what kind of assignments they undertake to earn them. Badging or ranking systems serve to recognize student achievements, and the transparency of student progress inspires competition that can drive more interest in the material among students.

> **Learning analytics** is the field associated with deciphering trends and patterns from educational big data, or huge sets of student-related data, to further the advancement of a personalized, supportive system of higher education. Preliminary uses of student data were directed toward targeting at-risk learners in order to improve student retention. The widespread adoption of learning and course management systems has refined the outcomes of learning analytics to look at students more precisely. Student-specific data can now be used to customize online course platforms and suggest resources to students in the same way that businesses tailor advertisements and offers to customers. Universities are already employing analytics software to make the advising process more efficient and accurate, while researchers are developing mobile software to coach students toward productive behaviors and habits that will lead to their success.

Far-term horizon

On the far-term horizon, set at four to five years away from widespread adoption, are *3D printing* and *wearable technology*. 3D printing provides a more accessible, less expensive, desktop alternative to industrial forms of rapid prototyping. Many of the discussions surrounding 3D printers stem from the Maker culture, an enthused community of designers, programmers, and others that bring a do-it-yourself approach to science and engineering. Wearable technology, making its first appearance in the *NMC Horizon Report* series, refers to the integration of devices and related electronics into clothing and accessories. A growing collection of wearable technology has appeared in the marketplace, and collectively hints at the potential for teaching and learning, though there are not yet many concrete education examples.

> **3D printing** has become much more affordable and accessible in recent years in large part due to the efforts of MakerBot Industries. Founded in 2009, this company has promoted the idea of openness by offering products that can be built by anyone with minimal technical expertise. With MakerBot Replicators selling in the range of $1,500 to $3,000, it now only requires a small financial investment to own a 3D printer. Websites including Thingiverse offer source files that anyone can use to print objects without original designs. In an educational context, 3D printing is already implemented in a number of research and lab settings. Over the next four to five years, 3D printers will be increasingly used in the arts, design, manufacturing, and the sciences to create 3D models that illustrate complex concepts or illuminate novel ideas, designs, and even chemical and organic molecules.

> **Wearable technology** will increase in impact as enabling technologies, such as augmented reality

and thin film displays, gain traction in the consumer market. Bendable OLED displays can wrap around furniture and other curved surfaces, which makes it easy to imagine computing devices and accessories that meld with the human body. Perhaps the most anticipated wearable technology is Google's "Project Glass," augmented reality enabled glasses that operate via voice command, presenting the wearer with an information-laden view of their surroundings. Wearable devices are also proving to be effective tools for research because they use sensors to track data, such as vital signs, in real-time. Although wearable technology is not yet pervasive in higher education, the current highly functional clothing and accessories in the consumer space show great promise.

Student-specific data can now be used to customize online course platforms and suggest resources to students in the same way that businesses tailor advertisements and offers to customers.

Each of these technologies is described in detail in the main body of the report, where a discussion of what the technology is and why it is relevant to teaching, learning, or creative inquiry can also be found. Our research indicates that all six of these technologies are already having a clear and immediate impact on practices in higher education, and this report aims to document that in a simple and compelling fashion.

The advisory board of 51 technology experts spanned 13 countries this year, and their names are listed at the end of this report. Despite their diverse backgrounds and experience, they share a consensus view that each of the profiled topics will have a significant impact on higher education around the globe over the next five years. The key trends driving interest in their adoption, and the challenges institutions will need to address if the technologies are to reach their potential, also reflect the advisory board's perspective, and are the focus of the next sections of the *NMC Horizon Report: 2013 Higher Education Edition,* where each is detailed in the context of teaching, learning, and creative inquiry.

Key Trends

The technologies featured in each edition of the *NMC Horizon Report* are embedded within a contemporary context that reflects the realities of our time, both in the sphere of higher education and in the world at large. To ensure this context was well understood, the advisory board engaged in an extensive review of current articles, interviews, papers, and new research to identify and rank trends that are currently affecting teaching, learning, and creative inquiry in higher education. Once detailed, the initial list of dozens of trends was then ranked according to how significant each was likely to be for higher education in the next five years. The highest ranked of those trends had significant agreement among the advisory board members, who considered them to be key drivers of educational technology adoptions for the period 2013 through 2018. They are listed here in the order in which the advisory board ranked them.

1 Openness — concepts like open content, open data, and open resources, along with notions of transparency and easy access to data and information — is becoming a value. As authoritative sources lose their importance, there is need for more curation and other forms of validation to generate meaning in information and media. "Open" continues its diffusion as a buzzword in education, and it is increasingly important to understand the definition. Often mistakenly equated only with "free," open education advocates are working towards a common vision that defines "open" as free, copyable, remixable, and without any barriers to access or interaction.

2 Massively open online courses are being widely explored as alternatives and supplements to traditional university courses. Led by the successful early experiments of world-class institutions (like MIT and Stanford), MOOCs have captured the imagination of senior administrators and trustees like few other educational innovations have. High profile offerings are being assembled under the banner of institutional efforts like edX, and large-scale collaborations like Coursera and the Code Academy. As the ideas evolve, MOOCs are increasingly seen as a very intriguing alternative to credit-based instruction. The prospect of a single course achieving enrollments in the tens of thousands is bringing serious conversations on topics like micro-credit to the highest levels of institutional leadership.

3 The workforce demands skills from college graduates that are more often acquired from informal learning experiences than in universities. Informal learning generally refers to any learning that takes place outside of a formal school setting, but a more practical definition may be learning that is self-directed and aligns with the student's own personal learning goals. Employers have specific expectations for new hires, including communication and critical thinking skills — talents that are often acquired or enhanced through informal learning. Online or other modern environments are trying to leverage both formal and informal learning experiences by giving students traditional assignments, such as textbook readings and paper writing, in addition to allowing for more open-ended, unstructured time where they are encouraged to experiment, play, and explore topics based on their own motivations. This type of learning will become increasingly important in learning environments of all kinds.

4 There is an increasing interest in using new sources of data for personalizing the learning experience and for performance measurement. As learners participate in online activities, they leave a clear trail of analytics data that can be mined for insights.

Learning analytics experiments and demonstration projects are currently examining ways to use data for enrichment. Dashboards filter this information so that student progress can be monitored in real time. As the field of learning analytics matures, the hope is that this information will enable continual improvement of learning outcomes.

5 The role of educators continues to change due to the vast resources that are accessible to students via the Internet. Institutions are now faced with a critical shift as students engage in more informal learning outside of the classroom, and are using always-connected devices to surf the web, download apps, and read articles. Educating learners on how to decipher credible resources and aggregate content has become imperative, and there is a need for university educators to fulfill the position of content guide. The emergence of MOOCs, open content, and free online seminars also raises the question of who is considered the expert. Educators are providing mentorship and connecting students with the most effective forums and tools to navigate their areas of study.

As authoritative sources lose their importance, there is need for more curation and other forms of validation to generate meaning in information and media.

6 Education paradigms are shifting to include online learning, hybrid learning, and collaborative models. Students already spend much of their free time on the Internet, learning and exchanging new information — often via their social networks. Institutions that embrace face-to-face/online hybrid learning models have the potential to leverage the online skills learners have already developed independent of academia. Online learning environments can offer different affordances than physical campuses, including opportunities for increased collaboration while equipping students with stronger digital skills. Hybrid models, when designed and implemented successfully, enable students to travel to campus for some activities, while using the network for others, taking advantage of the best of both environments.

Significant Challenges

Any discussion of technology adoption must also consider important constraints and challenges. The advisory board drew deeply from a careful analysis of current events, papers, articles, and similar sources, as well as from personal experience, in detailing a long list of challenges higher education institutions face in adopting any new technology. Several important challenges are explained below, but it was clear that behind them all was a pervasive sense that individual organizational constraints are likely the most important factors in any decision to adopt — or not to adopt — a given technology.

Even institutions that are eager to adopt new technologies may be critically constrained by the lack of necessary human resources and the financial wherewithal to realize their ideas. Still others are located within buildings that simply were not designed to provide the radio frequency transparency that wireless technologies require, and thus find themselves shut out of many potential technology options. While acknowledging that local barriers to technology adoptions are many and significant, the advisory board focused its discussions on challenges that are common to the higher education community as a whole. The highest ranked challenges they identified are listed here, in the order in which the advisory board ranked them.

1 Faculty training still does not acknowledge the fact that digital media literacy continues its rise in importance as a key skill in every discipline and profession. Despite the widespread agreement on the importance of digital media literacy, training in the supporting skills and techniques is rare in teacher education and non-existent in the preparation of faculty. As lecturers and professors begin to realize that they are limiting their students by not helping them to develop and use digital media literacy skills across the curriculum, the lack of formal training is being offset through professional development or informal learning, but we are far from seeing digital media literacy as a norm. This challenge is exacerbated by the fact that digital literacy is less about tools and more about thinking, and thus skills and standards based on tools and platforms have proven to be somewhat ephemeral.

Simply capitalizing on new technology is not enough; the new models must use these tools and services to engage students on a deeper level.

2 The emergence of new scholarly forms of authoring, publishing, and researching outpace sufficient and scalable modes of assessment. Traditional approaches to scholarly evaluation such as citation-based metrics, for example, are often hard to apply to research that is disseminated or conducted via social media. New forms of peer review and approval, such as reader ratings, inclusion in and mention by influential blogs, tagging, incoming links, and re-tweeting, are arising from the natural actions of the global community of educators with increasingly relevant and interesting results. These forms of scholarly corroboration are not yet well understood by mainstream faculty and academic decision makers, creating a gap between what is possible and what is acceptable.

3 Too often it is education's own processes and practices that limit broader uptake of new technologies. Much resistance to change is simply comfort with the status quo, but in other cases, such as in promotion and tenure reviews, experimentation or innovative applications of technologies are often seen as outside the role of researcher or scientist, and thus discouraged. Changing these processes will require major shifts in attitudes as much as they will in policy.

4 The demand for personalized learning is not adequately supported by current technology or practices. The increasing demand for education that is customized to each student's unique needs is driving the development of new technologies that provide more learner choice and control and allow for differentiated instruction. It has become clear that one-size-fits-all teaching methods are neither effective nor acceptable for today's diverse students. Technology can and should support individual choices about access to materials and expertise, amount and type of educational content, and methods of teaching. The biggest barrier to personalized learning, however, is that scientific, data-driven approaches to effectively facilitate personalization have only recently begun to emerge; learning analytics, for example, is still in the very nascent stage of implementation and adoption within higher education.

5 New models of education are bringing unprecedented competition to the traditional models of higher education. Across the board, institutions are looking for ways to provide a high quality of service and more learning opportunities. MOOCs are at the forefront of these discussions, enabling students to supplement their education and experiences at brick-and-mortar institutions with increasingly rich, and often free, online offerings. As these new platforms emerge, however, there is a need to frankly evaluate the models and determine how to best support collaboration, interaction, and assessment at scale. Simply capitalizing on new technology is not enough; the new models must use these tools and services to engage students on a deeper level.

6 Most academics are not using new technologies for learning and teaching, nor for organizing their own research. Many researchers have not had training in basic digitally supported teaching techniques, and most do not participate in the sorts of professional development opportunities that would provide them. This is due to several factors, including a lack of time and a lack of expectations that they should. Many think a cultural shift will be required before we see widespread use of more innovative organizational technology. Some educators are simply apprehensive about working with new technologies, as they fear the tools and devices have become more of a focus than the learning. Adoption of progressive pedagogies, however, is often enabled through the exploration of emerging technologies, and thus a change in attitude among academics is imperative.

These trends and challenges are a reflection of the impact of technology that is occurring in almost every aspect of our lives. They are indicative of the changing nature of the way we communicate, access information, connect with peers and colleagues, learn, and even socialize. Taken together, they provided the advisory board a frame through which to consider the potential impacts of nearly 50 emerging technologies and related practices that were analyzed and discussed for possible inclusion in this edition of the *NMC Horizon Report* series. Six of those were chosen through successive rounds of ranking; they are detailed in the main body of the report.

Massively Open Online Courses

Time-to-Adoption Horizon: One Year or Less

When Stephen Downes and George Siemens coined the term in 2008, massively open online courses (MOOCs) were conceptualized as the next evolution of networked learning. The essence of the original MOOC concept was a web course that people could take from anywhere across the world, with potentially thousands of participants. The basis of this concept is an expansive and diverse set of content, contributed by a variety of experts, educators, and instructors in a specific field, and aggregated into a central repository, such as a web site. What made this content set especially unique is that it could be "remixed" — the materials were not necessarily designed to go together but became associated with each other through the MOOC. A key component of the original vision is that all course materials and the course itself were open source and free — with the door left open for a fee if a participant taking the course wanted university credit to be transcripted for the work. Since those early days, interest in MOOCs has evolved at an unprecedented pace, fueled by the attention given to high profile entrants like Coursera, Udacity, and edX in the popular press. In these new examples, "open" does not necessarily refer to open content or even open access, but only equates to "no charge." Ultimately, many challenges remain to be resolved in supporting learning at scale. The most compelling aspect of the proliferation of MOOCs is that it is helping frame important discussions about online learning that simply could not have taken place before the advent of actual experiments in learning at scale.

Overview

The term "massively open online course" was hardly a thought bubble during the discussions for the *NMC Horizon Report: 2012 Higher Education Edition*. Over the past year, MOOCs have gained public awareness with a ferocity not seen in some time. World-renowned universities, including MIT (edX) and Stanford (Coursera), as well as innovative start-ups such as Udacity jumped into the marketplace with huge splashes, and have garnered a tremendous amount of attention — and imitation. Designed to provide high quality, online learning at scale to people regardless of their location or educational background, MOOCs have been met with enthusiasm because of their potential to reach a previously unimaginable number of learners. The notion of thousands and even tens of thousands of students participating in a single course, working at their own pace, relying on their own style of learning, and assessing each other's progress has changed the landscape of online learning.

A number of respected thought leaders believe that the current manifestation of MOOCs has significantly deviated from the initial premise outlined by George Siemens and Stephen Downes in 2008, when they pioneered the first courses in Canada. They envisioned MOOCs as ecosystems of connectivism — a pedagogy in which knowledge is not a destination but an ongoing activity, fueled by the relationships people build and the deep discussions catalyzed within the MOOC. That model emphasizes knowledge production over consumption, and new knowledge generated helped to sustain and evolve the MOOC environment.

Despite these philosophical distinctions among MOOC implementations, one aspect that both early and contemporary MOOCs have in common is that they leverage a multitude of emerging pedagogies and tools, including blended learning, open educational resources, and crowd-sourced interaction. The technologies that enable the workflow of MOOCs vary in different models, but the common thread is that

these sorts of tools are readily available and easy to use. MOOCs draw upon cloud-based services such as WikiSpaces, YouTube, and Google Hangouts, among many others, to foster discussions, create and share videos, and engage in all the other activities that have become essential to teaching and learning in a modern online learning environment.

Although there are clear differences among the major MOOC projects, it is important to note that their basic pedagogical approaches are very similar. For Coursera, edX, and Udacity — the three major players in the MOOC space — course materials are located in a hub or central repository and they all use automated software to assess student performance through quizzes and homework assignments. The social structures of the major MOOC projects are also similar, with students participating in online forums, study groups, and in the case of Coursera and Udacity, organized student meet-ups. Content-wise, Coursera emphasizes video, with students watching recorded lectures from field experts as the main substance of the courses. At the time of publication, Coursera had over two million students enrolled in 200 courses, while edX and Udacity have reached around 500,000 students, across 23 courses and 19 courses, respectively.

While extremely promising, current MOOC models still largely mirror traditional lecture formats.

While extremely promising, current MOOC models still largely mirror traditional lecture formats. Coursera, for example, is centered around video lectures led by renowned educators from prestigious universities in popular areas such as microeconomics and artificial intelligence. Students watch these videos and demonstrate what they have learned via quizzes and papers. Although the quality of the video and related content provided is high, this delivery model is very much based in traditional models of instruction, and does not include the notions of openness and connectivism outlined by Siemens and Downes. Indeed, the content on each of the major sites is not "open," as pervasive copyright notices make clear.

As massively open online courses continue their high-speed trajectory in the near-term horizon, there is a great need for reflection that includes frank discussions about what a sustainable, successful model looks like. Some experts believe that the pace at which MOOCs are developing is too rapid for genuine analysis; others maintain that they are not as disruptive of a technology as initially touted. Time will settle those questions, but there is no doubt that MOOCs have already had a significant influence on the future course of online learning, and deserve close attention, study, and continued experimentation.

Relevance for Teaching, Learning, or Creative Inquiry

"Free" has played a major role in the rise of massively open online courses, though institutions are brainstorming ways to monetize them, such as charging for special certifications. Last year, the Federal Reserve Bank of New York reported that Americans owe over $900 billion in student loans, yet 40% of students enrolled at four-year universities do not get their degree in under six years. Furthermore, there is a growing chorus of students expressing frustration about what they are actually getting — and not getting — out of higher education for their money.

In many current models, massively open online courses present opportunities for learners to freely experiment with a variety of subjects and acquire new skills that may not be associated with a degree plan at brick-and-mortar institutions. An English major, for example, could enroll in an edX course on the foundations of computer graphics or circuits and electronics. In other words, learners are not stuck on a single pathway.

Related advances in both classroom and online learning are emphasizing personalized learning, and if massively open online courses could both scale globally and yet cater to individual learning styles, it would be a very exciting combination. In their current forms, MOOCs already allow learners of all ages, incomes, and levels

of education to participate in a wide array of courses without being enrolled at a physical institution. The most effective MOOCs make creative use of a variety of educational strategies and frequently leverage multimedia to demonstrate complex subjects. One recent entrant in Spain, unX, has integrated badges as a way to reward learners for their participation and concept mastery.

As MOOC projects proliferate, the hope is that they will invent new innovative and informal ways for learners to demonstrate their knowledge at scale. Peer review systems, student gurus, badges, and other forms of assessment are currently being explored, but there is no real verdict yet on what is most effective. To continue to gain traction, MOOCs will need to strike a fine balance between automating the assessment process while delivering personalized, authentic learning opportunities.

A sampling of applications of massively open online courses across disciplines includes the following:

> **Music.** In the spring of 2013, Indiana University-Purdue University Indianapolis and the Purdue University Department of Music and Arts Technology will offer a new MOOC, "Music for the Listener," that can be converted into credit. The six-week course covers the music of western civilization from 600 AD to the present. The learning environment is being delivered through Course Networking, with full translation features, rich media, and social networking tools: go.nmc.org/thecn.

> **Physics.** A MOOC called "Landmarks in Physics" delivered through Udacity was created by an MIT graduate who filmed in Italy, the Netherlands, and England to create a virtual tour that explains the basic concepts of physics at the sites of important discoveries in our history: go.nmc.org/phy.

> **Writing and Composition.** The Gates Foundation awarded a grant to Ohio State University to design a MOOC for Coursera. This course will engage participants as writers, reviewers, and editors in a series of interactive reading, composing, and research activities with assignments designed to help them become more effective consumers and producers of alphabetic, visual, and multimodal texts. OSU faculty members have developed the Writers Exchange, an idea-networking website to support the course: go.nmc.org/osu.

Massively Open Online Courses in Practice

The following links provide examples of massively open online courses in use in higher education settings:

Caltech's Learning from Data
go.nmc.org/caltech
The California Institute of Technology piloted the "Learning from Data" MOOC in April 2012. The first offering included live streaming and real-time Q&A sessions with the participants, along with automated grading and discussion forums. Since then, it has been offered four times, with over 100,000 enrolled students.

Games MOOC
go.nmc.org/gamesmooc
The Games MOOC is a community site woven around a series of three courses about the use of games in education, including traditional games, massively multiplayer online role-playing games, game-based learning, and immersive environments. The first courses were piloted in the fall of 2012.

Google's Open Course Builder
go.nmc.org/googco
Google created an open course builder and its first massive open online course, "Power Searching with Google." It drew 150,000 students, and helped sharpen their Internet search skills.

Open Course for Educators (Career and Technical Education 230: Instructional Technology)
go.nmc.org/opecou
This Maricopa Community Colleges' course stems from a National Science Foundation-funded project to increase the ability of STEM teachers to collaboratively learn and apply STEM skills using information and communication technology. Participating educators acquire knowledge and skills using Canvas and 3D Game Lab learning management systems, and Google+ Community.

UMW's Digital Storytelling 106
go.nmc.org/ds106
Anyone can take this online digital storytelling course at University of Mary Washington (UMW), one of the few that adhere to the original connectivist notion of a massive online course, but only students registered at the university can receive credit. For the past couple years, it has also been taught at several other institutions. UMW is currently exploring how to give credit to other state college students as well as incoming high school students.

unX
go.nmc.org/csevunx
The Centro Superior para la Enseñanza Virtual is encouraging MOOC enrollment to Latin American communities through a Spanish platform called unX. The model includes many interactive features along with a digital badging system.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about massively open online courses:

College Is Dead. Long Live College!
go.nmc.org/ylazv
(Amanda Ripley, *TIME*, 18 October 2012.) When the Pakistani government shut down access to YouTube in September 2012, an 11-year old girl connected with U.S. students and found a solution to continue her online studies using Udacity.

How 'Open' Are MOOCs?
go.nmc.org/ope
(Steve Kolowich, *Inside Higher Ed*, 8 November 2012.) This article explores several misunderstandings in the way many chief academic officers view massively open online courses and their potential to supplement traditional university classes.

Jump Off the Coursera Bandwagon
go.nmc.org/cou
(Doug Guthrie, *The Chronicle of Higher Education*, 17 December 2012.) This author observes that as universities rush to deliver online education, they may be too quick to launch insufficient models. As a result, many MOOCs are not addressing critical pedagogical issues, in addition to interactivity and customization.

MOOCs and Money
go.nmc.org/money
(Matt Greenfield, *Education Week*, 1 October 2012.) MOOCs have some possible monetizing strategies that can work as long as they continue to attract millions of students. The author argues that many current students are attracted to MOOCs out of curiosity, and ponders whether enrollment numbers will continue to be high over the next few years.

The Single Most Important Experiment in Higher Education
go.nmc.org/single
(Jordan Weissmann, *The Atlantic*, 18 July 2012.) This article discusses Coursera's new partnerships with several other universities. One school, the University of Washington, is giving credit for its Coursera courses. The funding from all these new universities will allow the company to blossom as a market for learning.

xED Book
go.nmc.org/xed
(Dave Cormier, George Siemens, and Bonnie Stewart, Accessed 2 January 2013.) George Siemens and two education researchers are writing a book that will discuss how the Internet is restructuring knowledge and the implications for MOOCs. They are currently chronicling their ideas on this site.

The Year of the MOOC
go.nmc.org/moo
(Laura Pappano, *The New York Times*, 2 November 2012.) Over the past year, MOOC development has become a major trend. This article examines the current higher education institutions and organizations offering MOOCs, discussing their strategies and the challenges each are facing.

Tablet Computing

Time-to-Adoption Horizon: One Year or Less

In the past two years, advances in tablets have captured the imagination of educators around the world. This category is led by the incredible success of the iPad, which at the time of publication had sold more than 85 million units and is predicted by GigaOM to sell over 377 million units by 2016. Other similar devices such as the Samsung Galaxy Nexus, Kindle Fire, the Nook, Sony's Tablet S, and the Microsoft Surface have also entered this rapidly growing market. In the process, the tablet (a device that does not require a mouse or keyboard) has come to be viewed as a new technology in its own right, one that blends features of laptops, smartphones, and earlier tablet computers with always-connected Internet and thousands of apps with which to personalize the experience. As these new devices have become more used and understood, it has become even clearer that they are independent and distinct from other mobile devices such as smartphones, e-readers, or tablet PCs. With significantly larger screens and richer gesture-based interfaces than their smartphone predecessors — and a growing and ever more competitive market — they are ideal tools for sharing content, videos, images, and presentations because they are easy for anyone to use, visually compelling, and highly portable. Tablets have gained traction in education because users can seamlessly load sets of apps and content of their choosing, making the tablet itself a portable personalized learning environment.

Overview

When the Apple iPad was released in 2010, a new category of mobile device was born, distinct from smartphones, ultra-small laptops, e-readers, and other kinds of portable devices. Suddenly people had the ability to download and read books, watch videos, learn foreign languages, and much more — all through a large, high-resolution touchscreen that made the experience convenient, vibrant, and shareable. On these always-connected devices, several people could sit down together and easily watch the same movie and study the same images.

Tablet computing continues to capture the immediate focus of technology adopters, as it has for the past year. In the early months of 2012, the category was new, and the focus was on the early entrant, the iPad, as there were no viable competitors in the marketplace yet. Now

Tablets have gained traction in education because users can seamlessly load sets of apps and content of their choosing, making the tablet itself a portable personalized learning environment.

the tablet market is very different, with a wide range of solid alternatives, operating systems, and form factors, and there is real competition in the market for the first time.

According to a recent report from the web analytics firm, Chitika, Internet traffic from the iPad dropped over 7% in late December 2012 (go.nmc.org/chiki) from its share of 86% of all tablet traffic. This decline is the result of emergent new competitors in the tablet scene, including the Kindle Fire, Samsung Galaxy, Google Nexus, and the Microsoft Surface — all of which enjoyed increased web traffic shares at the end of the year. Nexus traffic saw a 135% increase in July 2012

alone. Consumers now have a growing array of choices in the tablet market, though the iPad still sets the pace for the category, and continues to hold its solid position at the top.

Mobile apps continue to push the capabilities of these devices, and hundreds of thousands of specialized apps are available to extend the functionality of tablets, integrating features including location awareness, network connections, and other built-in sensors, such as accelerometers. The larger screen real estate allows for more detailed interfaces or viewing area than smartphones. Apps range from games to banking services that allow users to check their credit card balances to science and art apps that enable users to explore outer space, the Louvre, and many other places that they may not ever get to see in person in their lifetimes. It is this transformative nature of apps that has helped tablets become popular and powerful tools in higher education.

It is increasingly clear that tablets are not a new kind of lightweight laptop, but rather a completely new technology.

Extremely portable, tablets have become significant distribution points for magazines and e-books, with major retailers including Amazon revealing that their e-books outperform their print books. In December 2012, *Newsweek* ended 80 years as a print publication, and went completely digital, largely as a result of the compelling experience that tablet devices bring to the magazine and periodical market.

Screen resolution in tablets improved significantly in the last year, and ultra-high resolution displays such as Apple's Retina Display and Nexus' high-resolution display are more common. As a result, any app using rich media has benefited. High-definition video is the norm, and video providers have stepped up with myriad ways to access live and archived video content. Real-time two-way video calls, pioneered with FaceTime, are now common. Cameras have added capabilities, sharper images, and higher resolution — and social media enhancements have made sharing video and pictures very simple. Fast, easy email, web browsers, and rich, full-featured game platforms are all everyday tools on the new devices. It is increasingly clear that tablets are not a new kind of lightweight laptop, but rather a completely new technology.

Relevance for Teaching, Learning, or Creative Inquiry

The rising popularity of tablets in higher education is partly the product of campuses across the world embracing the BYOD (bring your own device) movement. It is so easy for students to carry tablets from class to class, using them to seamlessly access their textbooks and other course materials as needed, that schools and universities are rethinking the need for computer labs, or even personal laptops. A student's choice of apps for his or her tablet makes it easy to build a personalized learning environment, with all the resources, tools, and other materials they need on a single device, and with most tablets, the Internet is woven into almost every aspect of it.

Productivity apps, including Cheddar, TagMyDoc, Dropbox and many more (go.nmc.org/wiwip) enable learners to take and share notes, create to-do lists, store all of their files, and organize their academic schedules. The advent of services such as iBooks Author is also helping universities formulate strategies for textbooks and reading assignments. The Learning Studio at Abilene Christian University, for example, worked with key faculty to develop prototypes of learning resources in iBooks Author. The process helped identify strategic opportunities in multi-touch books as next-generation textbooks (go.nmc.org/aculs).

In higher education, it is now a bit of an anomaly for a university to be without its own branded tablet app that integrates features like campus maps, access to grades, university news, and more. Having an app in the iTunes and Android marketplace has become essential to the recruiting process, to better orient students

to their surroundings, and alert them to campus opportunities. Some universities, such as Missouri State, have incorporated their iTunes U catalogs in the app, making it easy to download video lectures and other course materials on-the-go. As tablets face imminent widespread adoption, higher education institutions are equipping students with the skills to develop content for them. Carnegie Mellon University, for example, now offers a course on the art of iPad programming (go.nmc.org/icmu).

Mobile apps are also tightly integrated with social networks, making tablets effective tools for collaborating and sharing. Many note-taking and annotation apps enable users to immediately email content to peers or post insights to their social networks. Students who use Evernote, for example, can share digital notebooks and see each other's text, picture, or video updates in real-time (go.nmc.org/ever). An increasing number of educators are also turning to Edmodo's app (go.nmc.org/edmodo) to communicate with students about assignments and schedule updates.

Because of their portability, large display, and touchscreen, tablets are also ideal devices for fieldwork. Many institutions are relying on handheld computers in place of cumbersome laboratory equipment, video equipment, and various other expensive tools that are not nearly as portable or as inexpensive to replace. At the College of Wooster in Ohio, geology students are using iPads to take and annotate photos of Icelandic terrain (go.nmc.org/woost), and similarly, earth science students at Redlands College in Australia are using them to collect and share data on indigenous rocks (go.nmc.org/redla). In these scenarios, the immediate access to recording and analytical tools enables direct and active learning in the field.

In the past two years, more colleges and universities have launched one-to-one pilot programs in which they have provided every student on campus (or those enrolled in a specific program) with their own tablet. Each tablet comes pre-loaded with course materials, digital textbooks, and other helpful resources. The Geisel School of Medicine at Dartmouth College, for example, has adopted this type of program with iPads and is sharing their findings and resources as they go, via a special website (go.nmc.org/geisel).

Where one-to-one learning is not yet possible, many institutions, including the Community College of Aurora in Colorado, the University of Richmond, and the University of South Carolina, have also made tablets available via check-out systems to students who may not have one, in which students can borrow tablets to do coursework that is specifically designed to be completed with the devices.

With their growing number of features, tablets give traction to other educational technologies — from facilitating the real-time data mining needed to support learning analytics to offering a plethora of game-based learning apps. Transitioning to tablets is relatively painless for students as they already use them or very similar devices outside of the classroom to download apps, connect to their social networks, and surf the web. To maximize the potential of tablets in higher education, faculty members are also exploring creative ways to incorporate them into coursework.

A sampling of tablet computing applications across disciplines includes the following:

> **Art.** At Plymouth University in the UK, students working toward their Illustration degree are using the iPad and an illustration app called Brushes to produce drawings that can be played back as video. This activity is encouraging reflection and discussion on the drawing process and enabling students to contrast technique and highlight and correct any bad habits: go.nmc.org/ipa.

> **Biology.** In a pilot program at Yale University's Department of Molecular, Cellular, and Developmental Biology, instructors are sharing images from their digital microscopes with students' iPads through a mobile app. By connecting microscope with tablet, students are able to annotate images and capture them for future use: go.nmc.org/yavis.

> **Journalism and Mass Communications.** Professor Messner at Virginia Commonwealth University

secured iPads for his students so they could create multimedia news stories from happenings on the campus and surrounding community. The students learned the importance of social media in journalism and found the iPad useful for gathering news and sources: go.nmc.org/jou.

> **Special Needs.** Vanderbilt University graduate students are designing an Android app that enables visually impaired students to learn math. Using haptic technology integrated into new touchscreen devices, the vibrations and audio feedback help students feel and hear shapes and diagrams: go.nmc.org/hapt.

Tablet Computing in Practice

The following links provide examples of tablet computing in use in higher education settings:

Chinese Language Classes Experiment with iPads
go.nmc.org/chilang
Students studying introductory Chinese at Northwestern University are supplementing their course material with iPad apps, which are enabling them to look up word definitions and hear their own pronunciations juxtaposed with those of native speakers, as well as help them learn how to correctly write characters by tracing the order of strokes directly on the device.

MobiLearn
go.nmc.org/mobilearn
At HAMK University of Applied Sciences in Finland educators initiated the MobiLearn project to develop creative ways for integrating mobile devices into the curriculum. They are currently piloting Samsung Galaxy tablets and have cited that the devices work well for creating and sharing documents.

Samsung Galaxy Tablets at Lavington Primary School
go.nmc.org/lavington
Samsung is piloting a program called "Smart School" at Lavington Primary School in Africa in which classrooms are equipped with Galaxy Tablets. So far, teachers have noted that the devices have made learning experiences more personalized and interactive.

Seton Hall University and Samsung Windows 8 Tablet
go.nmc.org/epir
Seton Hall University recently became the first university in the US to adopt Windows 8 PC tablets. By having a combination of tablet mobility with the functionality of a computer, the university believes they are enabling quicker access to information, deeper engagement, and greater flexibility.

Stanford University's iPad Implementation
go.nmc.org/suin
The Stanford University School of Medicine distributed iPads to incoming students and studied their use in classrooms and laboratories. They found the tablets were favored over laptops for note taking and especially effective in quickly accessing reference materials and educating patients in clinical settings.

Tablets at Amrita University
go.nmc.org/amrita
Amrita University students and teachers are using a $35 tablet called Aakash — a low-cost alternative to other mobile devices. Their ongoing research is focused on developing responsive UI-based content for tablets that integrates with their formative assessment process and e-learning environments.

UWS Deploys iPads to Support IT-Enhanced Learning
go.nmc.org/uwsip
The University of Western Sydney (UWS) announced that 11,000 incoming students and staff members would be receiving iPads as part of a comprehensive curriculum renewal strategy. UWS is moving to a blended learning environment for all degrees beginning in 2013 and believes tablets are an important tool to support this new learning and teaching model.

For Further Reading

The following articles and resources are recommended for those who wish to learn more about tablet computing:

Given Tablets but No Teachers, Ethiopian Children Teach Themselves
go.nmc.org/eth
(David Talbot, *Forbes*, 29 October 2012.) Kids in two remote Ethiopian villages responded with surprising

aptitude when tablet computers were dropped off, all boxed up, with no instruction as to how they worked. The children quickly taught themselves to use the devices and were soon even hacking settings to personalize the devices.

Google Wages War with Apple and the Rest of the Tablet Industry, Unleashes Impressive Nexus 7+Mobile

go.nmc.org/warapp

(Drew Olanoff, *TechCrunch*, 13 November 2012.) The author of this article reviews the recent mobile upgrade of the Google tablet line from Nexus and claims that Apple now has serious competition in the tablet market. Notable differences are the device's voice command feature, Google Now, and advanced mapping technology of Google Maps.

How a Classroom of iPads Changed My Approach to Learning

go.nmc.org/redu

(Chris Blundell, *Edudemic*, 3 October 2012.) One-to-one deployment of iPads at Redlands College has abandoned the computing model of labs and laptop trolleys, creating a paradigm shift where students can learn anywhere and at anytime. The college's IT staff reported that this new approach has been saving them time and effort managing software because of the ease of installation and maintenance.

Tablets are Changing the Tech You Use, Whether You Own One or Not

go.nmc.org/tabchan

(Louie Herr, *Digital Trends*, 9 September 2012.) The author of this article argues that the release of tablets into the market has disrupted software and hardware trends. He explains the decline of netbooks and flash and the subsequent rise of HTML5 and cloud storage as the indicators of how tablets are shaping the way we engage with computer technology.

Teaching with Tablets

go.nmc.org/teachw

(Staff Writers, *Online Universities*, 21 August 2012.) This infographic shows the distribution of tablet ownership across multiple platforms, each device's specific features, and owners' opinions of their effectiveness in educational settings. It further explains the tablet's relevance for college students and quantifies Apple's current impact on education.

Why Tablets are the Future of Electronic Medical Records

go.nmc.org/emr

(Richard MacManus, *readwrite*, 27 September 2012.) Tablets equipped with Electronic Medical Records (EMR) mobile applications are enabling more efficient interactions between physicians and patients. The study of small to medium size practices, conducted by EMR vendor drchrono, found that over 60 minutes per day were saved using iPad-equipped EMRs.